Chapter 9

Wrong Blood Type: Transfusion Reaction

Holly Ringhauser and James Cipolla

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.69653

Abstract

Blood products are frequently required in an inpatient setting for a number of serious conditions. It is of the utmost importance that providers are aware of the potential for adverse reactions and human error when ordering or administering these products. Patients who require blood products should have a signed informed consent form and a type and screen performed prior to transfusion. The patient's identity should be confirmed using two patient identifiers. There are two major categories for blood transfusion reactions, immune-mediated and nonimmune-mediated. Common manifestations of a transfusion reaction are nonspecific and may be attributed to a patient's other medical problems, so the index of suspicion must be high in order to identify and treat these reactions.

Keywords: blood transfusion, adverse reaction(s), hemolysis, immune-mediated, safety

1. Introduction

A 28-year-old female is brought in by emergency medical services (EMS) following a motor vehicle collision in which she was the restrained driver. Her initial vital signs include a heart rate of 100 BPM, blood pressure of 90/68 mmHg, respiratory rate of 18/min, pulse ox of 96% on room air, and an oral temperature of 98°F. She complains of abdominal pain, especially in the left upper quadrant. Chest and pelvic X-rays are negative for acute traumatic injuries, and her FAST exam is positive. The patient's blood pressure drops to 76/50 mmHg and she is found to have a point-of-care hemoglobin of 5.8 g/dL. A massive transfusion protocol is started and she is given 2U packed red blood (PRBCs) and 1U of platelets. She is rushed to the operating room, and while she is being prepped for an exploratory laparotomy, she is found to have a temperature of 101.8°F and has dark urine draining from her Foley catheter. The operating room nurse is concerned about an acute transfusion reaction, and the blood transfusion is immediately stopped.

Whole blood, platelets, or plasma are collected from volunteer donors after a careful prescreening process. The prescreening process identifies volunteers with high-risk behavior, who use or have used certain medications, or who have recently traveled to areas affected by endemic diseases which may affect donated blood products. Following donation, these products are then screened by the blood bank for a battery of infectious diseases, undergo typing, and are stored until needed for patient use. Whole blood is separated into components, making it easy to transfuse only what a patient requires rather than whole blood. Packed red blood cells (PRBCs), platelets, fresh frozen plasma (FFP), and cryoprecipitate are the main blood components available in the USA, as well as individual clotting factors for specific disorders (for example, hemophilia A and B). In massive transfusion protocols, PRBCs, platelets, and FFP are given in a 1:1:1 ratio known as balanced resuscitation, which is close to giving the patient whole blood. There are many factors to take into consideration before deciding to transfuse a patient, which are outside the scope of this chapter.

Patients who require blood products should have a signed informed consent form and a type and screen performed prior to transfusion, whenever possible. If the patient is unstable and requires emergent uncrossmatched blood, a type and screen should still be sent for subsequent transfusions. A type and screen will indicate the patient's blood type (ABO and Rh status), whereas a type and cross tests a particular blood product against the patient's blood to confirm that they are compatible. If the patient has a previous type and screen on file with the blood bank, it should be the same ABO and Rh type as the current sample; otherwise, the suspicion for a mislabeled blood specimen should be high.

The patient's identity should be confirmed using two patient identifiers. Appropriate identifiers include the patient's name, date of birth, hospital identification number, or medical record number. Room number should never be used to identify a patient. Prior to administering blood products, two providers (usually RNs) should confirm the quantity and type of product, the ABO and Rh type, and the serial number of the product. Many centers have instituted a checklist to ensure compliance with each of these steps.

There are four major blood groups, A, B, AB, and O. These indicate the types of antigens present on the surface of the RBCs. A patient's immune system produces antibodies to the ABO antigens that are not present (**Table 1**) [1].

A second major surface antigen is the Rhesus factor or Rh factor. Administration of Rh+ blood to a patient who is Rh− typically causes little to no adverse reactions in a healthy adult. However, in women of childbearing age, it is a concern because the fetus and mother can

	A	**B**	**AB**	**O**
Antigens present	A antigen	B antigen	A and B antigens	None
Antibodies present	Anti-B	Anti-A	None	Anti-A and Anti-B
Blood products they can receive	A, O	B, O	AB, A, O Universal recipient	O Universal donor

Table 1. ABO blood types.

have a different Rh status. If an Rh− mother is pregnant with an Rh+ fetus and is exposed to their blood (i.e., trauma, gynecologic procedures, etc.), she will develop anti-Rh antibodies that can cross the placenta. This will likely not affect the current pregnancy, but subsequent pregnancies with Rh+ fetuses are at risk for developing complications such as jaundice or hydrops fetalis [2]. This process can be prevented by administering rho(d) immune globulin to the mother when there is a concern or high risk for feto-maternal hemorrhage, even in small quantities.

There are two major categories for blood transfusion reactions: immune-mediated and non-immune-mediated. Immune-mediated reactions include all cellular and humoral responses to blood products, while nonimmune-mediated reactions include volume overload, electrolyte abnormalities, and hypothermia, among others [3]. Common manifestations of a transfusion reaction are nonspecific and may be attributed to patient's other medical problems. Signs and symptoms include fever, chills, back or flank pain, or changes in vital signs (specifically, blood pressure and heart rate).

An acute hemolytic reaction is an immune-mediated event, which typically occurs within the first 24 hours of a transfusion [4, 5]. It is due to ABO incompatibility and is most commonly due to human error. Antigen-antibody complexes form between donor and patient blood, leading to complement fixation and catastrophic intravascular hemolysis, which in turn can lead to shock, renal failure, and potentially death [6].

Delayed hemolytic reactions can occur days or even weeks after a blood transfusion and are caused by previously formed antibodies in the patient, which react with antigens on the surface of the donor cells [4, 5]. These are not ABO incompatibility reactions but are instead caused by minor antigen incompatibility. These reactions are difficult to diagnose due to their nonspecific symptoms and delayed onset after a transfusion. They are more common in patients who have undergone multiple transfusions in the past.

Febrile nonhemolytic reactions are also immune-mediated but do not result in the destruction of RBCs. These reactions are defined as an elevation in patient temperature of 1°C or more either during or following a transfusion, which is not explained by the patient's other medical issues [6]. A transfusion should be immediately stopped once there is a concern for a febrile reaction, and the remaining blood products and IV tubing should be returned to the blood bank to rule out acute hemolysis or bacterial contamination. If these tests are negative, a febrile nonhemolytic reaction can be diagnosed. These reactions can be caused by inflammatory cytokines or pyrogens in donor products or by preformed patient cytokines/pyrogens. A majority of patients who are diagnosed with this type of reaction will not have subsequent reactions in the future; however, if a second reaction does occur, the patient should then only be given leukocyte-reduced products and may benefit from receiving antipyretics prior to transfusion [6].

Posttransfusion purpura is an immune-mediated reaction to blood products which results in severe thrombocytopenia. This is a rare disorder caused by alloantibodies against a platelet antigen and is characterized as a precipitous drop in platelets approximately 1 week after blood product administration. Signs and symptoms include purpura, gastrointestinal (GI) bleeding, gross hematuria, or excessive wound bleeding. Treatment includes administration of corticosteroids and IV immunoglobulin or plasmapheresis.

There are two immune-mediated allergic processes associated with transfusion reactions, which are urticarial and anaphylactic reactions. Urticarial reactions are immunoglobulin E (IgE)-mediated and consist of GI distress (nausea and vomiting, abdominal cramping, and diarrhea) and mild upper respiratory symptoms such as rhinorrhea. Treatment consists primarily of antihistamines. Anaphylactic reactions are IgA mediated and begin within seconds to minutes of the start of transfusion. These reactions include a sudden-onset cough, bronchospasm/laryngospasm, angioedema, severe hypotension, shock, or death. These reactions occur primarily in patients with selective IgA deficiency but can also occur in patients with antibodies to other donor plasma proteins. Treatment includes immediately stopping the transfusion, securing the airway (including intubation, if needed), and giving epinephrine, corticosteroids, and antihistamines [6].

Transfusion-associated acute lung injury (TRALI) is an immune-mediated transfusion reaction, which manifests as an inflammatory lung injury within the first 6 hours of transfusion. It is due to donor granulocyte-induced acute respiratory distress syndrome (ARDS). The chest X-ray findings are the same as in other causes of ARDS, namely, diffuse bilateral pulmonary infiltrates, and the treatment is the same (lung protective ventilation strategies and supportive care). TRALI is the leading cause of death due to blood transfusion reactions but is still relatively low around 10% [6].

Graft-versus-host disease can be seen in severely immunocompromised patients who receive blood products. It is an immune-mediated transfusion reaction caused by donor T lymphocytes, which attack patient human leukocyte antigen (HLA) antigens. Signs and symptoms include rash, elevated liver function test (LFTs), diarrhea, and bone marrow suppression and typically develop a week or more after transfusion. Treatment consists of supportive care, and prevention can be accomplished by giving irradiated PRBC or platelet transfusions to at-risk patients [8]. FFP and cryoprecipitate do not have to be irradiated; however, as this is a lymphocyte-mediated reaction and these products do not contain lymphocytes.

In addition to immune-mediated transfusion reactions, there are a number of nonimmune transfusion reactions which can occur, including transfusion-associated circulatory overload (TACO), nonimmune hemolysis, hypothermia, electrolyte abnormalities, and infectious diseases.

Transfusion-associated circulatory overload (TACO) is a nonimmune mediated transfusion reaction which is often confused with TRALI. Similar to TRALI, it also presents with respiratory distress following transfusion, but unlike TRALI, it is a type of acute cardiogenic pulmonary edema [7]. Several clinical features can separate this from TRALI such as elevated brain natriuretic peptide (BNP) and central venous pressure (CVP) and it is generally improved with diuresis. Patients with a history of heart failure, kidney insufficiency or failure, poor nutrition (leading to decreased intravascular oncotic pressure due to low albumin), and patients at extremes of age (pediatric and elderly patients) are at an increased risk of TACO [9]. Treatment consists of supportive care and diuresis, and prevention includes slower rates of infusion or infusing blood products in aliquots rather than whole units.

Nonimmune hemolytic transfusion reactions are due to red cell destruction by transfusing PRBCs at the same time as hypertonic or hypotonic IV fluids or medications, by thermal damage

from warmers or freezers or mechanical damage from cardiopulmonary bypass pumps, extracorporeal membranous oxygenation pumps, or continuous renal replacement therapy [9].

Other considerations regarding adverse blood transfusion reactions include hypothermia, electrolyte abnormalities, and infectious diseases. Trauma patients or patients who are already hypothermic prior to transfusion should ideally receive blood via a warmer. Patients with renal disease or preexisting electrolyte abnormalities should be closely monitored for signs of hyperkalemia or hypocalcemia, including cardiac monitoring during and after transfusion. Although rare, bacterial, or viral contamination of blood products can occur. Proper collection, storage, and administration of blood products are keys in limiting bacterial contamination. All blood products undergo vigorous screening for viral diseases including hepatitis B and C, cytomegalovirus (CMV) and human T-cell lymphotropic virus type 1 (HTLV-1) prior to administration. The overall incidence of blood-borne pathogen transmission during transfusion is low [9].

Once an adverse reaction has been identified, the following actions should be performed:

a. Immediate cessation of blood administration.

b. Transfer blood product(s) and tubing back to the blood bank for analysis. Attach new IV tubing that has been primed with saline.

c. Recheck the patient's identity via their hospital assigned ID number, patient wristband, etc. as well as all blood products.

d. Notify the blood bank immediately. In some hospitals, it may also be necessary to directly notify the pathologist on call as they will be evaluating the patient's posttransfusion blood work.

e. Transfusion reaction orders include repeat type and screen, Coombs' testing (direct antiglobulin), and plasma and urinalysis (in some cases, to check for hemolysis). Other tests that may be considered include a complete blood count, peripheral blood smear, bilirubin, serum haptoglobin, and lactate dehydrogenase (LDH), all of which can indicate hemolysis.

f. Specific therapies geared toward each type of transfusion reaction (diuretics, antihistamines, etc.).

g. Inform the patient of the error. Being honest with patients regarding medical errors is of the utmost importance and should be done promptly.

The patient was found to be blood type O-positive, but an error in the blood bank caused a unit of A-negative blood to be incorporated into the trauma blood container. She was aggressively resuscitated with IV crystalloid to maintain a urine output of at least 100 mL/hr and was found to have a grade IV splenic laceration. She had an emergent splenectomy performed and was subsequently given three additional units of O-positive blood. Postoperatively, she was found to have elevated blood urea nitrogen (BUN) and creatinine (indicating acute kidney injury), elevated indirect bilirubin, elevated serum LDH, and hemoglobinuria (indicating acute hemolysis), and persistent anemia (likely a combination of acute blood loss and

hemolysis). She required intubation and supportive care for 6 days postoperatively and was started on a course of plasmapheresis to remove any A antigen- anti-A antibody complexes that may still have been circulating in her blood stream. Additionally, she required several weeks of renal replacement therapy until her renal function recovered. She was ultimately discharged from the hospital with no long-term sequelae.

2. Analysis of errors

a. The initial type and screen for the patient was waived prior to the first unit being administered because of her hemodynamic instability. In unstable patients with acute blood loss, it is appropriate to give O-negative blood (to women of childbearing age) or O-positive blood (to all other patients).

b. Blood bank crossmatching was also waived prior to administration of the first unit of blood given the patient's mechanism of injury (major trauma) and hemodynamic instability. In most major trauma centers, a cooler of "trauma blood" arrives in the trauma bay for all of the highest level activation trauma patients. This cooler contains uncrossmatched packed red blood cells. This is also the case in massive transfusion protocols. The utmost level of care must be taken by blood bank staff to ensure that only O-negative or positive blood goes into uncrossmatched containers to avoid an ABO incompatibility reaction.

c. The provider who is administering the blood transfusion must check the patient's hospital-issued wristband and identification number against the information listed on each blood product prior to administration. Many hospitals also require a second provider to verify this information to avoid errors.

d. The patient should be reassessed and vital signs documented 15 minutes into a transfusion to ensure that they are not becoming febrile, hemodynamically unstable, or have complaints of itching, flank pain, chills, or other signs and symptoms concerning for a blood transfusion reaction.

e. If a transfusion reaction is suspected, the blood products should be stopped immediately and appropriate actions should be taken to identify and treat the reaction.

Author details

Holly Ringhauser and James Cipolla*

*Address all correspondence to: james.cipolla@sluhn.org

Department of Trauma and Surgical Critical Care, St. Luke's University Hospital, Bethlehem, PA, USA

References

[1] Dean L. Blood Groups and Red Cell Antigens [Internet]. Blood Transfusions and the Immune System. Chapter 3. Bethesda (MD): National Center for Biotechnology Information (US); 2005. Available from: https://www.ncbi.nlm.nih.gov/books/NBK2265/

[2] Dean L. Blood Groups and Red Cell Antigens [Internet]. The Rh blood group. Chapter 7. Bethesda (MD): National Center for Biotechnology Information (US); 2005. Available from: https://www.ncbi.nlm.nih.gov/books/NBK2269/

[3] The Department of Clinical Service, Research, and Teaching, University of Michigan at Ann Arbor. Chapter 7. Adverse Reactions to Transfusion. (n.d.). Available from: https://www.pathology.med.umich.edu/bloodbank/manual/bbch_7/ [Accessed: November 28, 2016]

[4] Sandler SG.. Transfusion Reactions. 2016. Available from: http://emedicine.medscape.com/article/206885-overview [Accessed: November 28, 2016]

[5] Marx, JA, Hockberger RS, Walls RM, Adams J. Blood and blood components. In: Rosen's Emergency Medicine: Concepts and Clinical Practice. Chapter 7. St. Louis: Mosby; 2002

[6] Marino PL, Sutin KM. Anemia and red blood cell transfusions in the ICU. In: The ICU Book. Chapter 36. Philadelphia: Lippincott Williams & Wilkins; 2007

[7] Criner, GJ, Barnette RE, D'Alonzo GE. Use of blood components. In: Critical Care Study Guide: Text and Review. Chapter 55. New York: Springer: 2010

[8] Thomas K, MD, FCCP. Anemia and RBC transfusion in the ICU. In: ACCP Critical Care Medicine Board Review. Northbrook, IL: American College of Chest Physicians; 2012

[9] Ogedegbe H O. A review of non-immune mediated transfusion reactions. Laboratory Medicine. 2002;**33**(5):380-385. DOI:10.1309/uyey-2cch-cump-ekrt

IntechOpen