



Blood Products Are True Life-Savers: A Case Study

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Annie is an 8-year-old with a 2-week history of abnormal bruising. She was referred by her primary pediatrician to a pediatric oncology service and admitted. Upon initial examination, she had bruises scattered over her lower extremities. Laboratory findings were remarkable for a white blood cell (WBC) count of 2200 μL and an absolute neutrophil count of 572 $/\text{mm}^3$, hemoglobin of 7.4 g/dL, and platelets of 19,000 μL . The smear showed questionable blasts. Annie's chemistries were within normal limits, but her coagulations were abnormal with a prothrombin time of 17.4 sec, partial thromboplastin time of 48 sec, fibrinogen of 90 mg/dL, and fibrin degradation products (FDP) > 40 μL (Klee, 1995). A bone marrow was performed secondary to pancytopenia and demonstrated blasts and a marrow indicative of acute promyelocytic leukemia (APML). Her cytogenetics showed the classic 15:17 translocation of APML, which was hypothesized based on Annie's presentation with disseminated intravascular coagulation (DIC). During initial diagnosis she received several blood products that included packed red blood cells (PRBCs), platelets, fresh frozen plasma (FFP), and cryoprecipitate. Her treatment regimen included all-trans-retinoic acid, intrathecal cytarabine, daunomycin, and high-dose cytarabine. Her treatment course was complicated 2 weeks after initiation of chemotherapy by fevers of unknown origin and low blood counts.

Why Did Annie Present with Pancytopenia?

Malignant cells, called blasts, are immature white cells that fail to mature. These defective blast cells then accumulate and proliferate in an abnormal, uncontrolled, and destructive manner, crowding out and inhibiting the production of normal cells in the bone marrow, such as white blood cells (WBCs), red blood cells (RBCs), and platelets. Annie's presenting signs and symptoms upon initial diagnosis for leukemia are a result of the lack of mature and functional WBCs, RBCs, and platelets (Kline, 2004).

Table 1. Blood Products

Blood Product	Indications/Important Points/Outcomes
Packed Red Blood Cells (RBCs)	<ul style="list-style-type: none"> Restores RBCs (improving oxygenation, and anemia) and volume when massive blood loss has occurred. Hemoglobin < 7 g/dL or if patient is symptomatic or in shock for volume replacement (may vary). 10 ml/kg of PRBCs will raise the hemoglobin level by 2.5–3 g/dL Amount of PRBCs: <ul style="list-style-type: none"> oncology patients = 10–15 ml/kg sickle cell patients @ 10 ml/kg Donor and recipient must be ABO/Rh identical and compatible.
Platelets	<ul style="list-style-type: none"> Treatment of thrombocytopenia and platelet function abnormalities. Cellular component of blood. Indicated for <ul style="list-style-type: none"> bleeding platelet count < 10,000 cells/mm^3 or 50,000 cells/mm^3 (brain tumors) invasive procedures Cross-matching is not required, but ABO/Rh identical and compatible platelets are preferred. Random donor platelets <ul style="list-style-type: none"> Pools of platelet concentrates from different donors made from whole blood collection. Single donor platelets <ul style="list-style-type: none"> Platelets collected from single donor using apheresis techniques reducing number of donor exposures and risk of alloimmunization. 1 unit of platelets should raise the platelet count by 10,000 cells/mm^3 (varies depending on weight).
Fresh Frozen Plasma (FFP)	<ul style="list-style-type: none"> Liquid portion of blood that remains after coagulation has taken place and when RBCs are removed from whole blood. Used to replace coagulation factors in bleeding patients with multiple coagulation factor deficiencies as a result of liver disease, DIC, or dilutional coagulopathy (i.e., massive blood replacement). Based on prolonged PT (> 17–18 seconds) and PTT (> 55–60 seconds) levels. Cross-matching is not required, but donor and recipient must be ABO/Rh identical/compatible.
Cryoprecipitate	<ul style="list-style-type: none"> Replaces fibrinogen deficiencies. Indicated for fibrinogen levels less than 150 mg/dL. Cross-matching is not required.
Granulocytes (WBCs)	<ul style="list-style-type: none"> Indicated for severe and persistent neutropenia with infection in patients unresponsive to standard therapy (i.e., antibiotics, IVIG, growth factors). Often used if suspected or documented fungal infection not responsive to conventional therapy. Treatment = 1 unit/day for 4–5 days. Must be ABO/Rh compatible.
Albumin	<ul style="list-style-type: none"> Albumin provides volume expansion in situations in which crystalloid solutions are not adequate such as shock and massive hemorrhage. Indicated for low albumin levels and hypoproteinemia. Albumin available as 5% or 25% solution No ABO blood group antibodies present; compatibility is not a factor.

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Table 2. Blood Product Compatibilities

Blood Group	Compatible RBCs	Compatible Plasma
O	O	O, A, B, AB
A	A, O	A, AB
B	B, O	B, AB
AB	AB, A, B, O	AB
Rh type	RBC Rh type	Plasma Rh type for transfusion
Positive (+)	Positive (+) or negative (-)	Positive (+) or negative (-)
Negative (-)	Negative (-)	Positive (+) or negative (-)

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What Are Blood Components?

Blood is a living tissue comprising cells suspended in a water fluid called *plasma*. Blood components (WBCs, RBCs, platelets, cryoprecipitate, and FFP) are portions of a unit of blood that can be used for different patient needs (American Association of Blood Banks [AABB], 2004). See Table 1 for indications, important points, and outcomes for the major types of blood products.

Why Did Annie Receive so Many Blood Products?

Annie was anemic and thrombocytopenic, and in DIC, which occurs in virtually all patients with APML. The leukemic promyelocytes contain procoagulants that can trigger DIC, as well as fibrinolytic activators. The cell lysis that results from conventional chemotherapy releases these enzymes and can exacerbate the coagulopathy (Norville & Bryant, 2002). Based on Annie's initial presentation and her diagnosis of APML, several blood products were required to get her out of this emergent crisis at diagnosis.

What Do ABO Identical and Rh Compatible Mean?

Blood is typed according to antigens carried on the RBCs and antibodies in the serum. The four major blood types are A, B, AB, and O. Rh typing determines whether the Rh factor, Rh0(D), is present (Rh-positive) or absent (Rh-negative) on the RBCs.

- Type O (universal donor)—no antigens; anti-A and anti-B antibodies
- Type A—A antigens; anti-B antibodies
- Type B—B antigens; anti-A antibodies
- Type AB (universal recipient)—no antibodies; A and B antigens
- Rh positive—carries the D antigen
- Rh negative—lacks the D antigen.

See Table 2 for blood product compati-

bilities and Table 1 for specific blood component crossmatching and compatibility requirements. It is essential that the clinician ensures blood product compatibilities before administration. Annie required several blood products during her initial diagnosis. Before any blood product was administered and to ensure the safety of Annie, the blood bank, as well as the clinicians, ensured proper ABO/Rh crossmatching and compatibility.

Why Are Blood Products for Oncology Patients Leukocyte-Reduced and Irradiated?

The indications for leukocyte-reduced blood components include the need to decrease the recurrence of anaphylactic, febrile, and nonhemolytic transfusion reactions caused by donor white cell antigens reacting with recipient white cell antibodies. Leukoreduction also minimizes and prevents cytomegalovirus transmission and decreases the risk of human leukocyte antigen alloimmunization in oncology patients undergoing long-term treatment (AABB, 2004; Corwin & AuBuchon, 1993; Norville & Bryant, 2002).

The indications for irradiated (i.e., exposed to a measured amount of radiation) blood components include the need to prevent the proliferation of transfused T-lymphocytes capable of replication and to reduce posttransfusion graft versus host disease in patients receiving blood components (AABB, 2004; Norville & Bryant, 2002). Annie received PRBCs, platelets, FFP, and cryoprecipitate. Irradiation and leukoreduction is indicated for oncology or stem-cell-transplant patients receiving PRBCs and platelets. Irradiation and leukoreduction are not indicated for FFP or cryoprecipitate because these components contain fewer or no viable white cells.

What Safety Steps Need to Be Implemented Before Annie Receives a Blood Product?

The AABB requires that an informed consent form be signed prior to the administration of RBCs, platelets, FFP, cryoprecipitate, and some factor products. Consent is recommended for immune globulins and albumin. In addition, Annie must have a physician's order for the blood product. The order must include the blood product type, amount and rate, any premedications, special processing, and indication. Type and crossmatch specimen must be drawn from Annie, labeled at the bedside, and verified against the patient identification band using two patient identifiers such as the patient's name, medical record number, or date of birth. The blood specimen must include Annie's patient label with date, time, and the blood drawer's initials. The specimen is then sent to the blood bank for crossmatching. The nurse should review Annie's transfusion history and determine the need for premedications. Premedications may be required if the patient has a history of reaction to blood products, such as hives, fever, or chills.

After Annie's blood product is ready and sent to her unit, careful checking of the blood product must be done. Two qualified clinicians (i.e., registered nurse, physician, advanced practice nurse) are needed to check the blood product prior to infusion at the bedside before administration. Information on the blood bank order and requisition must match the information on the label attached to the blood product and Annie's identification band. The check must include the patient's name, identification number, the type of blood product ordered, the patient's blood type, the donor's blood type, verification of ABO/Rh compatibility, any required processing (i.e., irradiation), expiration date of the blood product, and blood product unit identification number. All these double checks must be documented by the two clinicians on the appropriate unit-based records.

What Are the Nursing Considerations in Administering Annie's Blood Product?

Table 3 highlights important nursing considerations of blood product administration. Please refer to your institution's specific policies for blood product administration. Prior to any blood product

Table 3. Nursing Considerations of Blood Product Administration

Blood Product	Nursing Considerations
Packed Red Blood Cells	<ul style="list-style-type: none"> • Must be started within 30 min after removal from blood bank. • Infusion must be complete within 4 hr of initiation. • Usual transfusion rates = 2–5 ml/kg/hr (start slowly). Example: 2.5 ml/kg/hr for the first 15 min, then if tolerated 5.0 ml/kg/hr for the remainder of the infusion with a maximum rate of 250 ml/hr. • Obtain vital signs at baseline, at the 15-min mark (before the rate increase), and then hourly until infusion complete; repeat with each new unit.
Platelets	<ul style="list-style-type: none"> • Administer by gravity or as fast as the patient can tolerate • Infuse over 1 hr (maximum of 4 hr) at 30 ml/kg/hr (maximum rate) • Obtain vital signs at baseline, at the 15-min mark, end of infusion, and 30 min post-transfusion.
Fresh Frozen Plasma	<ul style="list-style-type: none"> • Infuse within 4 hr; 1 hr preferred at a maximum rate of 0.5ml/kg/min. • Obtain vital signs at baseline, every 30 min for the first hour, and every hour until complete; repeat with each new unit
Cryoprecipitate	<ul style="list-style-type: none"> • Transfuse within 6 hr of thawing • Administer slowly over 5–15 min • Obtain vital signs at baseline and end of infusion. • Use of same set for multiple bags.
Granulocytes (WBCs)	<ul style="list-style-type: none"> • Never use a leukocyte reduction filter. • Transfuse within 24 hr of collection (as soon as they are available as WBCs die quickly). • Usually infused over 2–4 hr (start at 1ml/kg/hr) • Obtain vital signs at baseline, every 15 min for the first hour, and then every 30 min until end of infusion. • Pre-medication with acetaminophen and diphenhydramine may be indicated to prevent reactions. • Watch patient closely for fever, chills, and urticaria. • Assess for acute pulmonary symptoms (occasional): dyspnea, development of infiltrates, chest tightness, and hypoxia. • <i>Do NOT administer Amphotericin B products within 4 hr of a granulocyte transfusion; concurrent or close administration has been associated with severe pulmonary reactions.</i>
Albumin	<ul style="list-style-type: none"> • Administer with nonfiltered IV tubing. • Obtain vital signs at baseline and end of infusion. • Average pediatric dose and administration times <ul style="list-style-type: none"> — Albumin 5% = 1g/kg = 20 ml/kg at 1 to 2 ml/min or faster if the patient is in shock — Albumin 25% = 1g/kg = 4ml/kg at 0.2 to 0.4 ml/min

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administration, it is important to address the patient's past transfusion history (if applicable) to determine any premedication needs. (Annie did not have a prior history of receiving blood products prior to her first transfusion.) Then obtain the patient's baseline vital signs including temperature, heart rate, respiratory rate, and blood pressure and assess lung status before transfusion of the blood product begins. The physician or advanced practice nurse should be notified before starting the transfusion if the patient has abnormal vital signs or wet lung sounds. The patient's intravenous line should be flushed with normal saline pre- and post-transfusion. According to the AABB, normal saline is the only medication

compatible with all blood products. Other medications/solutions have an unpredictable effect on the blood component and are not approved by the Food and Drug Administration. Use a 170–260 micron filter for Annie's blood product infusions (PRBCs, platelets, FFP, cryoprecipitate). Use of a filter during albumin transfusion is optional (see institution-specific guidelines). Monitor Annie's general condition throughout the transfusion, assessing for signs and symptoms of a transfusion reaction (see the following discussion on transfusion reactions). Obtain subsequent vital signs and assessments according to institution specific guidelines and type of blood product administration (Triulzi, 2002).

How Should Annie Be Monitored and Treated for a Possible Transfusion Reaction?

Assess Annie frequently, particularly during the first 10–15 critical minutes of her transfusion for any signs and symptoms of a transfusion reaction, as shown in Table 4. If a major ABO incompatibility exists or a severe reaction occurs, it usually happens within the first 50 ml of the transfusion. Annie and her caregivers should also be informed about signs and symptoms of a possible transfusion reaction and that any reaction should be reported to the nurse immediately.

The critical steps in the event of a possible reaction are as follows:

1. Stop Annie's blood product transfusion immediately, keeping the line open with normal saline.
2. Notify Annie's physician.
3. Administer medications as ordered and appropriate based on symptoms (i.e., acetaminophen, diphenhydramine, methylprednisolone, and epinephrine).
4. Check all labels, forms, and patient identification at the bedside to determine whether the transfused blood product was intended for Annie.
5. Report the suspected reaction to the blood bank and fill out required paperwork.
6. Obtain blood and urine samples from Annie, if required, and send samples to the blood bank with the discontinued blood bag, administration set, and all forms/labels.
7. Restart blood transfusion per physician approval only if Annie's reaction was hives (AABB, 2004; Triulzi 2002).

Conclusion

The requirements of blood transfusions have increased dramatically with more intensive treatment regimens, resulting in marrow suppression. Annie was in trouble upon her initial diagnosis and would have died without blood product support. Blood products save lives! At this time, Annie continues to do well; she has been off therapy for almost 6 years!

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Suggested Reading

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Table 4. Signs and Symptoms of Blood Product Transfusion Reactions

Complication	Signs/Symptoms
Hemolytic Reaction Incompatible Blood	<ul style="list-style-type: none"> • Chills/shaking • Fever • Pain • Nausea/vomiting • Chest tightness • Red/black urine • Headache • Flank pain • Shock/renal failure/DIC
Bacterial Sepsis	<ul style="list-style-type: none"> • Rigors/chills • Fever • Shock
Febrile Reactions <ul style="list-style-type: none"> • Leukocyte, platelet, or plasma protein antibodies • Cytokines 	<ul style="list-style-type: none"> • Fever • Chills
Transfusion-Related Acute Lung Injury	<ul style="list-style-type: none"> • Dyspnea • Pulmonary edema
Allergic Reactions <ul style="list-style-type: none"> • Recipient reacts to allergens in donor's blood 	<ul style="list-style-type: none"> • Urticaria • Flushing • Asthmatic wheezing • Laryngeal edema
Circulatory Overload <ul style="list-style-type: none"> • Too rapid transfusion • Excessive quantity of blood transfused 	<ul style="list-style-type: none"> • Dyspnea • Rhales • Cyanosis • Dry cough • Distended neck veins
Hypothermia	<ul style="list-style-type: none"> • Chills • Low temperature • Irregular heart rate • Possible cardiac arrest
Delayed Reactions	
Delayed Hemolytic Reaction	<ul style="list-style-type: none"> • Destruction of RBCs and fever 5-10 days after the transfusion
Iron Overload	<ul style="list-style-type: none"> • Increased iron levels
Transmission of Infection <ul style="list-style-type: none"> • Hepatitis • AIDS • Malaria • Syphilis • Bacteria • Viruses 	<ul style="list-style-type: none"> • Jaundice • Fever • Headache • Substernal pain • Hypotension • Flushing • Vomiting/Diarrhea
Alloimmunization (antibody formation) <ul style="list-style-type: none"> • Occurs in patients receiving multiple transfusions 	<ul style="list-style-type: none"> • Increased risk of hemolytic, febrile, and allergic reactions • Refractory to platelets

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