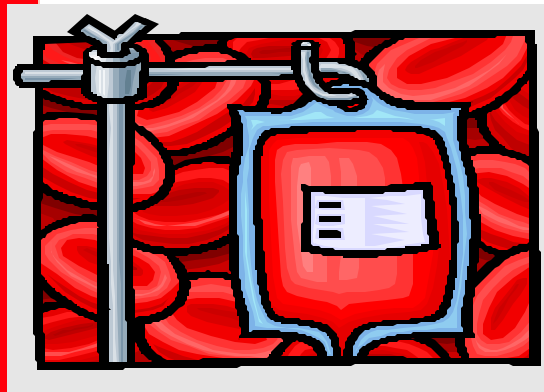


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Practice Guidelines for Blood Transfusion: A Compilation from Recent Peer-Reviewed Literature



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Developed by American Red Cross Biomedical Headquarters

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Users of this brochure should refer to the Circular of Information regarding the approved indications, contraindications and risks of transfusion, and for additional descriptions of blood components. Copies of the Circular of Information can be obtained from your American Red Cross region or through the American Association of Blood Banks (internet address <http://www.aabb.org>). The complete text of the side effects and hazards of blood transfusion from the current Circular of Information appears in an appendix at the end of this brochure.

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INTRODUCTION

The standards of the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) make specific mention of blood transfusion in a number of core functions essential to quality medical care. For example, the need for transfusion is considered one of the key parameters for determining the appropriateness of an operative procedure. An acute hemolytic transfusion reaction due to ABO incompatibility is specifically identified as a reviewable sentinel event for which a comprehensive analysis of cause, corrective action, preventive action and reporting are required. Blood transfusion is acknowledged to be a therapy that involves risks, so that the organization's performance monitoring and improvement program must address the use of blood and blood components. Furthermore, the medical staff is charged with the responsibility to take the leadership role in improving transfusion practice when indicated.

Successful performance of these functions requires that the medical staff agree to some set of practice guidelines for ordering blood transfusion. Ideally, practice guidelines would be grounded in well-designed clinical trials that clearly establish efficacy, and quantify risk, in at least the most common settings in which this therapy is applied. Unfortunately, there have been very few such studies performed, and transfusion practice remains largely based on expert advice, tradition, community practice, personal experience and, occasionally, a best guess. Surveys of blood usage for specific diagnoses confirm that this results in widely varying usage for comparable patients at different institutions. In some reviews, the identity of the ordering physician, and not any feature of the patient, diagnosis or treatment, emerges as the primary predictor of which types and how many units of blood components will be transfused.

INTRODUCTION (continued)

Given the known and hypothetical risks of transfusion, as well as the cost, liability and workload involved with this therapy, there are many reasons to move the basis of transfusion practice in a particular institution away from anecdotal experience and reasonable guesses, and toward expert advice and clinical evidence. This brochure is a compilation of blood usage guidelines from experts and expert panels, as well as the results of significant clinical transfusion trials, published in the English language in peer-reviewed journals since 1991. The authors, all of whom are physician staff for the American Red Cross, have made every attempt to fairly reproduce the advice and lessons contained in these publications. It is their hope that this brochure will be a valuable resource to hospitals who obtain blood and blood components from the American Red Cross as they develop and update their blood usage guidelines for the purpose of improving transfusion safety.

**RED BLOOD CELLS
GENERAL INFORMATION**

Components:	<p>Approved name: Red Blood Cells.</p> <p>Also referred to as Packed Cells, Red Cells, Packed Red Blood Cells, RBCs, or Blood.</p> <p>Preparation variations include Red Blood Cells (Adenine-Saline Added); Red Blood Cells, Low Volume; Red Blood Cells Apheresis; Red Blood Cells Deglycerolized; Red Blood Cells Irradiated; Red Blood Cells Leukocytes Reduced; and Red Blood Cells Washed.</p>
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Description of Components:	<p>Red Blood Cells consist of erythrocytes concentrated from whole blood donations by centrifugation or collected by apheresis method. The component is anticoagulated with citrate and may have had one or more preservative solutions added.</p> <p>Depending on the preservative-anticoagulant system used, the hematocrit of Red Blood Cells ranges from about 60% (e.g., AS-1, AS-3) to about 75% (e.g., CPDA-1). The acellular portion of the component contains an average of about 50 ml of donor plasma (range about 20 ml to about 80 ml). The remainder is comprised of the preservative and anticoagulant solution.</p> <p>Each unit contains approximately 60 g of hemoglobin or 180 ml of pure red cells, depending on the hemoglobin level of the donor and the starting whole blood collection volume. Unless designated as a low volume collection, each unit will contain at least 50 g of hemoglobin.</p> <p>Each unit of Red Blood Cells contains approximately 250 mg of iron, most in the form of hemoglobin.</p>
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**RED BLOOD CELLS
GENERAL INFORMATION**

<p>Selection and Preparation:</p>	<p>Red Blood Cells must be compatible with ABO antibodies present in the recipient serum, and crossmatched (serologic or electronic) to confirm compatibility with ABO and other antibodies prior to routine transfusion.</p> <p>Extended storage preservative-anticoagulant preparations such as AS-1 and AS-3 are appropriate for nearly all patient types. Practitioners concerned about preservative-anticoagulant in neonates may elect to use a different preparation (e.g., CPD or CPDA-1) or to remove preservative-anticoagulant from transfusion aliquots prior to administration, for example, by centrifugation and volume reduction or washing.</p> <p>Red Blood Cells are capable of transmitting cytomegalovirus, mediating graft-versus-host disease and causing febrile, nonhemolytic reactions. For recipients at particular risk from these transfusion-related complications, use of CMV low-risk, gamma-irradiated and leukoreduced preparations should be considered.</p>
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<p>Dosing:</p>	<p>A dose of one unit of compatible Red Blood Cells will increase the hemoglobin level in a normal-size adult who is not bleeding or hemolyzing by approximately 1 g/dL.</p> <p>In neonates, a dose of 15 ml/kg of AS-1 or AS-3 packed red cells with a hematocrit of approximately 60% will increase the hemoglobin by approximately 3 g/dL.</p>
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**RED BLOOD CELLS
GENERAL INFORMATION**

<p>Response:</p>	<p>Unless the recipient is bleeding or hemolyzing, and provided the transfused red cells are compatible, the post-transfusion hemoglobin can be accurately predicted from the patient's estimated blood volume, baseline red cell mass and transfusion volume.</p> <p>Transfused red cells have a half-life of approximately 30 days in the absence of other processes that would result in red cell loss or premature removal.</p>
<p>Indications and Contra-indications:</p> <p>Ref: 8</p>	<p>Red blood cells are indicated for patients with a symptomatic deficiency of oxygen-carrying capacity or tissue hypoxia due to an inadequate circulating red cell mass. They are also indicated for exchange transfusion (e.g., for hemolytic disease of the newborn) and red cell exchange (e.g., for acute pulmonary crisis in sickle cell disease).</p> <p>Red blood cells should not be used to treat anemia that can be corrected with a non-transfusion therapy such as iron or recombinant erythropoietin. They also should not be used as a source of blood volume, oncotic pressure, coagulation factors or platelets.</p> <p>For complete Side Effects and Hazards see appendix.</p>

RED BLOOD CELLS UTILIZATION GUIDELINES

Perioperative	<p>General:</p> <p>The function of a RBC transfusion is to deliver oxygen to tissues. Hemoglobin levels in active bleeding are imprecise measures of tissue oxygenation. Adequate or inadequate fluid resuscitation can significantly alter the measured hemoglobin concentration. In addition, a number of factors must be considered besides the blood hemoglobin level such as oxygenation in the lungs, blood flow, hemoglobin-oxygen affinity and tissue demands for oxygen.</p> <p>Consequently, the adequacy of oxygen delivery must be assessed in individual patients, particularly in patients with limited cardiac reserve or significant atherosclerotic vascular disease. If available, mixed venous O₂ levels, O₂ extraction ratios, or changes in oxygen consumption may be helpful in assessing tissue oxygenation. Other factors to consider, in addition to the above, include anticipated degree and rate of blood loss and the effect of body temperature or drugs/anesthetics on oxygen consumption.</p> <p>Notwithstanding the above, the following recommendations are made by an American Society of Anesthesiologists Task Force:</p> <ol style="list-style-type: none">1. Transfusion is rarely indicated when the hemoglobin level is above 10 g/dL and is almost always indicated in patients when the hemoglobin level is below 6 g/dL;2. The determination of transfusion in patients whose hemoglobin level is 6-10 g/dL should be based on the patient's risk of complications due to inadequate oxygenation.
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RED BLOOD CELLS UTILIZATION GUIDELINES

Perioperative (continued): Refs: 3, 4, 29	<p>The use of alternative measures to reduce allogeneic red cell use should be considered, including preoperative autologous donation, intra-operative and post-operative autologous blood recovery, acute normovolemic hemodilution, and operative and pharmacologic measures that reduce blood loss.</p> <p>Sickle Cell Disease: Exchange transfuse preoperatively for major surgery and eye surgery.</p>
Oncology:	Same as for Hematology and Critical Care

RED BLOOD CELLS UTILIZATION GUIDELINES

Critical Care:	<p>General:</p> <p>The same considerations regarding individualization of red cell transfusions apply to critical care, as perioperative patients (see above). The effects of anemia must be separated from those of hypovolemia, although both can impede tissue oxygen delivery. Blood loss of greater than 30% of blood volume causes significant clinical symptoms but resuscitation with crystalloid alone is usually successful in young healthy patients with blood loss of up to 40% of blood volume (e.g., 2-liter blood loss in an average adult male). Beyond that level of acute blood loss after adequate volume resuscitation, acute normovolemic anemia will exist. However, oxygen delivery in healthy adults is maintained even with hemoglobin levels as low as 6-7 g/dL. Thus up to half the blood volume in a bleeding, otherwise healthy young adult can be replaced with crystalloid without the need for red cell transfusion.</p> <p>In support of a conservative red cell transfusion policy in critical care is a multicenter, randomized, controlled trial comparing a transfusion trigger of 7 g/dL with a trigger of 9 g/dL in normovolemic critically ill patients. Overall 30-day mortality was similar in the two groups and in the subset of more seriously ill patients. However, in less acutely ill or younger patients, the restrictive strategy resulted in a <u>lower</u> 30-day mortality.</p> <p>In support of considering cardiovascular status in the decision to transfuse red cells is a retrospective study of blood transfusion in elderly patients with an acute myocardial infarction, which showed lower short-term mortality when patients were transfused with a hemoglobin as high as 10 g/dL.</p>
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RED BLOOD CELLS UTILIZATION GUIDELINES

Critical Care (continued):	<p>Thus transfusion triggers for red cells in critical care must be customized to defined patient groups, and the decision to transfuse must be made on the basis of individual patient characteristics. Unfortunately, the availability of carefully performed clinical trials to assist the clinician is extremely limited.</p> <p>Neonates: Transfuse with ≤ 20 ml/kg for:</p> <ul style="list-style-type: none">a) Acute blood loss of $> 10\%$ blood volumeb) Hemoglobin < 8 g/dL in a stable newborn with apnea, bradycardia, tachycardia, tachypnea, decreased vigor or no weight gainc) Respiratory Distress Syndrome or severe congenital heart disease and hemoglobin < 12 g/dL <p>Do not transfuse above hemoglobin of 15 g/dL.</p> <p>Sickle Cell Disease: Exchange transfuse for rapid treatment to prevent organ or life-threatening conditions:</p> <ul style="list-style-type: none">a) acute chest syndromeb) acute stroke/transient ischemic attack (TIA)c) priapism
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Refs: 3, 14,
29, 30

RED BLOOD CELLS UTILIZATION GUIDELINES

Hematology	<p>Asymptomatic Chronic Anemia: Treat with pharmacologic agents based on the specific diagnosis (e.g., Vit B₁₂, folic acid, recombinant erythropoietin, iron). Do not transfuse.</p> <p>Symptomatic Chronic Anemia: Transfuse to minimize symptoms and risks associated with anemia. Transfusion is usually required when hemoglobin is at 5-8 g/dL.</p> <p>Severe Thalassemia: Transfuse to help prevent symptomatic anemia and suppress endogenous erythropoiesis by maintaining hemoglobin at 9.5 – 11 g/dL.</p> <p>Sickle Cell Disease: Transfuse to help reverse or prevent symptomatic anemia and/or vaso-occlusion. Transfusions are not necessary for chronic, steady state anemia. Transfusions can be performed in three different ways: acute simple transfusion, chronic simple transfusion and exchange transfusion. Post-transfusion hematocrits should be maintained below 35% to avoid hyperviscosity.</p> <p>Acute simple transfusions Transfuse to increase oxygen-carrying capacity when no reduction in hemoglobin S level is required:</p> <ol style="list-style-type: none">a) symptomatic anemiab) complicated pain crisis unresponsive to medicationc) splenic sequestrationd) accelerated hemolysis (delayed hemolytic reaction, warm autoimmune hemolytic anemia; sickle crisis)e) preoperatively
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**PLATELETS
GENERAL INFORMATION**

Components:	<p>Approved names: Platelets; Platelets Pooled; Platelets Pheresis; platelets also referred to as random donor platelets, randoms, platelet concentrates, or RDPs.</p> <p>Platelets Pheresis also referred to as single donor platelets, pheresis, apheresis, single donors, or SDPs.</p> <p>Preparation variations include Platelets Irradiated; Platelets Pooled Irradiated; Platelets Pheresis Irradiated; Platelets Leukocytes Reduced; and Platelets Pheresis Leukocytes Reduced.</p>
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Description of Components:	<p>Platelets (RDP): derived from Whole Blood; contain $>5.5 \times 10^{10}$ platelets (usual content approximately 7.5×10^{10}) per bag in approximately 50 mL of plasma. Anticoagulant is the same as used for the whole blood collection, usually CPD.</p> <p>Platelets Pheresis (SDP): obtained using automated instrumentation; contain $> 3.0 \times 10^{11}$ platelets (usual content approximately 4.5×10^{11}) per bag in about 250 mL of plasma. Anticoagulant is ACD.</p>
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Selection and Preparation:	<p>Four to eight RDPs pooled at the hospital prior to transfusion to prepare an adult dose. SDPs ready for transfusion.</p> <p>SDPs and RDPs should be ABO-identical with the recipient when possible.</p> <p>Rh-negative recipients should receive Rh-negative platelets when possible, particularly in women of childbearing potential.</p>
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PLATELETS
GENERAL INFORMATION

Dosing:	<p>Four to eight units of pooled RDPs or one SDP for profound thrombocytopenia or thrombocytopathy.</p> <p>Transfuse as needed to stop bleeding. To help prevent bleeding, transfuse as needed to maintain target platelet count.</p>
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Response:	<p>Measure platelet count from 10 minutes to 3 hours after transfusion. Generally, expect an increase in platelet count of approximately 7-10,000/ mm³ for each RDP given, or 30-40,000/ mm³ for each SDP given.</p> <p>Response to platelet transfusion is adversely affected by the presence of fever, sepsis, splenomegaly, severe bleeding, consumptive coagulopathy, HLA alloimmunization and treatment with certain drugs (e.g., amphotericin).</p>
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<p>Indications and Contra-indications:</p> <p>Ref: 8</p>	<p>Use to treat bleeding due to critically decreased circulating platelet counts or functionally abnormal platelets.</p> <p>Use prophylactically to prevent bleeding at prespecified low platelet counts.</p> <p>Do not use in patients with autoimmune thrombocytopenia or thrombotic thrombocytopenic purpura except for life-threatening hemorrhage.</p> <p>For complete Side Effects and Hazards see appendix.</p>
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PLATELETS UTILIZATION GUIDELINES

Perioperative	<p>Cardiothoracic Surgery:</p> <ul style="list-style-type: none">a) Routine prophylactic transfusions are not required in the absence of bleeding.b) When coagulation parameters are not significantly abnormal, counts $<100,000/\text{mm}^3$ accompanied by major unexpected bleeding from a microvascular source are appropriately treated with platelet transfusion. <p>Other Surgical Procedures:</p> <ul style="list-style-type: none">a) Intraoperative platelet counts should be obtained to guide transfusion. Microvascular bleeding in the setting of potential dilutional thrombocytopenia may require empiric transfusion before counts are available.b) Prophylactic preoperative transfusion is rarely required for counts $>100,000/\text{mm}^3$, is usually required for counts $<50,000/\text{mm}^3$ and is guided by risk factors for intermediate counts.c) Procedures with insignificant blood loss or vaginal deliveries can be performed at counts $<50,000/\text{mm}^3$ without prophylactic transfusion.d) Neurologic or ophthalmologic procedures require a platelet count near $100,000/\text{mm}^3$.e) Transfusion may be required with apparently adequate counts when known platelet dysfunction results in microvascular bleeding.
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PLATELETS UTILIZATION GUIDELINES

Perioperative (continued):	<p>Specific Procedures:</p> <ol style="list-style-type: none">a) When prophylactic transfusion is deemed necessary, a post-transfusion count should be obtained to assure an appropriate increment before performance of the procedure.b) In the absence of other coagulopathy, major invasive procedures require platelet counts of at least 40,000 to 50,000/mm³ (including CVP placement, paracentesis / thoracentesis, respiratory tract / GI biopsies, closed liver biopsy, sinus aspiration & dental extraction).c) Lumbar puncture or fiberoptic bronchoscopy (without biopsy) by an experienced operator may be safely performed in the presence of a platelet count $\geq 20,000/\text{mm}^3$.d) GI endoscopy without biopsy may be safely performed at platelet counts $< 20,000/\text{mm}^3$. <p>Platelet Function Defects:</p> <p>Patients with congenital or acquired defects in platelet function may be transfused for critical bleeding or before major surgery regardless of the platelet count. Transfusion is generally not indicated when platelet dysfunction is extrinsic to the platelet (e.g., uremia, certain types of von Willebrand Disease, hyperglobulinemia) since transfused platelets function no better than the patient's own platelets. Transfusion should be undertaken only when more conservative options fail since alloimmunization to missing surface glycoproteins may cause life-threatening future refractoriness (e.g., Glanzmann Thrombasthenia, Bernard-Soulier Syndrome).</p>
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PLATELETS UTILIZATION GUIDELINES

Oncology (continued):

Chemotherapy for Solid Tumors:

The usual prophylactic transfusion trigger is $\leq 10,000/\text{mm}^3$. The greater risk of bleeding from bladder neoplasms / necrotic tumors and the serious impact of even minor bleeding in patients with limited physiologic reserve may warrant a transfusion trigger of $\leq 20,000/\text{mm}^3$.

Transfusion Refractoriness:

- a) Post-transfusion platelet increments obtained 10-60 minutes after infusion should be obtained whenever possible. The American Society of Clinical Oncology recommends that additional products be given if transfusion triggers remain unmet.
- b) Alloimmune refractoriness is more likely in the setting of at least two consecutive poor platelet increments. Alloimmunization should be confirmed by demonstration of antibodies to platelets (e.g., to human leukocyte antigens [HLA]). Single donor products identified by HLA matching and/or crossmatching should be transfused.
- c) The incidence of HLA alloimmunization has been shown to be reduced by the use of leukoreduced blood products (platelets and RBCs) in any patient expected to receive multiple platelet transfusions during the course of therapy.
- d) Severely alloimmunized patients who do not respond to available matched products do not benefit from unmatched prophylactic platelet transfusions and should only be transfused for active bleeding.

Refs: 4, 5, 12,
16, 20, 21,
23, 28

PLATELETS UTILIZATION GUIDELINES

Critical Care	<p>Massive Transfusion: Platelets should not be given routinely. In the presence of microvascular bleeding, transfusion may be appropriate when counts are $<100,000/\text{mm}^3$.</p> <p>Disseminated/Local Intravascular Coagulation (DIC/LIC) and/or Sepsis: Microvascular bleeding is treated in children and adults with platelet counts $<50,000/\text{mm}^3$ or neonates $<100,000/\text{mm}^3$.</p> <p>Neonates: A prophylactic transfusion trigger of $<20,000/\text{mm}^3$ for stable neonates at term, or $<30,000/\text{mm}^3$ for stable premature neonates, is justified. High-risk neonates (those with extremely low birthweight, perinatal asphyxia, ventilatory assistance with an $\text{FIO}_2 > 40\%$ or clinical instability) may be transfused at $<30,000/\text{mm}^3$ at term or $<50,000/\text{mm}^3$ if premature.</p>
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Refs: 3, 7, 16,
17

PLATELETS UTILIZATION GUIDELINES

Hematology	<p>Idiopathic Thrombocytopenic Purpura (ITP):</p> <ul style="list-style-type: none">a) Patients who experience major, life-threatening bleeding or intraoperative hemorrhage should receive high-dose platelet transfusions.b) Prophylactic transfusions are usually inappropriate since transfused platelets do not survive any longer than patients' native platelets. Transfusion may be considered before elective splenectomy with platelet counts $\leq 10,000/\text{mm}^3$. <p>Thrombotic Thrombocytopenic Purpura (TTP) and Heparin-Induced Thrombocytopenia with Thrombosis (HITT):</p> <p>Due to the significant risk of fatal thrombosis, platelets should only be transfused in the setting of life-threatening hemorrhage.</p> <p>Post-Transfusion Purpura (PTP):</p> <p>Platelets may be used therapeutically for severe bleeding. Transfusion of randomly selected platelets is usually ineffective. Though efficacy is not well documented, human platelet antigen (HPA)-1a (PI^{A1})-negative platelets are frequently given empirically while specific alloantibody testing is in progress. High-dose intravenous immunoglobulin with steroids is the treatment of choice for PTP.</p> <p>Neonatal Alloimmune Thrombocytopenia (NAIT):</p> <p>Platelets must lack the HPA recognized by circulating maternal antibodies. If maternal platelets are used, they should be washed or volume-reduced.</p> <p>Aplastic Anemia:</p> <p>Transfuse stable patients prophylactically at counts $\leq 5,000/\text{mm}^3$ and patients with fever or minor hemorrhage at counts 6,000-10,000/mm^3.</p>
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Refs: 2, 4, 5,
7, 8, 11, 13,
16, 21

**FRESH FROZEN PLASMA (FFP)
GENERAL INFORMATION**

Components:	<p>Approved name: Fresh Frozen Plasma</p> <p>Also referred to as FFP or plasma.</p> <p>Preparation variations include FFP Donor Retested; Liquid Plasma; Plasma; Thawed Plasma; Plasma Frozen Within 24 Hours; and Plasma Cryoprecipitate Reduced.</p>
Description of Components:	<p>Fresh Frozen Plasma consists of the noncellular portion of blood that is separated and frozen within hours after donation. FFP may be prepared from whole blood or collected by apheresis. The anticoagulant solution used is indicated on the label.</p> <p>The volume of each unit varies depending on the manufacturing method, and is indicated on the label. By definition each milliliter of plasma contains 1 IU of each coagulation factor.</p>
Selection and Preparation:	<p>FFP must be ABO-compatible with the recipient's red cells for routine transfusion, for example, group A FFP is suitable for group A and group O patients. FFP must be thawed, usually in a water bath, and infused immediately or stored at 1-6°C for up to 24 hours. After 24 hours, the product is no longer FFP, but can still be used as a source of stable coagulation factors.</p>

**FRESH FROZEN PLASMA (FFP)
GENERAL INFORMATION**

Indications and Contra- indications:	<p>FFP is indicated for use in patients with the following conditions:</p> <ol style="list-style-type: none"> 1. Bleeding with a deficiency of multiple coagulation factors. 2. Preoperative with a deficiency of multiple coagulation factors. 3. Massive transfusion with coagulation abnormalities. 4. Bleeding on warfarin therapy. 5. Urgent invasive procedure on warfarin therapy. 6. Thrombotic thrombocytopenic purpura. 7. Coagulation factor deficiency when no concentrate is available. 8. Rare specific plasma protein deficiencies, such as C1-inhibitor. <p>Do not use FFP when coagulopathy can be corrected with Vitamin K.</p> <p>Do not use FFP as a source of blood volume.</p> <p>For complete Side Effects and Hazards see appendix.</p>
Ref: 8	

FRESH FROZEN PLASMA (FFP) UTILIZATION GUIDELINES

Perioperative	<p>Warfarin and Liver Disease: Patients with liver disease or those taking warfarin may safely undergo operative or invasive procedures when the PT is ≤ 1.5 times mid-range normal. Emergent reversal of therapeutic warfarin effect is usually achieved with 5-8 mL/kg of FFP.</p> <p>Factor Deficiency: Prophylactic correction of a known factor deficiency for which specific concentrates are unavailable is guided by recommended perioperative hemostatic levels for each type of procedure.</p> <p>Massive Transfusion and Cardiopulmonary Bypass: There is no role for prophylactic FFP use in massively transfused patients (≥ 1 blood volume in 24 hours) or those who have undergone cardiopulmonary bypass. Microvascular bleeding due to presumed or measured PT/APTT prolongation >1.5 times mid-range normal warrants FFP transfusion once fibrinogen levels are increased to $>80-100$ mg/dL with cryoprecipitate and/or residual heparin effect is reversed.</p> <p>Refs: 3, 4, 9</p>
Oncology:	See Critical Care.

FRESH FROZEN PLASMA (FFP) UTILIZATION GUIDELINES

Critical Care	<p>Warfarin: Patients on warfarin who experience serious bleeding are treated with Vitamin K (at a dose determined by the INR) and FFP or prothrombin complex concentrates as clinically warranted.</p> <p>Acute Disseminated Intravascular Coagulation: Treat underlying cause and support with FFP, cryoprecipitate and platelets.</p> <p>Thrombotic Thrombocytopenic Purpura: Daily plasma exchange with FFP or cryoprecipitate-poor plasma is initiated with 1 - 1.5 plasma volumes and may need to be increased to twice-daily single plasma volume exchanges in refractory patients.</p> <p>Refs: 4, 6, 9, 10</p>
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FRESH FROZEN PLASMA (FFP) UTILIZATION GUIDELINES

Hematology	<p>Coagulopathic Bleeding Coagulopathic bleeding, defined as a PT >1.5x mid-range normal, APTT >1.5x top normal or factor assay <25%, is treated with FFP in the following settings:</p> <ol style="list-style-type: none">a) Replacement of single factor deficiencies (e.g., congenital deficiency of factors II, V, VII, IX, X or XI) when specific or combined factor concentrates are not available. In the absence of concentrates, fibrinogen or factor VIII and XIII deficiencies are usually treated with cryoprecipitate but may also be treated with FFP.b) Multiple coagulation factor deficiencies (e.g., liver disease, Vitamin K deficiency). <p>Specific Plasma Protein Deficiencies Deficiency of other plasma proteins in a setting where concentrates are not readily available are also treated with FFP:</p> <ol style="list-style-type: none">a) Treatment or prophylaxis of thromboembolism in Antithrombin, Protein C and Protein S deficiencies.b) Therapy of acute angioedema or preoperative prophylaxis in hereditary C1-inhibitor deficiency. <p>Thrombotic Thrombocytopenic Purpura See under Critical Care.</p>
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Refs: 4, 9

**CRYOPRECIPITATED AHF
GENERAL INFORMATION**

Components:	<p>Approved names: Cryoprecipitated Antihemophilic Factor (AHF); Cryoprecipitated AHF, Pooled</p> <p>Also referred to as cryoprecipitate, cryoprecipitate pool, cryo, pooled cryo.</p>
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Description of Components:	<p>A cryoprecipitate unit is prepared by thawing one unit of FFP between 1-6°C and recovering the cold-insoluble precipitate. The cryoprecipitate is refrozen within 1 hour.</p> <p>If the label indicates “ Cryoprecipitated AHF, Pooled,” several units of cryoprecipitate have been pooled into one bag, and the volume of the pool is indicated on the label.</p> <p>Cryoprecipitate contains fibrinogen, Factor VIII:C, Factor VIII:vWF (von Willebrand factor), Factor XIII, and fibronectin.</p> <p>Each unit of cryoprecipitate should contain at least 80 IU Factor VIII:C and 150 mg of fibrinogen in ~ 15mL of plasma.</p>
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**CRYOPRECIPITATED AHF
GENERAL INFORMATION**

<p>Selection and Preparation:</p>	<p>Cryoprecipitate is considered to be an acellular blood component. Compatibility testing is unnecessary. Rh type need not be considered. It is preferable to use cryoprecipitate that is ABO-compatible with the recipient's red cells.</p> <p>CMV testing and leukoreduction are not required.</p> <p>Frozen cryoprecipitate is thawed in a protective plastic overwrap in a waterbath at 30-37°C up to 15 minutes. Thawed cryoprecipitate should be kept at room temperature and transfused as soon as possible after thawing or within 6 hours if it is a closed single unit or has been pooled prior to freezing. It should be transfused within 4 hours if it is an open system or units have been pooled after thawing.</p> <p>For pooling, the precipitate in each unit should be mixed well with 10 -15 mL of diluent to ensure complete removal of all material from the container. Cryoprecipitate pooled prior to freezing requires no extra diluent.</p>
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<p>Dosing:</p>	<p>The number of cryoprecipitate units required can be calculated from the desired increase in coagulation factor level (in percent), multiplied by the patient's plasma volume (in milliliters), divided by the content of the coagulation factor in a cryoprecipitate unit (assume minimum potency).</p> <p>The frequency of dosing depends on the half-life and recovery of the coagulation factor that is being replaced (check factor levels).</p> <p>A typical dose for the treatment of hypofibrinogenemia is one cryoprecipitate unit per 7 - 10 kg of body weight.</p>
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CRYOPRECIPITATED AHF UTILIZATION GUIDELINES

Perioperative Ref: 27	Fibrin Sealant: Both autologous and allogeneic cryoprecipitate units have been used in the preparation of fibrin sealant for topical use, but commercially produced, virally-inactivated fibrin sealant is preferable with respect to safety and efficacy.
Oncology: Ref: 13	Hypofibrinogenemia / dysfibrinogenemia: Transfuse for bleeding associated with fibrinogen levels <100 to 120 mg/dL or reduced functional levels of fibrinogen.

CRYOPRECIPITATED AHF UTILIZATION GUIDELINES

Critical Care:	<p>Cryoprecipitate is especially useful when it is not possible to give enough FFP to provide adequate levels of fibrinogen and Factor VIII without volume-overloading the patient.</p> <p>Cryoprecipitate has been used for uremic bleeding, but efficacy has not been clearly demonstrated, and desamino D-arginine vasopressin (DDAVP) is preferred.</p> <p>Cryoprecipitate should not be used in the critical care setting as a source of fibronectin to improve reticuloendothelial system function.</p> <p>Massive Transfusion: Transfuse for bleeding in massively transfused patients when the fibrinogen level is documented to be <100 mg/dL. Hypofibrinogenemia is not likely to contribute to bleeding until the level falls below 50 – 80 mg/dL.</p> <p>Hypofibrinogenemia / dysfibrinogenemia: Transfuse for bleeding. Most cases of hypofibrinogenemia/ dysfibrinogenemia in critical care are associated with DIC or hepatic insufficiency.</p>
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Refs: 4, 13,
17

CRYOPRECIPITATED AHF UTILIZATION GUIDELINES

Hematology	<p>Fibrinogen deficiencies are uncommon, and are variably associated with bleeding. The treatment of patients with an isolated fibrinogen deficiency should be reserved for episodes of clinical bleeding, or when there is a significant risk of bleeding complications due to an invasive procedure or pregnancy.</p> <p>For hemophilia A or vWD, cryoprecipitate should only be used if appropriate virus- inactivated Factor VIII or Factor VIII:vWF concentrates are not available. DDAVP is the treatment of choice for type 1 vWD.</p> <p>Congenital afibrinogenemia / Congenital and acquired dysfibrinogenemia:</p> <p>Transfuse for bleeding or risk of bleeding associated with a fibrinogen level <100 mg/dL by a quantitative or functional assay.</p> <p>Factor XIII deficiency:</p> <ol style="list-style-type: none">a) Transfuse for bleeding and prophylaxis.b) Factor XIII deficiency is rare, and characterized by bleeding and poor wound healing.c) Factor XIII has a half-life of 4 to 14 days, and only ~ 1-5% activity levels are needed to control bleeding. Newborns with Factor XIII deficiency should be placed on a prophylactic regimen of replacement therapy because of the high incidence of intracranial hemorrhage.d) Virus inactivated Factor XIII concentrates are preferred for the treatment of Factor XIII deficient patients, but are not readily available. Cryoprecipitate can be given in doses of one bag per 10-20 kg of body weight every 3 to 4 weeks. FFP can also be used.
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Refs: 1, 4, 8,
15

THE ROLE OF TRANSFUSION COMMITTEE

Description:	<p>Hospitals are required by accrediting agencies (e.g., Joint Commission on Accreditation of Healthcare Organizations, American Association of Blood Banks and College of American Pathologists) to ensure appropriate use of blood products. How this is done may vary from hospital to hospital. Some maintain a Transfusion Committee dedicated solely to this function. Others may charge the Quality Assurance Committee with this task, or a Blood and Tissue Committee. For the most part, the accrediting agencies don't care exactly how this peer review function is accomplished, as long as it gets done.</p> <p>The responsible committee should address these aspects of blood use:</p> <ol style="list-style-type: none">1. Ordering2. Distribution, handling, and dispensing3. Administration4. Monitoring of patients for appropriate responses.
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THE ROLE OF TRANSFUSION COMMITTEE

Membership and Structure:	<p>Members of the committee should include representatives from the Medical Staff, Nursing, Hospital Administration, and the Transfusion Service. The Medical Director of the Transfusion Service is a vital member of the committee who may or may not serve as chairperson.</p> <p>The committee should establish <i>guidelines</i> for administration of each of the blood components transfused in the institution, using the medical literature as a resource. This brochure was developed in order to assist hospitals with this task.</p> <p>Since it is vital that the medical staff participates fully in the monitoring process, it is best to have the transfusion guidelines formally approved by the Medical Staff before implementation.</p> <p>Transfusion guidelines are intended to remind ordering physicians of the transfusion practices for which there is general support and clinical trial evidence. Guidelines cannot be expected to cover every instance in which a transfusion is indicated. There will be clinical situations, outside of the guidelines, when a transfusion is necessary. It is also not the case that every patient whose circumstance falls within a particular guideline will necessarily be helped by a transfusion. In every case, the rationale for giving - or not giving - a transfusion should be clear from the medical record documentation.</p>
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THE ROLE OF TRANSFUSION COMMITTEE

Process:	<p>The review of transfusions can be done prospectively (before blood is issued) or retrospectively (after blood is issued). Theoretically, prospective review is preferable, because the interventions can intercept unnecessary transfusions and correct inaccurate transfusion orders in real time, thereby directly helping individual patients. For certain high cost blood products, prospective review may be appropriate. Similarly, prospective review of potentially dangerous orders, for example, an order for platelet transfusion to a patient with thrombotic thrombocytopenic purpura or an order for four units of red blood cells for a child, may also require review prior to blood issue. For most transfusions and blood products, however, involving large numbers of transfusions and patients, retrospective reviews are adequate and most commonly used.</p> <p>For each transfusion, the following information should be documented:</p> <ol style="list-style-type: none">1. Physician order2. Indication3. Applicable lab or clinical results before and after the transfusion4. Assessment of outcome. <p>Trained clerical staff can do chart or electronic record reviews, using the guidelines (e.g., hemoglobin level, platelet count, diagnosis) developed by the committee. When there are questions about the indications and results of a transfusion, the clinical records can be reviewed at the committee meeting.</p> <p><i>The most helpful evidence of the need for transfusion is documentation of the indication by the physician in the recipient's medical record (e.g., progress notes).</i></p>
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THE ROLE OF TRANSFUSION COMMITTEE

Process (continued):	If the transfusion committee is unable to determine a justification for the transfusion, the patient's physician should be contacted for additional information, usually by a letter from the chair of the committee. The additional information may explain the transfusion; if not, there is an opportunity to educate the patient's physician. If the letter is ignored, or unacceptable responses are returned, the respective department chair may need to be involved in order to complete the intent of the peer review process.
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THE ROLE OF TRANSFUSION COMMITTEE

Monitors:	<p>Blood usage should be monitored by whatever parameter is useful for the institution. This can be done by physician, by group (for example, clinical department, location, institution) or by clinical setting (for example, number of packed red blood cells used per total hip replacement, platelet use during cardiac surgery, total blood use during liver transplants, total blood use for a particular diagnosis related group (DRG). Outliers can be investigated in a spirit of peer review, and corrective interventions should be educational.</p> <p>The Transfusion Committee must ensure that blood is administered correctly. Before a transfusion is given there must be informed consent according to the institutional procedures, confirmation that the component is intended for the patient and is not expired, and verification of the patient's identity. Failure to properly identify transfusion recipients remains a significant cause of acute hemolytic transfusion reactions and transfusion-related fatalities.</p> <p>The wastage of blood components should be monitored. Usually this will involve products prepared but not used (e.g., thawed fresh-frozen plasma, pooled platelets). Autologous units which are donated but not used should also be monitored; autologous donation is not a risk-free procedure, and should be ordered only when the benefits of avoiding allogeneic transfusion outweigh the risks of donation. Other possible quality indicators include RBC unit expiration and/or wastage rate. In the past, crossmatch-to-transfusion (C:T) ratios were tracked, at least in part because the Joint Commission on Accreditation of Healthcare Organizations previously required this number to be reported. Institutions may find it valuable to continue to calculate C:T's.</p>
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THE ROLE OF TRANSFUSION COMMITTEE

Monitors (continued):	The committee should review adverse reactions to blood products. The committee must also ensure that a mechanism exists for reporting and evaluation of suspected transfusion-transmitted diseases.
Reports:	The transfusion committee or its equivalent, should generate reports of its work to other interested entities of the hospital (e.g., clinical departments of the Medical Staff, the Medical Staff Executive Committee, the Clinical Practices Committee, the Credentials Committee) appropriate for the particular institution. The intent of this reporting is to provide other peer review committees with the results of reviews of transfusion related patient care.
Summary:	<p>Hospitals are required to have a transfusion committee, or its equivalent. Even if it were not required by accrediting agencies, such an entity is highly valuable within an institution for transfusion-related matters that the blood bank cannot handle independently.</p> <p>The work of auditing and monitoring blood utilization is not sophisticated. It is simply a matter of having appropriate policies and procedures in place, reviewing and revising them as necessary, and monitoring that they are followed.</p> <p>As with all aspects of high quality medical care, it is important in transfusion practice to say what you do, do what you say, and document what you have done.</p>
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APPENDIX: SIDE EFFECTS and HAZARDS of BLOOD TRANSFUSION

The following sections are reproduced from the August 2000 Circular of Information:
A. General

"The following side effects and hazards pertain to transfusion of Whole Blood or any component prepared from blood collected from individual donors.

Immunologic Complications, Immediate

1. *Hemolytic transfusion reaction*, the destruction of transfused red cells, is discussed in detail in the section on red-cell-containing components.
2. *Immune-mediated platelet destruction*, one of the causes of refractoriness to platelet transfusion, is the result of alloantibodies in the recipient to HLA or platelet-specific antigens on transfused platelets. This is described in more detail in the section on Platelets.
3. *Febrile nonhemolytic reaction* is typically manifested by a temperature elevation of ≥ 1 C or 2 F occurring during or shortly after a transfusion and in the absence of any other pyrexia stimulus. This may reflect the action of antibodies against white cells or the action of cytokines, either present in the transfused component or generated by the recipient in response to transfused elements. Febrile reactions may accompany about 1% of transfusions; they occur more frequently in patients previously alloimmunized by transfusion or pregnancy. No routinely available pre- or posttransfusion tests are helpful in predicting or preventing these reactions. Antipyretics usually provide effective symptomatic relief. Patients who experience repeated, severe febrile reactions benefit from receiving leukocyte-reduced components; if these reactions are thought to be due to cytokines in the component, prestorage leukocyte reduction may be beneficial.
4. *Allergic reactions* usually occur as urticaria, but may also include wheezing or angioedematous reactions. No laboratory procedures are available to predict or prevent these reactions, which usually respond to antihistamines or, in severe cases, corticosteroids or epinephrine.

Anaphylactoid reactions, characterized by autonomic dysregulation, severe dyspnea, pulmonary and/or laryngeal edema, and bronchospasm and/or laryngospasm, are rare but dangerous complications requiring immediate treatment with corticosteroids and epinephrine. The majority of these reactions have been reported in IgA-deficient patients who have IgA antibodies of the IgE class. Such patients may not have received prior transfusions and may develop symptoms after infusion of very small amounts of IgA-containing plasma, in any transfusion component.

Transfusion-related acute lung injury (TRALI) occurs when acutely increased permeability of the pulmonary microcirculation causes massive leakage of fluids and protein into the alveolar spaces and interstitium, usually within 6 hours of transfusion. The occurrence of TRALI is associated, in many cases, with the presence of granulocyte antibodies in the donor or recipient. The specific mechanism of action is not clear. Treatment consists of aggressive respiratory support.

APPENDIX: SIDE EFFECTS and HAZARDS of BLOOD TRANSFUSION (continued)

Immunologic Complications, Delayed

1. *Delayed hemolytic reaction* is described in detail in the section on red-cell-containing components.
2. *Alloimmunization* to antigens of red cells, white cells, platelets, or plasma proteins may occur unpredictably after transfusion. Primary immunization does not become apparent until days or weeks after the immunizing event, and does not usually cause symptoms or physiologic changes. If components that express the relevant antigen are subsequently transfused, however, there may be accelerated removal of cellular elements from the circulation and/or systemic symptoms. Clinically significant antibodies to red cell antigens will ordinarily be detected by pretransfusion testing; alloimmunization to antigens of other blood components can only be detected by specialized testing.
3. *Graft-vs-host disease* (GVHD) is a rare but extremely dangerous condition that occurs when viable T lymphocytes in the transfused component engraft in the recipient and react against tissue antigens in the recipient. GVHD can occur if the host does not recognize as foreign and reject the transfused cells, and can follow transfusion of any component that contains even very small numbers of viable T lymphocytes. Severely immunocompromised recipients are at greatest risk (ie, fetuses receiving intrauterine transfusions, recipients of transplanted marrow or peripheral blood progenitor cells, and selected patients with severe immunodeficiency conditions), but GVHD has been reported in immunologically normal recipients heterozygous for a tissue antigen haplotype for which the donor is homozygous. This is most likely to occur when the transfused component is from a blood relative or has been selected for HLA compatibility. Leukocyte-reduced components contain sufficient residual T lymphocytes that GVHD remains a risk. Gamma irradiation of the component renders T lymphocytes incapable of proliferation and is presently the only approved means to prevent GVHD.

Nonimmunologic Complications

1. *Transmission of infectious disease* may occur because this product is made from human blood. This may be due to known or unknown agents, eg, viruses. This may occur despite careful selection of donors and testing of blood. Donor selection criteria are designed to screen out potential donors with increased risk of infection with HIV-1/2, HTLV-I/II, and hepatitis, as well as other agents. All blood and components released for transfusion have been found negative on approved tests for markers of infection with hepatitis B and C, HIV-1 and -2 (including HIV-1 antigen), and HTLV-I/II (see section on Testing of Donor Blood). These procedures do not totally eliminate the risk of transmitting these viruses.

APPENDIX: SIDE EFFECTS and HAZARDS of BLOOD TRANSFUSION (continued)

Cytomegalovirus (CMV) may, unpredictably, be present in white-cell-containing components from donors previously infected with this virus, which can persist lifelong despite the presence of serum antibodies. Up to 70% of donors may be anti-CMV positive. Transmission of CMV by transfusion may be of concern in low-birthweight (<1200 grams) premature infants born to CMV seronegative mothers and in certain other categories of immunocompromised individuals, if they are CMV seronegative. For at-risk recipients, the risk of CMV transmission by cellular components can be reduced by transfusing CMV seronegative or leukocyte-reduced components.

For other infectious agents, there are no routinely available tests to predict or prevent disease transmission. All potential blood donors are subjected to stringent screening procedures intended to reduce to a minimum the risk that they will transmit infectious agents. These organisms include *Babesia* sp., *Bartonella* sp., *Borrelia* sp., *Brucella* sp., the agent of Colorado tick fever, *Leishmania* sp., *Parvovirus* sp., plasmodia, rickettsia, *Toxoplasma* sp., and certain trypanosomes.

2. **Bacterial contamination** occurs rarely but can cause acute, severe, and sometimes life-threatening effects. Onset of high fever (≥ 2 C or ≥ 3.5 F rise in temperature), severe chills, hypotension, or circulatory collapse during or immediately after transfusion should suggest the possibility of bacterial contamination and/or endotoxin reaction. Platelet components stored at room temperature, previously frozen components thawed by immersion in a waterbath, and red cell components stored for several weeks at 1-6 C have been implicated. Both gram-positive and gram-negative organisms have been identified as causing septic reactions. Organisms capable of multiplying at low temperatures and those using citrate as a nutrient are most often associated with red cell contamination; a variety of pathogens, as well as skin contaminants, have been found in platelet concentrates. Endotoxemia in recipients has resulted from multiplication of *Yersinia enterocolitica* in stored red-cell-containing components.

Prompt recognition of a possible septic reaction is essential, with immediate discontinuation of the transfusion and aggressive therapy with broad-spectrum antimicrobials and vasopressor agents, if necessary. In addition to prompt sampling of the patient's blood for cultures at several different temperatures, investigation should include examination of material from the blood container by Gram's stain, and cultures of specimens from the container and the administration set.

3. **Circulatory overload**, leading to pulmonary edema, can occur after transfusion of excessive volumes or at excessively rapid rates. This is a particular risk in the elderly and in patients with chronic severe anemia in whom low red cell mass is associated with high plasma volume. Small transfusion volumes can precipitate symptoms in at-risk patients who already have a positive fluid balance.

APPENDIX: SIDE EFFECTS and HAZARDS of BLOOD TRANSFUSION (continued)

Nonimmunologic Complications (continued)

- Pulmonary edema should be promptly and aggressively treated, and infusion of colloid preparations, including plasma components and the suspending plasma in cellular components, reduced to a minimum.
4. *Hypothermia* carries a risk of cardiac arrhythmia or cardiac arrest. Rapid infusion of large volumes of cold blood can depress body temperature, and the danger is compounded in patients experiencing shock or surgical or anesthetic manipulations that disrupt temperature regulation. At rapid infusion use of a blood warming device should be considered. Warming must be accomplished using an FDA-cleared warming device so as not to cause hemolysis.
 5. *Metabolic complications* may accompany large-volume transfusions, especially in patients with liver or kidney disease.
 - a) Citrate "toxicity" reflects a depression of ionized calcium due to the presence in the circulation of large quantities of citrate anticoagulant. Body stores of calcium are large and citrate is, ordinarily, promptly metabolized by the liver, so this complication is rare. Patients with severe liver disease or those with circulatory collapse that prevents adequate hepatic blood flow, may have physiologically significant hypocalcemia after rapid, large-volume transfusion. Citrated blood administered rapidly through central intravenous access may reach the heart so rapidly that ventricular arrhythmias occur. Standard measurement of serum calcium does not distinguish ionized from complexed calcium; ionized calcium testing or EKG monitoring is more helpful in detecting physiologically significant alteration in calcium levels.
 - b) Other metabolic derangements can accompany rapid or large-volume transfusions, especially in patients with pre-existing circulatory or metabolic problems. These include acidosis or alkalosis (deriving from changing concentrations of citric acid and its subsequent conversion to pyruvate and bicarbonate) and hyper- or hypokalemia."

WARNING: Because whole blood and blood components are made from human blood, they may carry a risk of transmitting infectious agents, eg, viruses, and theoretically, the Creutzfeldt-Jakob disease (CJD) agent and variant Creutzfeldt-Jakob (vCJD) agent. Careful donor selection and available laboratory tests do not eliminate the hazard.

APPENDIX: SIDE EFFECTS and HAZARDS of BLOOD TRANSFUSION (continued)

B. Red Blood Cells

"Listed below are hazards that apply specifically to components that contain red cells.

1. **Hemolytic transfusion reaction** is the immunologic destruction of transfused red cells, nearly always due to incompatibility of antigen on the transfused cells with antibody in the recipient's circulation. Non-immunologic hemolysis occurs rarely, but can result from: a) introduction of hypotonic fluids into the circulation; b) effects of drugs co-administered with transfusion; c) effects of bacterial toxins; d) thermal injury to transfusion components, by either freezing or overheating; or e) metabolic damage to cells, as from hemoglobinopathies or enzyme deficiencies. The most common cause of severe, acute hemolytic reactions is transfusion of ABO-incompatible blood, resulting from identification errors occurring at some point(s) in the transfusion process. Serologic incompatibility undetected during pretransfusion testing is a much less common cause of acute hemolysis. If a hemolytic reaction is suspected, the transfusion must be stopped and the transfusion service laboratory notified. Information identifying the patient, the transfusion component, and associated forms and labels should be reviewed immediately to detect possible errors. A postreaction blood sample, preferably drawn from a site other than the transfusion access, should be sent to the laboratory along with the implicated unit of blood and administration set.

Acute hemolytic reactions characteristically begin with an increase in temperature and pulse rate; symptoms may include chills, dyspnea, chest or back pain, abnormal bleeding, or shock. Instability of blood pressure is frequent, the direction and magnitude of change depending upon the phase of the antigen-antibody event and the magnitude of compensatory mechanisms. In anesthetized patients, hypotension and evidence of disseminated intravascular coagulopathy (DIC) may be the first sign of incompatibility. Laboratory findings can include hemoglobinemia and/or hemoglobinuria, followed by elevation of serum bilirubin; in less catastrophic acute hemolytic reactions, a positive direct antiglobulin test (DAT) is commonly found. Treatment includes measures to maintain or correct arterial blood pressure; correct coagulopathy, if present; and promote and maintain urine flow.

Delayed hemolytic reactions occur in previously red-cell-alloimmunized patients in whom antigens on transfused red cells provoke anamnestic production of antibody that reaches a significant circulating level while the transfused cells are still present in the circulation; the usual time frame is 2 to 14 days after transfusion. Signs may include unexplained fever, development of a positive DAT, and unexplained decrease in hemoglobin/hemocrit. Hemoglobinemia and hemoglobinuria are uncommon, but elevation of lactic dehydrogenase (LDH) or bilirubin may be noted. Most delayed hemolytic reactions have a benign course and require no treatment.

APPENDIX: SIDE EFFECTS and HAZARDS of BLOOD TRANSFUSION (continued)

2. Antigens on transfused red cells may cause red cell **alloimmunization** of the recipient, who may experience red cell antibody-mediated reactions to subsequent transfusions. There is no practical way to predict or prevent alloimmunization in any specific transfusion recipient. Clinically significant antibodies to red cell antigens will usually be detected in pretransfusion antibody screening tests.
3. **Circulatory overload**, resulting in pulmonary edema, can accompany transfusion of any component at a rate more rapid than the recipient's cardiac output can accommodate. Whole Blood creates more of a risk than Red Blood Cells because the transfused plasma adds volume without increasing oxygen-carrying capacity. Patients with chronic anemia have increased blood volumes and are at increased risk for circulatory overload.
4. **Iron overload** is a long-term complication of repeated red cell transfusions. Each transfusion contributes approximately 250 mg of iron. Patients requiring multiple transfusions for aplastic anemia, thalassemias, or hemoglobinopathies are at far greater risk than patients transfused for hemorrhagic indications, because blood loss is an effective means of iron excretion. Patients with predictably chronic transfusion requirements should be considered for treatment with iron-chelating agents."

C. Platelets

"Listed below are hazards that apply specifically to components that contain platelets.

1. **Bacterial Contamination:** Platelet products are the most likely among blood components to be contaminated with bacteria. Gram-positive skin flora are the most commonly recovered bacteria from contaminated platelet units. Gram's stain of suspected contaminated units of Platelets, Platelets Pheresis, or Platelets Pooled may be helpful. Prompt management including broad-spectrum antibiotic therapy along with culture of patient sample, implicated unit, and administration set is important.
2. **Platelet Alloimmunization:** Platelets bear a variety of antigens, including HLA and platelet-specific antigens. Patients transfused with platelets often develop HLA antibodies. The patient may become refractory to all but HLA-selected platelets (see "Platelets Pheresis"). When platelets are transfused to a patient with an antibody specific for an expressed antigen, the survival time of the transfused platelets may be markedly shortened. Nonimmune events may also contribute to reduced platelet survival. It is possible to distinguish immune from nonimmune platelet refractoriness by assessing platelet recovery soon after infusion, ie, 10-60 minute postinfusion platelet increment. In immune refractory states secondary to serologic incompatibility, there is poor recovery in the early postinfusion interval. In nonimmune mechanisms (ie, splenomegaly, sepsis, fever, intravascular devices, and DIC) platelet recovery within 1 hour of infusion may be adequate while longer-term survival (ie, 24-hour survival) is reduced. Serologic tests may be helpful in selecting platelets with acceptable survival.

APPENDIX: SIDE EFFECTS and HAZARDS of BLOOD TRANSFUSION (continued)

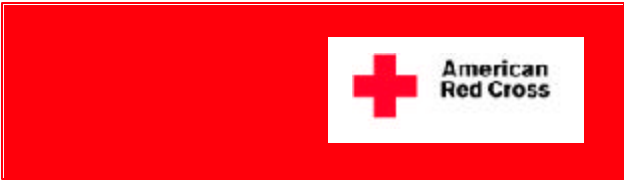
3. **Red Cell Alloimmunization:** Immunization to red cell antigens may occur because of the presence of residual red cells in Platelets. When Platelet units from Rh-positive donors are given to an Rh-negative female of childbearing potential, prevention of D immunization by use of Rh immune Globulin should be considered. In some patients, Platelets suspended in plasma that contains anti-A or anti-B may cause a positive DAT and possibly low-grade hemolysis if the recipient's red cells express the corresponding antigen."

D. Fresh Frozen Plasma (FFP)

"Antibodies in the plasma may react with the recipient's red cells, causing a positive DAT. In rare instances, TRALI may develop."

E. Cryoprecipitated AHF

"If a large volume of ABO-incompatible cryoprecipitate is used, the recipient may develop a positive DAT and, very rarely, mild hemolysis."



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