lowers the incidence of posttransfusion fever, cytomegalovirus (CMV) infections, and alloimmunization. Other theoretical benefits include less immunosuppression in the recipient and lower risk of infections. Plasma, which may cause allergic reactions, can be removed from cellular blood components by washing.

PLATELETS

Thrombocytopenia is a risk factor for hemorrhage, and platelet transfusion reduces the incidence of bleeding. The threshold for prophylactic platelet transfusion is 10,000/μL. In patients without fever or infections, a threshold of 5000/μL may be sufficient to prevent spontaneous hemorrhage. For invasive procedures, the usual target level is 50,000/μL platelets.

Platelets are given either as pools prepared from RDs or as SDAPs from a single donor. In an unsensitized patient without increased platelet consumption (splenomegaly, fever, disseminated intravascular coagulation [DIC]), two units of transfused RD per square-meter body surface area (BSA) is anticipated to increase the platelet count by approximately 10,000/μL. Patients who have received multiple transfusions may be alloimmunized to many HLA- and platelet-specific antigens and have little or no increase in their posttransfusion platelet counts. Patients who may require multiple transfusions are best served by receiving SDAP and leukocyte-reduced components to lower the risk of alloimmunization.

Refractoriness to platelet transfusion may be evaluated using the corrected count increment (CCI):

$$\text{CCI} = \frac{\text{posttransfusion count}(/\mu\text{L}) - \text{pretransfusion count}(/\mu\text{L})}{\text{number of platelets transfused} \times 10^{-11}} \times \text{BSA}\ (\text{m}^2)$$

where BSA is body surface area measured in square meters. The platelet count performed 1 h after the transfusion is acceptable if the CCI is 10×10^9/mL, and after 18–24 h an increment of 7.5×10^9/mL is expected. Patients who have suboptimal responses are likely to have received multiple transfusions and have antibodies directed against class I HLA antigens. Refractoriness can be investigated by detecting anti-HLA antibodies in the recipient's serum. Patients who are sensitized will often react with 100% of the lymphocytes used for the HLA-antibody screen, and HLA-matched SDAPs should be considered for patients who require transfusion. Although ABO-identical HLA-matched SDAPs provide the best chance for increasing the platelet count, locating these products is difficult. Platelet cross-matching is available in some centers. Additional clinical causes for a low platelet CCI include fever, bleeding, splenomegaly, DIC, or medications in the recipient.

FRESH-FROZEN PLASMA

FFP contains stable coagulation factors and plasma proteins: fibrinogen, antithrombin, albumin, and proteins C and S. Indications for FFP include correction of coagulopathies, including the rapid reversal of warfarin; supplying deficient plasma proteins; and treatment of thrombotic thrombocytopenic purpura. FFP should not be routinely used to expand blood volume. FFP is an acellular component and does not transmit intracellular infections, e.g., CMV. Patients who are IgA-deficient and require plasma support should receive FFP from IgA-deficient donors to prevent anaphylaxis (see below).

CRYOPRECIPITATE

Cryoprecipitate is a source of fibrinogen, factor VIII, and von Willebrand factor (VWF). It is ideal for supplying fibrinogen to the volume-sensitive patient. When factor VIII concentrates are not available, cryoprecipitate may be used because each unit contains approximately 80 units of factor VIII. Cryoprecipitate may also supply VWF to patients with dysfunctional (type II) or absent (type III) von Willebrand's disease.

PLASMA DERIVATIVES

Plasma from thousands of donors may be pooled to derive specific protein concentrates, including albumin, intravenous immunoglobulin, antithrombin, and coagulation factors. In addition, donors who have high-titer antibodies to specific agents or antigens provide hyperimmune globulins, such as anti-D (RhoGam, WinRho), and antisera to hepatitis B virus (HBV), varicella-zoster virus, CMV, and other infectious agents.

ADVERSE REACTIONS TO BLOOD TRANSFUSION

Adverse reactions to transfused blood components occur despite multiple tests, inspections, and checks. Fortunately, the most common reactions are not life threatening, although serious reactions can present with mild symptoms and signs. Some reactions can be reduced or prevented by modified (filtered, washed, or irradiated) blood components. When an adverse reaction is suspected, the transfusion should be stopped and reported to the blood bank for investigation.

Transfusion reactions may result from immune and nonimmune mechanisms. Immune-mediated reactions are often due to preformed donor or recipient antibody; however, cellular elements may also cause adverse effects. Nonimmune causes of reactions are due to the chemical and physical properties of the stored blood component and its additives.

Transfusion-transmitted viral infections are increasingly rare due to improved screening and testing. As the risk of viral infection is reduced, the relative risk of other reactions increases, such as hemolytic transfusion reactions and sepsis from bacterially contaminated components. Pretransfusion quality assurance improvements further increase the safety of transfusion therapy. Infections, like any adverse transfusion reaction, must be brought to the attention of the blood bank for appropriate studies (Table 138e-3).

IMMUNE-MEDIATED REACTIONS

Acute Hemolytic Transfusion Reactions Immune-mediated hemolysis occurs when the recipient has preformed antibodies that lyse donor erythrocytes. The ABO isoagglutinins are responsible for the majority of these reactions. However, alloantibodies directed against other RBC antigens, i.e., Rh, Kell, and Duffy, are responsible for more fatal hemolytic transfusion reactions.

Acute hemolytic reactions may present with hypotension, tachypnea, tachycardia, fever, chills, hemoglobinemia, hemoglobinuria, chest and/or flank pain, and discomfort at the infusion site. Monitoring

TABLE 138e-3 RISKS OF TRANSFUSION COMPLICATIONS

	Frequency, Episodes: Unit
Reactions	
Febrile (FNHTR)	• 1–4:100
Allergic	• 1–4:100
Delayed hemolytic	• 1:1000
TRALI	• 1:5000
Acute hemolytic	• 1:12,000
Fatal hemolytic	• 1:100,000
Anaphylactic	• 1:150,000
Infections[a]	
Hepatitis B	• 1:220,000
Hepatitis C	• 1:1,800,000
HIV-1, -2	• 1:2,300,000
HTLV-1 and -2	• 1:2,993,000
Malaria	• 1:4,000,000
Other Complications	
RBC allosensitization	• 1:100
HLA allosensitization	• 1:10
Graft-versus-host disease	Rare

[a]Infectious agents rarely associated with transfusion, theoretically possible, or of unknown risk include West Nile virus, hepatitis A virus, parvovirus B19, *Babesia microti* and *Babesia duncani* (babesiosis), *Borrelia burgdorferi* (Lyme disease), *Anaplasma phagocytophilum* (human granulocytic ehrlichiosis), *Trypanosoma cruzi* (Chagas' disease), *Treponema pallidum,* and human herpesvirus-8.

Abbreviations: FNHTR, febrile nonhemolytic transfusion reaction; HTLV, human T lymphotropic virus; RBC, red blood cell; TRALI, transfusion-related acute lung injury.