New York State Council on Human Blood and Transfusion Services

GUIDELINES FOR TRANSFUSION THERAPY OF INFANTS FROM BIRTH TO FOUR MONTHS OF AGE

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NEW YORK STATE COUNCIL ON HUMAN BLOOD AND TRANSFUSION SERVICES

GUIDELINES FOR TRANSFUSION THERAPY OF INFANTS FROM BIRTH TO FOUR MONTHS OF AGE

INTRODUCTION

New York State's population numbers more than 19 million people served by more than 200 hospitals. Some 875,000 units of red blood cell (RBC) components are transfused annually in the State, along with nearly 450,000 units of other components. The New York State Council on Human Blood and Transfusion Services, appointed by the Governor, is composed of eight experts in transfusion medicine and a representative of the public. The Council, with the approval of the Commissioner of Health, determines policies and standards for blood collection and transfusion in the State. Some of these standards are promulgated as regulations by the Department of Health; others are issued as guidelines and generally set the standard of practice in the State's blood banking community.

In revision of this document, several pediatric transfusion guidance documents were reviewed, as well as subspecialty articles in the field. In comparing these publications, it is clear that, in pediatric transfusion, a firm consensus is lacking regarding definitive indications for transfusion.

Informed consent for transfusion is necessary. New York State does not have a standard consent form or a requirement for the frequency for which informed consent should be obtained and documented. Specifications for informed consent are the purview of each transfusion facility, and its risk management advisors. However, it is recommended that documentation be placed in the patient's chart, signed by the transfusing physician, attesting that the indications, risks (including possible fatal adverse effects), benefits, estimated number of, and alternatives to transfusions have been explained to a patient or authorized surrogate. Documentation of the indications should include pertinent patient signs and symptoms, as well as hematological data. In the case of an infant, a parent or other legally authorized adult acts as a surrogate. The parent or surrogate's consent or refusal should be acknowledged, and documented in the chart, consistent with the policies of the transfusion facility. Follow-up of transfusion refusal should be consistent with the urgency of the need for transfusion, the facility's policies, the State laws applicable to the patient's age and other circumstances relevant to the specific patient.

The Blood Services Committee endeavored to produce a document that would serve as an educational tool, as well as a reference source. These guidelines are intended to be clear and concise, yet comprehensive in addressing the most important aspects of transfusion therapy for infants. They are designed to be of value to the transfusion medicine community, as well as to pediatricians, pediatric residents, and medical students. It is understood that these guidelines will need to be revised as advances are made in the field and new information becomes available.

In the first four months of life, infants require repeated RBC transfusions more frequently than older children and adults. This increased transfusion need usually stems from: (i) large volume phlebotomy for blood tests relative to the limited available blood volume; (ii) postnatal physiologic anemia frequently encountered in conditions involving cardiopulmonary compromise; (iii) limited or delayed responsiveness of infant bone marrow to various

hematologic stresses; and (iv) prolonged hospital stays for premature infants with very low birth weight.

Transfusion of blood components presents more potential risks with adverse outcomes for ill, high-risk infants than for older recipients. Concerns include transfusion-transmitted pathogens, particularly cytomegalovirus (CMV) which has been addressed through the recommendation for the use of CMV-safe components; the potential for transfusion-associated graft-vs-host disease; the risk for hyperkalemia particularly associated with large volume transfusions and recently, the concern about the potential association of transfusion with development of necrotizing enterocolitis. Erythropoietin has been evaluated as an alternative to RBC transfusion for the treatment of anemia of prematurity. However, erythropoietin's long-term safety, efficacy and cost-effectiveness have not been well established in this context. RBC transfusion guidelines are now more conservative than in the past, and the previous practice of replacing blood loss secondary to phlebotomy, volume-for-volume, is less prevalent. At the same time, increased emphasis has been placed on microsampling, volume efficient testing, and careful monitoring of blood samples expended for testing. If repeated small volume transfusions are needed, every effort should be made to reduce the number of donor exposures.

Transfusion therapy must be individualized, based on each infant's clinical status and on the resources of the institution. These guidelines set forth acceptable clinical circumstances under which transfusion may be given, but are not intended to be absolute indications for transfusion. Special clinical circumstances not covered by the guidelines may make transfusion therapy acceptable, and treatments included in these guidelines may not necessarily be clinically beneficial for a given patient.

I. PRETRANSFUSION TESTING OF INFANTS

A. An initial pretransfusion specimen from the infant must be tested for ABO group and Rh type.

Note: A heelstick specimen from the infant is preferable to a cord blood specimen, to allay concerns about potential cord blood misidentification and Wharton's jelly contamination.

B. An initial antibody screen must be done using a sample from either the infant or the mother. If no unexpected antibodies are detected initially in either the mother or infant, the RBC unit is ABO-compatible with the infant and mother and either Rh-negative or of the same Rh group as the infant:

1. repeat ABO/Rh grouping is not required;

2. repeat antibody screening is not required; and

3. compatibility testing is not required.

Note: If (maternal) IgG anti-A or anti-B antibodies are detected, ABO-compatible cells should be transfused until antibody is no longer demonstrable in the infant's serum; it is not necessary to perform compatibility tests on these units. If a non-group O infant has received blood components containing alloagglutinins

directed against his/her own A and/or B antigens, and if subsequent donor RBCs selected for transfusion are not group O, the infant's serum or plasma should be tested for anti-A and anti-B.

C. Compatibility testing is required only under the following conditions (the mother's serum may be used for the compatibility testing under conditions 1 and 2):

1. an unexpected antibody is detected in the infant's or mother's serum;

2. the infant has an unexplained positive direct antiglobulin test result (*e.g.,* not due to Rh immune globulin);

3. if the mother received Rh immune globulin; or

4. the infant is to receive RBC transfusion incompatible with the mother's serum (the compatibility test must then be performed with the infant's serum, including antiglobulin phase).

D. For infants with ABO hemolytic disease of the newborn, only group O RBCs should be transfused until compatibility tests are nonreactive with ABO-specific units.

E. For plasma, infants should receive ABO-specific components whenever possible, to avoid transfusing plasma antibody incompatible with the infant's red cell antigens.

F. Platelet transfusions should be ABO compatible.

II. TRANSFUSION THERAPY GUIDELINES FOR INFANTS

A. RBC transfusions may be performed to improve tissue oxygenation under the circumstances described in the Appendix on page 14 of this document.

Asymptomatic anemia of prematurity alone is not necessarily an indication for transfusion. Blood loss through phlebotomy is no longer replaced volume-for-volume.

B. Exchange Transfusion

Severe hemolytic disease of the newborn or progressive hyperbilirubinemia posing a risk for kernicterus (especially in the preterm, acidotic/asphyxiated infant) are the usual indications for exchange transfusion. However, early use of phototherapy, to convert skin-bound unconjugated bilirubin to a water-soluble excretable form, has resulted in a diminished need for exchange transfusion to relieve hyperbilirubinemia. In the event that an exchange transfusion is necessary, the following have been recommended:

- RBCs should be hemoglobin S-negative and CMV-safe.

- CPD, CPDA-1 and additive solution (with supernatant removed) packed RBCs reconstituted with frozen plasma or albumin have been used for exchange. The plasma should be of the same ABO group as the infant’s or group AB, and the RBCs are usually reconstituted to the desired hematocrit, generally to approximately 45 percent.

- In the case of components irradiated prior to storage, it may be advisable to use fresh RBCs and/or washed RBCs, and/or to transfuse more slowly than usual if there is concern regarding renal insufficiency or hyperkalemia. Insufficient published data are available regarding the safety of stored irradiated RBCs seven days old for exchange transfusion for infants with risk factors for hyperkalemia.

- The RBCs should be group O or other ABO group-compatible with the infant and mother, Rh-negative or Rh-identical with the infant, and lack RBC antigens to which the mother has made alloantibodies. RBCs should be crossmatch-compatible with the infant's serum or plasma. If an adequate infant sample is unavailable, or in the presence of significant maternal red cell alloantibodies, it may be desirable or necessary to demonstrate crossmatch compatibility with maternal serum or plasma, and/or with the infant's eluate (if the infant's direct antiglobulin test is positive).

- Blood components should be irradiated for exchange transfusions if there has been a previous intrauterine transfusion or if a directed donor unit from a blood relative is to be used, or if the infant and the donor are members of the same genetically homogeneous group. For other neonatal exchange transfusion cases, irradiation should be considered provided it does not delay transfusion and result in prolonged hyperbilirubinemia.

- Renal insufficiency and hyperkalemia are addressed in Section III. C., Special Considerations – Irradiated Blood Components (pages 8-9).

- The American Academy of Pediatrics has specific practice guidelines for management of hyperbilirubinemia, and recommends that exchange transfusions be performed only by trained personnel in an appropriately equipped neonatal intensive care unit.

C. Extracorporeal Membrane Oxygenation (ECMO)

ECMO is a form of heart-lung bypass for treating reversible pulmonary disease or temporary cardiac malfunction. Large volume RBC and platelet transfusions may be required.

Components used do not require irradiation. There has been one documented case of graft-vs-host disease in patients undergoing ECMO.

The recommendations in Section ll. B. (pages 3-4) regarding blood components for exchange transfusion also apply to ECMO. Also see information on page 5 regarding platelet transfusion.

D. Intrauterine Transfusion

The administration of intrauterine red blood cell or platelet transfusions should be performed only at institutions with high-risk obstetrical services experienced in this procedure. This procedure is usually considered for severe fetal anemia due to intrauterine blood loss of either a hemorrhagic or immunohematologic nature, such as severe Rh hemolytic disease or for severe fetal thrombocytopenia associated with neonatal alloimmune thrombocytopenia (NAIT). RBCs administered should be as fresh

as possible, group O, hemoglobin S-negative, crossmatch-compatible with the mother's serum, and have an adjusted hematocrit and red cell mass intended to achieve the desired therapeutic effect while minimizing the volume used. Platelets transfused for NAIT should be either crossmatch-compatible or negative for the antigen to which the mother has antibody. Additionally, intrauterine RBC and platelet transfusions should be CMV-safe (seronegative and/or leukoreduced) and irradiated. Any subsequent postdelivery transfusion, whether an exchange transfusion, supplemental RBC transfusion or platelet transfusion, should also be irradiated.

E. Platelet Transfusion

In view of the relatively high incidence of clinically silent intraventricular hemorrhage in premature (< 37 weeks gestation) thrombocytopenic infants, radiologic or sonographic determination of the presence or absence of intraventricular hemorrhage is crucial. The presence of intraventricular or other life-threatening hemorrhage should be emergently treated with platelet transfusion while the underlying etiology is being investigated and other therapy is instituted.

1. Non-immune thrombocytopenia – indications

   a. platelet count < 20-30,000/µL (20-30 x 10^9/L) in infants with a failure of production;

   b. platelet count < 50,000/µL (50 x 10^9/L) with bleeding, or prior to non-neurologic invasive procedures or minor surgery;

   c. platelet count < 100,000/µL (100 x 10^9/L) prior to neurological invasive procedures, cardiovascular or neurologic surgery, or other major surgery;

   d. qualitative platelet defect with bleeding, prior to invasive procedures or surgery, or with unexplained excessive bleeding during cardiopulmonary bypass; and

   e. platelet count < 80-100,000/µL (< 80-100 x 10^9/L) prior to and during an ECMO procedure, or with unexplained excessive bleeding during the procedure.

2. Immune thrombocytopenia

   Neonatal immune thrombocytopenia is caused by maternal anti-platelet antibodies, either auto- or allo(iso)-immune anti-platelet antibodies, which cross the placenta and interact with fetal platelets.

   a. Thrombocytopenia due to maternal autoantibodies: Intravenous immune globulin (IVIG), with or without steroids, is generally useful to increase the platelet count and to prolong platelet survival in this self-limiting disorder. Platelet transfusions are not indicated in the absence of life-threatening bleeding.

   b. Neonatal alloimmune (isoimmune) thrombocytopenia: The treatment of choice is IVIG, with or without steroids, matched antigen-negative platelets, and/or crossmatch-compatible platelets. If antigen-negative or compatible platelets are not immediately available, a trial of random donor platelets should be given to infants with severe thrombocytopenia (< 30,000/µL) and/or clinical bleeding. If

maternal platelets are used, the component must be irradiated and it is usually plasma reduced or washed to avoid passive infusion of antibody.

If neither matched antigen-negative nor crossmatch-compatible platelets are available, and there is poor response to random donor platelets, necessitating a postpartum emergency donation of a mother's platelets to her infant, infectious disease testing may be waived with the written authorization of the medical director of the blood bank per 10 NYCRR, Section 58-2.3(d). However, every attempt should be made to review the results of maternal antepartum infectious disease testing in order to avoid transfusion transmission of an infectious agent (*e.g.,* HIV) to an infant who may not have contracted it already because of maternal treatment during pregnancy or other protective factors.

Antepartum management of NAIT: If platelets are needed for IUT or at time of delivery, the component should be CMV-safe, irradiated, and either crossmatch-compatible or negative for the antigen to which the mother has antibody. In the case of antepartum maternal donation, all routine tests appropriate for neonatal transfusions should be performed, and the unit may be transfused, provided it meets standard criteria for allogeneic donation.

F. Granulocyte Transfusion

At present, the relative efficacy of granulocyte transfusions compared to appropriate available antibiotic therapy is controversial. Granulocytes may be considered under the following four circumstances:

1. bacterial sepsis unresponsive to antibiotics in infants under 2 weeks of age with neutrophil-plus-band count < 3,000/µL (3×10^9/L);

2. bacterial sepsis unresponsive to antibiotics in infants greater than 2 weeks of age with neutrophil-plus-band count < 500/µL (0.5×10^9/L);

3. fungal infection and neutropenia as defined in F.1. and F.2. above; and

4. documented infection unresponsive to antibiotics in the presence of a qualitative neutrophil defect, regardless of the neutrophil-plus-band count.

Note: Granulocyte concentrates usually carry significant red blood cell contamination. They should be ABO- and crossmatch-compatible and Rh-negative or Rh-identical with the infant and should lack any significant red cell antigen to which significant maternal alloantibodies are still detectable. The concentrate should be CMV-safe and irradiated. It should not be transfused within four to six hours of administration of the anti-fungal agent amphotericin B, in order to minimize the potential for adverse pulmonary reactions.

G. Indications for Fresh Frozen Plasma (FFP) and Plasma Frozen Within 24 Hours After Phlebotomy (PF24)

1. reconstitution of red blood cells for exchange transfusion or other massive transfusion;

2. isolated or multiple coagulation factor deficiency, with bleeding, or prior to invasive procedure or surgery, if specific factor replacement is not possible;

3. vitamin K deficiency resulting in a coagulopathy, with bleeding, or prior to invasive procedure or surgery;

4. thrombotic thrombocytopenic purpura (TTP);

5. replacement therapy in congenital antithrombin III deficiency, protein C deficiency or protein S deficiency, when specific factor replacement is not available; and

6. clinical evidence of coagulopathy when laboratory results are pending.

Note: Prophylactic administration of FFP/PF24 is not appropriate, except prior to invasive procedures or surgery, in the presence of significant congenital or acquired factor deficiency(ies).

H. Indications for Cryoprecipitate

1. von Willebrand disease, with bleeding, prior to invasive procedures or preoperatively, when factor concentrate containing von Willebrand factor is not available;

2. hypofibrinogenemia or dysfibrinogenemia, with bleeding or preoperatively, when fibrinogen concentrate is not available; and

3. replacement therapy in factor XIII deficiency, when factor Xlll concentrate is not available.

III. SPECIAL CONSIDERATIONS

A. RBC Age, Preservatives, Hemoglobin S Status

During RBC storage, there is an increase in potassium leakage from within the RBC to the supernatant. Packed RBCs of any age are acceptable for small volume “anemia” transfusions (approximately 15 mL/kg), unless there is a specific concern about hyperkalemia, which is generally not a problem for transfusions ≤ 25 mL/kg. However, it is a concern when units/components that have been irradiated. See page 9.

For an infant who requires multiple small volume transfusions, it is desirable to minimize the number of donor exposures by aliquoting the same unit repeatedly, using a sterile connecting device.

Red blood cell preservatives acceptable for small volume transfusions include CPD; CPDA-1; and additive solutions containing additional adenine, dextrose, and, in some cases, mannitol. The safety of additive solutions for massive or exchange transfusions has not yet been established in this country. For multiple transfusions of preterm neonates with severe renal insufficiency, it may also be desirable to remove the supernatant, which contains plasma and preservatives.

A suggestion for the use of hemoglobin S-negative RBCs in infants, in some literature, is based on case reports. This attribute is probably most important in exchange transfusion and other large volume and/or rapid transfusions, as well as for transfusion of hypoxemic neonates.

B. Cytomegalovirus

Cellular blood components from CMV-seropositive donors may contain residual leukocytes that can be infectious to seronegative infants. CMV-safe cellular components (RBCs and platelets) should be provided to infants who weighed < 1,200 g at birth or who are immunocompromised **AND** whose mothers are either seronegative or whose serostatus is unknown. An infant who is at risk for transfusion-transmitted CMV for any reason should receive CMV-safe cellular blood components.

Note: Use of CMV-seronegative or leukoreduced cellular components decreases the risk of CMV transmission. There are conflicting data on the efficacy of CMV-seronegative vs. leukoreduced cellular blood components for prevention of CMV transmission by transfusion.

C. Irradiated Blood Components

Transfusion-associated graft-vs-host disease (GVHD) has been reported in infants transfused with cellular blood components. The risks of GVHD in premature infants who have received a small volume transfusion of RBCs or platelets are unknown, although cases have been documented. Irradiation of cellular blood components with a minimum of 2,500 rad (25 Gy) is recommended for the following clinical circumstances:

1. infants with a known or suspected congenital T-cell immunodeficiency syndrome;

2. infants undergoing hematopoietic progenitor cell transplantation (the hematopoietic progenitor cell product itself must not be irradiated);

Note: Post-transplant patients should continue to receive irradiated blood components until the patient's physician determines that the patient has recovered immunologically and has demonstrated evidence of immune competence, by either post-vaccination titers or by immunologic assays.

3. fetuses receiving intrauterine transfusions as well as all subsequent cellular transfusions post delivery;

4. infants undergoing chemotherapy, radiotherapy, or other immunosuppressive therapy; and

5. premature infants < 1,200g birth weight.

It is recommended that the following cellular blood components be irradiated:

1. cellular blood components from blood relatives or when the infant and donor are members of the same genetically homogeneous group;

2. HLA-matched or crossmatch-compatible platelets; and

6. granulocyte components.

Note: For pre-term or term infants receiving large volume transfusions in association with exchange transfusion or ECMO with no risk factors as stated above, the risks of TA-GVHD and the need for irradiation must be balanced against those of any delay in transfusion while irradiation is performed.

The release of potassium is enhanced when a component has been irradiated. In the case of concern about renal insufficiency or hyperkalemia in a patient who is to receive a large volume and/or rapid transfusion (*e.g.*, during surgery) of RBCs that were irradiated prior to storage, measures that can be taken to try to minimize the potassium load include:

1. obtaining RBCs fresher than seven days old;

2. removing the supernatant following centrifugation;

3. using washed RBCs; and

7. reducing the rate of infusion.

It also may be advisable to avoid large-volume or rapid transfusion of stored irradiated RBCs through central lines. Insufficient published data are available on the safety of stored irradiated RBCs for either large or small volume transfusions, but calculations suggest that these are acceptable for small volume transfusions (*i.e.*, those ≤ 25 mL/kg) infused over 2 to 4 hours even on the 28-day expiration date of such cells.[1]

D. Recommendations for Blood Component Administration

1. Filtration: All RBCs, platelets, and plasma transfused to infants, as well as to adults, must be administered through a standard blood filter (80-260µ) or other appropriate filter.

   Granulocyte transfusions should be administered only through a standard blood filter; a microaggregate or leukocyte reduction filter should never be used for granulocyte components. A cryoprecipitate infusion set may minimize the loss of components because of smaller priming volume.

2. Leukoreduction: Whenever leukoreduced components have been stored, a standard blood filter should be used for administration.

   Note: The effectiveness of a leukoreduction filtration device in preventing alloimmunization and febrile transfusion reactions, already established in adults receiving transfusions, has yet to be demonstrated in the infant population, at least in part because such events are so uncommon in this group.

3. Infusion chambers: Because administration of blood components to infants is generally volume specific, it should be performed using a calibrated chamber device. The chamber may be in the form of a syringe or closed infusion set, such as a volumetric buretrol. If a syringe is used, the blood component to be administered

may be aspirated through a blood filter administration set attached to the unit. Blood issued should be limited to a four-hour supply.

Infusion pumps: Several available mechanical monitoring syringe pump devices allow constant infusion from a syringe with accurate rate- and volume-controlled delivery. Syringe pumps are suitable for volumes from 10 to 50 mL. Smaller volume transfusions, typically < 10 mL per episode, are usually given via a syringe containing a prefiltered blood component administered manually or using a syringe pump. Volumes > 50 mL are usually contained within a blood bag or transfer pack, and transfused either with a calibrated infusion pump or through an infusion set with a calibrated infusate chamber reservoir, such as a buretrol.

The advantages of electronic infusion devices include such features as flow monitoring, an alarm for high-pressure inflow status, and accurate infusion rate. Many electric infusion pumps are also battery-powered, allowing for patient portability. Infusion pumps require periodic monitoring for flow rate accuracy and possible hemolysis.

Pumps to be used for infusion of blood components must be approved by the director of the transfusion service.

4. Blood warming devices and phototherapy precautions: All blood components to be transfused to infants should be as close as possible to room temperature, especially when infused through a central venous line. The small volume of blood usually transfused to infants generally makes mechanical blood warmers impractical, as they require large volumes to pass through the warming coils. For most small volume infant transfusions, blood components may be warmed passively by placement in a temperature-controlled isolette, or at room temperature, for approximately 30 minutes prior to transfusion. Blood components should never be warmed directly, such as in hot water, or in a microwave device designed for thawing frozen components. Whenever transfusions are given during phototherapy, the tubing should be placed so as to minimize its exposure to the phototherapy light.

   Large volume transfusion of infants, such as exchange transfusions and transfusions during surgery, should be performed using a blood warmer to avoid hypothermia in the infant. Prewarmed syringe aliquots may also be taken from the exit port of a standard blood warming device.

5. Dose and rate of administration

   The rate of infusion depends on the type of component, the total volume to be infused, venous access, and the infant's intravascular fluid tolerance. Small volume red cell transfusions are usually infused over a 2 to 4 hour period, whereas plasma and platelet transfusions may be transfused more rapidly if the patient's cardiovascular status is stable. Total duration of administration for any component or pool must not exceed four hours.

Doses commonly used:

RBC: 10 – 15 mL/kg, as tolerated

FFP: 10 – 15 mL/kg, as tolerated

Platelets: 5 – 10 mL/kg, as tolerated

Large volume RBC transfusions should be administered using an infusion device, within a four hour time frame, as tolerated. If the transfusion interval is to exceed four hours, the blood component should be subdivided, and the second portion stored in the blood bank until needed.

For RBC transfusions, the expected response to a standard dose depends on the concentration of red blood cells in the component, which varies based on the anticoagulant/preservative solution used. RBCs with a hematocrit > 80%, such as those in CPD or CPDA-1, would be expected to result in an increment of 3 g/dL. Those in an additive solution, with a hematocrit of approximately 60%, would be expected to result in an increment of 2 g/dL. The dose may need to be adjusted depending on the patient's clinical condition, the desired hemoglobin increase, and the concentration of red blood cells in the component.

6. Volume reduction: There should be a valid medical reason for removing the plasma (*e.g.*, the presence of maternal anti-platelet antibodies). Volume reduction of cellular components can be achieved by centrifugation and expression of the supernatant prior to transfusion. However, volume reduction of platelet components may result in platelet loss and is seldom necessary because the usual dose of 5-10 mL/kg can usually be tolerated, depending on the infant's clinical status. Volume-reduced platelet components should rest at room temperature for one hour without agitation prior to resuspension to maximize function. Careful consideration should be given to the functional capacity and delay in availability of volume-reduced platelets. Such platelets must not be stored for more than two to four hours.

7. Vascular access in infants: Vascular access may present challenges in small infants. Typically, venous access is gained by using a small standard intravenous catheter or "butterfly" needle. These devices, generally ranging in size from 21- to 25-gauge, have been shown to be effective and to cause no significant hemolysis. However, small caliber devices limit the rate of infusion and the amount of infusion pressure that can be applied, particularly with electronic infusion pumps.

   The umbilical vein and other central veins should not be accessed for routine transfusion, except for exchange transfusions, because of the risk of infection and thrombosis. However, in neonatal intensive care units, the umbilical vein is commonly catheterized in very sick infants within 48 hours of birth. On rare occasions, venous "cut-downs" may be employed in order to attain vascular access, particularly for long-term care infants, but percutaneous indwelling catheter lines have largely replaced these (see Section III. C., page 9).

8. Monitoring recipients for complications and reactions: Transfusions should be administered in a monitored setting. Blood glucose should be checked periodically if glucose infusion was interrupted during transfusion; hypoglycemia may occur

suddenly. The infusion should be stopped, the infant evaluated clinically, and the situation assessed by the blood bank if any of the following develop during the transfusion:

a. apnea, tachypnea, or respiratory distress;

b. tachycardia, bradycardia, or arrhythmia;

c. cyanosis;

d. significant change in systolic blood pressure;

e. significant increase or decrease (> 1°C or > 2°F) in temperature; and/or

f. hemoglobinuria.

Whenever a hemolytic transfusion reaction is suspected, one should initiate a transfusion reaction work-up; send post-transfusion blood and urine specimens to the blood bank.

E. Minimizing Donor Exposure in Infants

Infant exposure to allogeneic blood may be minimized by limiting transfusions to strictly appropriate indications, so that the benefits outweigh the risks. If transfusion is required, a blood aliquot technique should be used whenever possible.

1. Blood aliquot techniques:

    a. One method uses blood collected using a quadruple pack (quad set), to aliquot a unit of packed RBCs into satellite bags within a closed system, thereby preserving the original component expiration date. Each of the satellite packs may be utilized as needed, either for a single infant requiring multiple transfusions or for more than one infant.

    b. Another method employs small (20-60 mL) satellite transfer packs that can be filled with blood from a particular blood unit using a sterile docking device. These devices allow aseptic thermal welding of two segments of blood or infusion tubing, thereby maintaining the sterility and original outdate of the blood component. The "freshness" of blood is a lesser concern than the risks of additional donor exposure, and aliquots from the same unit may be used until its expiration date.

    c. It is also possible to obtain individual syringe aliquots from RBC units, either through an injection port placed in the blood component unit or by docking a syringe, in a sterile fashion, to an aliquot bag. Once an RBC component unit is entered, the syringe aliquot and the remaining component will expire in 24 hours. Until dispensed, RBC aliquots should be stored at 1-6°C in a temperature-monitored refrigerator.

Individual syringe aliquots of platelets may be obtained from a platelet unit immediately prior to transfusion.

2. Blood relatives as donors: Use of maternal blood for transfusion is not recommended in the absence of a specific valid medical indication, and blood from the father and other relatives holds no advantage and may pose additional risks. Directed donation from all blood relatives, including the mother, carries an added risk of immune complications, such as alloimmunization to HLA antigens and transfusion-associated graft-vs-host disease. It is important to irradiate cellular components from all blood relatives, and whenever the recipient and the donor are members of the same genetically homogeneous group, to prevent the latter complication. In the scenario of a mother donating for her child, there is also the potential risk of transfusion-related acute lung injury (TRALI) due to maternal HLA and/or neutrophil antibodies directed against the child's white blood cells. Paternal blood for transfusion poses the risk of a missed private antigen/antibody incompatibility against an RBC antigen that would not be detected in routine screening; therefore, a full crossmatch should be performed. Incompatibility with HLA and/or neutrophil antigens can also occur.

APPENDIX

Guidelines for Transfusion of RBCs in Patients Less Than Four Months of Age

Hgb < 7 g/dL with low reticulocyte count and symptoms of anemia[a]

Hgb < 10 g/dL:

- CPAP/MV with mean airway pressure < 6 cm H_2O
- FIO_2 < 35% via oxygen hood
- On nasal canula
- Significant apnea or bradycardia
- Significant tachypnea or tachycardia[b]
- Low weight gain (<10 g/d over 4 days)

Hgb < 12 g/dL:

- CPAP/MV with mean airway pressure > 6-8 cm H_2O
- FIO_2 > 35% via oxygen hood

Hgb < 15 g/dL with severe pulmonary or cyanotic heart disease/congestive heart failure

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Abbreviations

FIO_2: fraction of inspired oxygen
TBV: total blood volume
CPAP/MV: continuous positive airway pressure/mechanical ventilation

[a] Tachycardia, tachypnea, poor feeding
[b] Heart rate greater than 180 beats/min or respiratory rate greater that 80 breaths/min, sustained > 24 hours.

Adapted from Fasano R, Luban NLC. Blood component therapy. Pediatr Clin N Am 2008;55:421-45.

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