

2015

BloodCenter of Wisconsin Pediatric Transfusion Guidelines

11/16/2015

Contents

Contents	2
Overview	3
Children < 4 months of Age	4
Red Blood Cells.....	4
Intrauterine/Exchange Transfusion	6
Platelets	8
Plasma	10
Children > 4 months of Age	12
Red Blood Cells.....	12
Platelets	15
Plasma	17
Cryoprecipitate (all ages)	19
Factor Concentrates	21
Special Attributes (all ages)	22

Overview

The purpose of these neonate and pediatric transfusion guidelines is:

1. To provide practitioners and caregivers with an overview of evidence-based, best practice for the appropriate use of blood and blood components in the neonate and pediatric patient and thereby to promote optimal transfusion therapy.
2. To provide up-to-date references to support these practices. Selected references are listed under each blood component.
3. Serve as audit criteria for monitoring blood ordering practice by the hospital transfusion committee or quality improvement committee.

The physicians and staff of the BloodCenter of Wisconsin's Medical Science Institute (MSI) have compiled these guidelines after critical review of the cited references to provide practitioners with a comprehensive summary of the literature and society recommendations applicable to the indications for transfusion of blood components and factor concentrates in adults. Information and recommendations provided reflect the current scientific and clinical knowledge at the time of publication, are only current as of their publication date, and are subject to change without notice as advances emerge. For guidelines pertaining to adult patients, the reader should refer to BloodCenter of Wisconsin Adult Transfusion Guidelines (November 2015). The BloodCenter of Wisconsin Medical Advisory Committee completed review and final approval of these guidelines on April 1, 2015.

The MSI physicians hope to foster adoption of best practice for usage of blood and blood component by providing this guidance to each institution. This guidance is intended for educational and informational purposes only. Updates to these guidelines will be done in as timely a fashion as possible when new evidence-based practice becomes available. BloodCenter of Wisconsin (BCW) does not approve or endorse any specific methods, practices, or sources of information. BCW assumes no liability for any injury and/or damage to persons or property arising out of or related to the use of or reliance on any guidance document published by BCW.

Each institution's medical staff in collaboration with their transfusion service medical director should review these guidelines. After review and acceptance by the institution's respective Medical Executive Committee, the institution's guidelines should be shared with all physicians and other practitioners who order blood and blood components. In addition, variations in practice, which take into account the needs of the individual patient and the resources and limitations unique to the institution, may warrant approaches, treatments and/or procedures that differ from the recommendations outlined in this guidance.

These pediatric guidelines are recommendations only. These recommendations should not be construed as dictating an exclusive course of management, treatment or care, nor does the use of such recommendations guarantee a particular outcome. This guidance is not intended to replace a practitioner's best judgment based on the clinical circumstances of a particular patient or patient population. The decision to transfuse or not to transfuse should be made by the patient's physician only after a careful assessment of the patient's clinical condition and laboratory parameters. Documentation for transfusion of all blood, blood components, and factor concentrates should include the indication(s) for the transfusion or infusion; this is especially important if the circumstances/indication for the transfusion falls outside established guidelines for the institution.

Children < 4 months of Age

Red Blood Cells

How Supplied:

All Red Blood Cell products supplied by BloodCenter of Wisconsin undergo pre-storage leukoreduction. Pediatric aliquots are supplied by BCW either as empty bags attached to the main RBC unit or pre-filled aliquots (3 bags filled, each with approximately 80-100 mL; 6 bags filled, each with 40-50 mL; 9 bags filled, each with 25-35 mL). Outdate for the filled aliquots is the original expiration date of the main donor unit.

Utilization Review Guidelines:

Red cell transfusions are primarily indicated to improve oxygen carrying capacity. Documentation of the indication(s) for transfusion and special circumstances for transfusion that take place outside these guidelines is recommended.

Indications:

1. Massive blood loss or acute blood loss due to trauma, surgery or other cause associated with hypovolemic shock
2. Hgb < 8 g/dL (Hct < 24%) in stable neonates with clinical manifestations of anemia (tachycardia, tachypnea, poor feeding, poor weight gain, apnea)
3. Hgb < 10 g/dL (Hct < 30%) in neonates with:
 - a. O₂ requirement < 35% by hood or nasal cannula
 - b. On continuous positive airway pressure (CPAP) or stable ventilator setting (mean airway pressure < 6 cm of water)
 - c. Significant apnea or bradycardia, significant tachycardia or tachypnea
 - d. Low weight gain (poor feeding)
4. Hgb < 12 g/dL (Hct < 35%) in neonates with:
 - a. FiO₂ requirement > 35%
 - b. On CPAP or IMV (Intermittent Mandatory Ventilation) with mean airway pressure ≥ 6-8 cm of water
 - c. Deteriorating respiratory status
 - d. With hypotension or shock requiring vasopressors
 - e. Recovering from major surgery
 - f. Severe traumatic brain injury

5. Hgb < 15 g/dL (Hct < 45%) in neonates
 - a. With cyanotic congenital heart disease

Attributes or Product Modifications (see page 22 for details):

1. Washed – recommended for patients requiring large volume RBC transfusions (>20mL/kg) if fresh blood (< 7 days) not available
2. Irradiated – for all neonates
3. CMV negative – for all infants with low birth weight < 1500 grams in the NICU
4. Leukoreduced – all RBC units supplied by BCW
5. Utilize dedicated adult unit for multiple transfusions to provide minimal donor exposure
6. RBCs < 7 days of age for intrauterine transfusions and large volume transfusions only (see below)

Dosing Recommendations:

- 10-15 mL/kg of body weight should raise the Hgb by 2-3 g/dL or the Hct by 6%.
- Transfusion rate is dependent on the clinical condition and age of the infant/pediatric patient; rate of transfusion should be prescribed by the ordering physician.

Outcome Indicators:

- Improvement in clinical status of infant (relief of symptoms related to decreased oxygen carrying capacity)

Comments:

- There is currently no definitive evidence for transfusion threshold in neonates. The use of restrictive (lower Hgb) vs. liberal (higher Hgb) threshold for prophylactic transfusion in this group was studied in 2 large randomized control trials. In those trials and the follow-up studies and analyses there is suggestion - but nothing definitive – that a liberal transfusion threshold may be neurologically protective in the long term.^{1,3,5,9,11}
- Minimal donor exposure can be facilitated by the use of aliquots supplied in advance by BloodCenter of Wisconsin or an appropriate system at the hospital.
- All blood donated by direct blood relatives should be irradiated prior to transfusion to prevent Transfusion-Associated Graft vs. Host Disease.^{2, 7, 8}

DIRECTED DONATION:

- Directed donations are blood donated by family or friends specifically for an individual.
- Donors must meet all the criteria for allogeneic blood donations which allow the units to be released into the general inventory if not needed by the patient.
- ABO/Rh group and type of directed donations must be compatible with the patient; if not, the unit is released into general inventory.
- Directed donations are not necessarily safer than that collected from volunteer donors

WHOLE BLOOD:

- *Availability of whole blood is limited in this community. When used, it is most often reconstituted from leukoreduced red cells and compatible plasma.*

Intrauterine/Exchange Transfusion

- Attributes specific to exchange therapy (hospital blood bank policies may vary-please contact your blood bank with questions):
 - a. Fresh blood (not older than 7 days)
 - b. Washed – if RBC unit older than 7 days
 - c. Irradiated
 - d. Preservative – CPDA-1
 - e. O negative red cells
 - f. Lacking implicated red cell antigen, where appropriate
 - g. CMV negative
 - h. CMV safe (leukoreduced) may be substituted for CMV negative to meet other requirements (i.e. antigen negative unit)
 - i. HgbS negative

Comments:

- If CPDA-1 units are unavailable, volume-reduced or washed Adsol units may be used as a substitute.
- Hgb S testing is often performed at the hospital. If needed, screening for Hgb S can be done at BloodCenter Immunohematology Reference lab during normal business hours.

References

1. Kirpalani H et al. The Premature Infants in Need of Transfusion (PINT) study: a randomized, controlled trial of a restrictive (low) versus liberal (high) transfusion threshold for extremely low birth weight infants. *Journal of Pediatrics* (2006);149(3):301-307.
2. Roseff SD et al. Guidelines for assessing appropriateness of pediatric transfusion. *Transfusion* (2002);42:1398-1413.
3. Bell EF et al. Randomized trial of liberal versus restrictive guidelines for red blood cell transfusion in preterm infants. *Pediatrics* (2005);115(6):1685-91.
4. Murray NA, Roberts IA. Neonatal transfusion practice. *Archives of Disease in Childhood Fetal & Neonatal Edition* (2004);89(2):F101-7.
5. LaCroix J et al. Transfusion Strategies for Patients in Pediatric Intensive Care Units. *N Engl J Med* (2007);356:1609-19.
6. Istaphanous GK et al. Red blood cell transfusion in critically ill children: A narrative review. *Pediatr Crit Care* (2011);12(2):174-183.
7. New York State Council on Human Blood and Transfusion Services. Guidelines for transfusion therapy of infants from birth to four months of age. Second Edition 2004.
8. Roseff SD ed. *Pediatric Transfusion: A physician's handbook*. AABB Press 3rd edition 2009.
9. Whyte R, Kirpalani H. Low versus high haemoglobin concentration threshold for blood transfusion for preventing morbidity and mortality in very low birth weight infants. *Cochrane Neonatal Review* (2011) Issue 11. Art. No: CD000512.
10. Fergusson DA et al. Effect of fresh red blood cell transfusions on clinical outcomes in premature, very low birth weight infants. *JAMA* (2012);308(14):1443-1451.
11. Whyte RK et al. Neurodevelopmental outcome of extremely low birth weight infants randomly assigned to restrictive or liberal hemoglobin thresholds for blood transfusion. *Pediatrics* (2009); 123:207-213.

Platelets

How Supplied:

Only leukocyte-reduced single donor apheresis platelets are supplied by BloodCenter of Wisconsin. Hospitals may request what they require including ABO/Rh and attributes. Hospitals have the option of ordering either 25 mL or 40 mL aliquots which have a 4 hour outdate. Another option for hospitals that have the ability to prepare aliquots is to request multiples of 3 empty aliquot bags attached to the main donor unit. Once prepared, these aliquots have a 4 hour outdate.

Utilization Review Guidelines:

Platelets are administered for the prevention and treatment of bleeding in infants with thrombocytopenia or platelet function defects. Documentation of the indication(s) for a transfusion episode and special circumstances for transfusion that take place outside these guidelines is recommended.

Indications:

1. Active bleeding or prior to invasive procedures
 - a. Platelet count < 50,000/ μ L in neonates
 - b. Platelet count < 100,000/ μ L in sick preterm neonates or those who need CNS surgery
 - c. Platelet dysfunction (acquired, including post-cardiopulmonary bypass, or inherent), regardless of platelet count
2. As a part of a massive transfusion protocol
3. Prophylactic use may be indicated in patients with a platelet count < 30,000/ μ L (depending on age)

Attributes or Product Modifications (see page 22 for details):

1. Leukoreduced – All platelets supplied by BCW
2. Irradiated – For all neonates
3. CMV Negative – For neonates with birth weight <1500 grams
4. Volume reduced – rarely indicated; contact Transfusion Service before ordering

Dosing Recommendations:

- 10-15 mL/kg of body weight gives an expected platelet count rise of 30,000/ μ L to 50,000/ μ L

Outcome Indicators:

- Cessation, reduction or prevention of bleeding

Special Situations:

- Neonatal Alloimmune Thrombocytopenia (NAIT):
 - a. Transfusion of platelet aliquots from random donors is an appropriate strategy in the management of unexpected, severe NAIT predominantly in first pregnancies, pending the availability of compatible platelets⁴.
 - b. For babies born to moms with history of NAIT, antigen negative platelets are available upon request.⁵ Please contact BCW Hospital Services well in advance of expected delivery.
 - c. For neonates with NAIT and receiving a maternal platelet product for transfusion, washing is recommended. Note: expiration of product is 4 hours,
- For infants with suspected polyagglutination, washed platelets may be indicated – contact a BloodCenter of Wisconsin physician if polyagglutination suspected.

References:

1. Poterjoy B, Josephson C. Platelets, Frozen Plasma, and Cryoprecipitate: what is the clinical evidence for their use in the neonatal Intensive care unit? *Seminars in Perinatology* (2009);33(1):66-74.
2. Roseff S, Luban N, Manno C. Guidelines for assessing appropriateness of pediatric transfusion. *Transfusion* (2002);42:1398-1413.
3. Roseff SD ed. *Pediatric Transfusion: A physician's handbook*. AABB Press 3rd edition 2009.
4. Kiefel V et al. Antigen-Positive Platelet Transfusion In Neonatal Alloimmune Thrombocytopenia (NAIT). *Blood*(2006);107(9):3761-3763.
5. Giers G et al. Retrospective comparison of maternal vs. HPA-matched donor platelets for treatment of fetal alloimmune thrombocytopenia. *Vox Sanguinis* (2010);98:423-430.

Plasma

How Supplied:

Plasma

- FFP or FP-24: Plasma prepared from either a whole blood or apheresis collection and frozen within 8 hours (FFP) or within 24 hrs (FP-24)
- Available as a batch of 6 aliquots from same donor (each aliquot contains between 30 to 50mL as labeled); always group AB, generally CMV seronegative
- While frozen, expiration is 1 year from date of collection
- Once thawed, the product must be transfused within 24 hours

Thawed plasma

- Unit of FFP or FP24 that was thawed and stored at 1-6 °C for 1-5 days
- Use is determined by individual institutional policy

These products are used interchangeably and are considered therapeutically equivalent for patient care.

Utilization Review Guidelines:

Neonates have decreased levels of most pro-coagulant and anticoagulant factors. In steady-state this does not cause increased bleeding or thrombosis. When there is unexpected thrombosis, bleeding or risk for bleeding, replacement of these factors via a plasma transfusion may be indicated, even in the absence of laboratory testing documentation. Documentation of the indication(s) for transfusion and special circumstances for transfusion that take place outside these guidelines is recommended.

Indications (not inclusive list):

1. Documented coagulopathy and bleeding or thrombosis
2. Support during Disseminated Intravascular Coagulation (DIC), Massive Transfusion, and during or within 24 hours after ECMO/CPB
3. Replacement therapy for clinically significant deficiency, including:
 - a. Multiple coagulation factor deficiency (i.e. liver disease)
 - b. When specific factor concentrates are not available (i.e. Factor II, Factor V, Factor X, Factor XI)
 - c. Clinically significant plasma protein deficiency (i.e. ADAMTS13, protein S)

4. Emergent correction of vitamin K deficiency (i.e. active bleeding, emergent surgery); but this does not preclude Vitamin K replacement
5. Neonates with unexplained bleeding unresponsive to other measures may be given plasma without PT, PTT.

Attributes or Product Modifications (see page 22 for details):

1. While GVHD has never been reported after plasma transfusions, and theoretically from previously frozen products, some institutions may elect to irradiate all products including plasma for certain immunocompromised patient populations.
2. Other attributes are not pertinent to plasma products.

Dosing Recommendations:

- A dose of 10-20 mL/kg of body weight typically raises procoagulant factors into hemostatic levels; monitor for desired outcome.

Outcome Indicators:

- Improvement of PT, PTT or correction of plasma protein defect/factor deficiency.
- Cessation, reduction or prevention of bleeding.

Comments:

- Evidence on the practice of plasma transfusion in neonates is not well established.
- Use of plasma to prevent bleeding or to correct mild prolongation of PT is not well established
- While fibrinogen is present in plasma, cryoprecipitate is the preferred replacement for treatment of bleeding due to low or dysfunctional fibrinogen.
- Plasma is not indicated for volume expansion, enhancement of wound healing or heparin reversal.

References:

1. Poterjoy B, Josephson C. Platelets, Frozen Plasma, and Cryoprecipitate: What is the Clinical Evidence for their use in the neonatal Intensive care unit? *Seminars in Perinatology* (2009); 33(1):66-74.
2. Roseff S, Luban N, Manno C. Guidelines for assessing appropriateness of pediatric transfusion. *Transfusion* (2002);42:1398-1413.
3. Roseff SD ed. *Pediatric Transfusion: A physician's handbook*. AABB Press 3rd edition 2009.
4. Circular of Information for the Use of Human Blood and Blood Components. US Dept. of Health and Human Services FDA and CBER April 2014.

Children > 4 months of Age

Red Blood Cells

How Supplied:

All Red Blood Cell products supplied by BloodCenter of Wisconsin undergo pre-storage leukoreduction. Pediatric aliquots are supplied by BCW either as empty bags attached to the main RBC unit or pre-filled aliquots (3 bags filled, each with approximately 80-100 mL; 6 bags filled, each with 40-50 mL or 9 bags filled, each with 25-35 mL). Outdate for the aliquot bags is the original expiration date of the main donor unit.

Utilization Review Guidelines:

Red cell transfusion may be appropriate to improve oxygen carrying capacity or as volume replacement in massive blood loss. Documentation of the indication(s) for transfusion and special circumstances for transfusion that take place outside these guidelines is recommended.

Indications:

1. Massive blood loss or acute blood loss due to trauma, surgery, or other cause associated with hypovolemic shock (>15% total blood volume)
2. Hgb \leq 8 g/dL emergent/urgent surgery; symptomatic anemia (tachypnea, tachycardia, hypotension), chemo/radiotherapy; hemodynamically stable pediatric ICU patients
3. Significant preoperative anemia when other corrective therapy not available
4. Hgb \leq 10 g/dL and severe brain injury
5. Hgb \leq 13 g/dL cyanotic heart disease, ECMO, severe pulmonary disease
6. Patients with hemoglobinopathies and/or chronic hemolytic anemias (e.g. Sickle cell disease, thalassemia) and undergo chronic or episodic transfusions for specific clinical indications

Attributes or Product Modifications (see page 22 for details):

1. Washed:
 - a. Life threatening allergic reactions despite pretreatment
 - b. ECMO or cardiac bypass surgery if fresh (<7 days) blood not available
2. Irradiated (for the prevention of Transfusion Associated Graft vs. Host disease):
 - a. Any products donated by a blood relative (directed donation)

- b. Patients treated with ECMO (extracorporeal oxygen membrane) or LVAD (left ventricular assist device)
 - c. Candidates or recipients of allogeneic or autologous BM (bone marrow) or HPC (hematopoietic cell) transplantation
 - d. Immunocompromised patients [e.g. Severe Combined Immune Deficiency Syndrome (SCIDS), Common Variable Immune Deficiency (CVID); Hodgkin's disease, non-Hodgkin's lymphoma or leukemia]
3. CMV Negative:
- a. Transplant recipients (bone marrow or hematopoietic cell transplant and solid organ):
 - 1) Allogeneic or autologous HPC transplant recipients who are CMV seronegative
 - 2) Solid organ transplant patients who are CMV seronegative
 - b. Congenital or acquired immunodeficiencies
4. Leukoreduced – all RBC units supplied by BCW
5. Sickle negative for patients with sickle cell disease/trait
6. Phenotyped-matched (C, E, K) – indicated for prevention of alloimmunization in certain chronically transfused children (e.g. Sickle cell disease, thalassemia)

Dosing Recommendations:

- 10-15 mL/kg of body weight should raise the Hgb by 2 to 3 g/dL or the Hct by 6%

Outcome Indicators:

- Improvement in clinical status of patient (relief of symptoms caused by decreased oxygen carrying capacity).
- One hour post-transfusion Hgb is equivalent to one drawn within 24 hours of transfusion if there is no ongoing blood loss.⁸

Comments:

- The use of a restrictive (lower Hgb) vs. liberal (higher Hgb) transfusion strategy in pediatric patients in the ICU whose condition was stable did not cause increase in multi-organ dysfunction, length of stay, death, or rate of infection. A sub-analysis of post surgical patients in this cohort showed the same results.^{2, 5, 6}

WHOLE BLOOD:

- *Availability of whole blood is limited in this community. When used, it is most often reconstituted from leukoreduced red cells and compatible plasma.*

DIRECTED DONATION:

- Directed donations are blood donated by family or friends specifically for an individual.
- Donors must meet all the criteria for allogeneic blood donations which allow the units to be released into the general inventory if not needed by the patient.
- ABO/Rh group and type of directed donations must be compatible with the patient; if not, the unit is released into general inventory.
- Directed donations are not necessarily safer than that collected from volunteer donors

References

1. Roseff SD et al. Guidelines for assessing appropriateness of pediatric transfusion. *Transfusion* (2002);42:1398-1413.
2. LaCroix J et al. Transfusion Strategies for Patients in Pediatric Intensive Care Units. *N Engl J Med* (2007);356:1609-19.
3. Istaphanous GK et al. Red blood cell transfusion in critically ill children: A narrative review. *Pediatr Crit Care* (2011);12 (2):174-183.
4. Roseff SD ed. *Pediatric Transfusion: A physician's handbook*. AABB Press 3rd edition 2009.
5. Rouette J et al. Red blood cell transfusion threshold in postsurgical pediatric intensive care patients: a randomized clinical trial. *Ann Surg* (2010); 251(3): 421-427.
6. Tyrrell CT, Bateman ST. Critically ill children: To transfuse or not to transfuse packed red blood cells, that is the question. *Pediatric Crit Care Med* (2012);13(2): 204-209.
7. Fung MK et al. *Neonatal Transfusion Guidelines*. AABB (2012).
8. Weisen AR et al. Equilibration of Hemoglobin concentration after transfusion in medical inpatients not actively bleeding. *Ann Int Med* (1994);121: 278-280.

Platelets

How Supplied:

Only leukocyte-reduced single donor apheresis platelets are supplied by BloodCenter of Wisconsin. Hospitals may request exactly what they require including ABO/Rh and attributes. Hospitals have the option of ordering either 25 mL or 40 mL aliquots which have a 4 hour outdate. Another option for hospitals that have the ability to prepare aliquots is to request multiples of 3 empty aliquot bags attached to the main donor unit. Once prepared, these aliquots have a 4 hour outdate.

Utilization Review Guidelines:

Platelets are administered for the prevention and treatment of bleeding in patients with thrombocytopenia or platelet function defects. Documentation of the indication(s) for a transfusion episode and special circumstances for transfusion that take place outside these guidelines is recommended.

Indications:

1. Active bleeding or prior to invasive procedures
 - a. Platelet count < 50,000/ μ L
 - b. Platelet count < 100,000/ μ L in critically ill children or surgery involving the neuraxis
 - c. Platelet dysfunction (acquired, including post-cardiopulmonary bypass, or inherent), regardless of platelet count
2. Massive bleeding, usually as part of a massive transfusion protocol
3. Prophylactic use may be indicated in patients with a platelet count < 30,000/ μ L, depending on age

Attributes or Product Modifications (see page 22 for details):

1. Leukoreduced – all platelet products supplied by BCW
2. Irradiated – when applicable
3. CMV negative – when applicable
4. Washed – Life threatening allergic reactions despite pretreatment
5. Volume Reduced – may be indicated in patients with significant volume restriction issues
6. HLA matched – when applicable; contact site Transfusion Service for additional information

Dosing Recommendations:

The following dose usually raises the platelet count by 30,000/ μ L to 50,000/ μ L:

- If child less than 10 kg of body weight, 1/4 apheresis platelet
- If child 10-30 kg of body weight, 1/2 apheresis platelet
- If child greater than 30 kg of body weight, 1 adult apheresis platelet

Outcome Indicators:

- Cessation, reduction or prevention of bleeding.

Comments:

- Prophylactic transfusion of platelets from random donors will not result in the expected rise in platelet count for patients with immune thrombocytopenia or thrombotic thrombocytopenic purpura.
- DDAVP should be considered in patients with inherited, reversible drug induced or uremic-associated platelet dysfunction.
- Bleeding can be multifactorial and other causes/treatments should be considered.

References:

1. Roseff S, Luban N, Manno C. Guidelines for assessing appropriateness of pediatric transfusion. *Transfusion* (2002);42:1398-1413.
2. Roseff S SD ed. *Pediatric Transfusion: A physician's handbook*. AABB Press 3rd edition 2009.

Plasma

How Supplied:

Plasma

- FFP or FP-24: Plasma prepared from either a whole blood collection and frozen within 8 hours (FFP) or within 24 hrs (FP-24)
- Available as a batch of 6 aliquots from a dedicated donor (each aliquot contains between 30 to 50mL as labeled); all aliquots are AB
- While frozen, expiration is 1 year from date of collection
- Once thawed, the product must be transfused within 24 hours

Thawed plasma

- Unit of FFP or FP24 that was thawed and stored at 1-6 °C for 1-5 days
- Use is determined by individual institutional policy

These products are used interchangeably and are considered therapeutically equivalent for patient care.

Utilization Review Guidelines:

Plasma transfusion therapy is indicated for treatment of documented coagulopathy, where the mechanism for coagulation defect is known, understood, and attributable to coagulation factor deficiency, and it is expected that replacement with plasma transfusion is the most efficient way to correct that deficiency. Documentation of the indication(s) for a transfusion episode and special circumstances for transfusion that take place outside these guidelines is recommended.

Indications (not inclusive list):

1. Support during Disseminated Intravascular Coagulation (DIC), Massive Transfusion, and during or within 24 hours after ECMO/CPB
2. Replacement therapy for clinically significant deficiency, including:
 - a. Multiple coagulation factor deficiency (i.e. liver disease)
 - b. When specific factor concentrates are not available (i.e. Factor II, Factor V, Factor X, Factor XI)
 - c. Clinically significant plasma protein deficiency (i.e. ADAMTS13, protein S)
3. Emergent reversal of vitamin K antagonist or correction of vitamin K deficiency (i.e. active bleeding, emergent surgery)

Attributes or Product Modifications (see page 22 for details):

1. None typically indicated
2. While GVHD has never been reported after Plasma transfusions, and theoretically from previously frozen products, some institutions may elect to irradiate all products including Plasma for neonates or certain immunocompromised patient populations

Dosing recommendations:

- A dose of 10-20 mL/kg of body weight typically raises procoagulant factors into hemostatic levels; monitor for desired outcome.

Comments:

- Plasma is not indicated for volume expansion, enhancement of wound healing or heparin reversal.
- For emergent reversal of Vitamin K antagonists, 4-Factor Prothrombin Complex Concentrate (4F-PCC) may also be considered.

References:

1. Roseff S, Luban N, Manno C. Guidelines for assessing appropriateness of pediatric transfusion. *Transfusion* (2002);42:1398-1413.
2. Roseff S (editor). *Pediatric Transfusion Therapy: A Physicians Handbook 3rd Edition.*(2009) Bethesda, MD: AABB Publishing.

Cryoprecipitate (all ages)

How Supplied: Cryoprecipitate (CRYO) is supplied as a single unit for smaller patients (e.g. neonates) or as 5-pool for larger patients. Cryoprecipitate contains fibrinogen, von Willebrand factor, Factors VIII and XIII.

Utilization Review Guidelines:

By itself, Cryoprecipitate is not effective in managing extensive, multi-factor clotting disorders found in neonates and pediatric patients. It should be used in conjunction with other transfusion support.

Documentation of the indication(s) for transfusion and special circumstances for transfusion that take place outside these guidelines is recommended.

Indications:

1. Hypofibrinogenemia (Fibrinogen < 125 mg/dL) or dysfibrinogenemia, with active bleeding or undergoing an invasive procedure¹
2. Hemophilia A (deficiency in factor VIII) or von Willebrand disease, only when virally-inactivated or recombinant concentrate is unavailable or DDAVP is not appropriate.
3. Replacement therapy in Factor XIII deficiency with active bleeding or undergoing an invasive procedure¹

Attributes or Product Modifications (see page 22 for details):

1. ABO type compatible CRYO should be used for neonates (and pediatric patients weighing < 5 kg of body weight)
2. While GVHD has never been reported after Cryoprecipitate transfusions, and theoretically from previously frozen products, some institutions may elect to irradiate all products including CRYO for pediatric patients or certain immunocompromised patient populations

Dosing Recommendations:

- One single unit of cryoprecipitate (20-25mL) per 7 kg of body weight will typically raise the fibrinogen by 100 mg/dL. Monitor for desired outcome.

Comments:

- For bleeding in patients with Hemophilia A or von Willebrand Disease, **contact pediatric hematologist for further guidance.**

- There are FDA-approved factor concentrates for replacement of fibrinogen and factor XIII. See Table on page 21.

References:

1. Roseff SD (editor). Pediatric Transfusion: A physician's handbook. AABB Press 3rd edition 2009.
2. Roseff SD et al. Guidelines for assessing appropriateness of pediatric transfusion. Transfusion (2002);42:1398-1413.

Factor Concentrates

The table below lists the available factor concentrates at BloodCenter of Wisconsin. For questions about children with known factor or suspected factor deficiencies, please consult a hematologist. *The management of each patient may be different based on clinical circumstance. Consult CHW (Children's Hospital of Wisconsin) at 414-266-2000 and ask for Hematologist On-Call.

Summary of Commonly Used Coagulation and Anticoagulation Factor Concentrates

Concentrates	Source	Preparation (generation*)	Description	Comments
Factor VIII concentrates	Recombinant	Recombinate (1st), Helixate FS (2nd), Kogenate FS (2nd), Refacto (3rd), Advate (3rd) Turoctocog alfa (NovoVIII)	Highly concentrated	Generally considered the product of choice for hemophilia A patients Recently approved in US but not marketed till 2015
	Pooled human plasma	Hemofil M, Monarc-M, Monoclate P	Ultrahigh-purity (prepared by immunoaffinity or monoclonal antibody purification) Pathogen- inactivated	
		Alphanate SD, Humate P, Koate DVI, Wilate	High- to intermediate-purity (by standard purification) Contain and can be dosed by vWF Pathogen-inactivated	Humate-P, Alphanate and Wilate are licensed for use in the US for vWD
Factor IX concentrates	Recombinant	Benefix (3rd)	Highly concentrated	Generally considered the product of choice for new hemophilia B patients
	Pooled human plasma	AlphaNine SD, Mononine	High purity Pathogen-inactivated	
		Three-factor PCCs (Konyne, Profilnine SD) Four-factor PCCs (Proplex T, Octaplex, K-centra) FEIBA (activated PCC)	Low- to intermediate-purity Pathogen-inactivated Three-factor PCCs contain variable but small amounts of Factor VII	FEIBA is equivalent in efficacy to recombinant Factor VIIa in treatment of bleeding in hemophilia A patients with inhibitors Thrombotic risk
Factor VIIa concentrate	Recombinant	NovoSeven (3rd)	Highly concentrated	Approved for hemophilia A and B with inhibitors
Fibrinogen concentrate	Pooled human plasma	RiaSTAP	Heat-treated, lyophilized	Approved for congenital afibrinogenemia and hypofibrinogenemia
Factor XIII concentrate	Cryo-depleted plasma	Corifact	Heat-treated, lyophilized	Approved for Factor XIII deficiency
Antithrombin concentrate	Pooled human plasma	Thrombate	Pathogen-inactivated	
	Recombinant	Atryn	Produced from transgenic goats	Approved for prevention of perioperative and peripartum VTE in patients with hereditary antithrombin deficiency

*In first-generation concentrates, animal and human proteins are used for fermentation and stabilization. In second-generation concentrates, human (no animal) proteins are used in fermentation but not stabilization. Third-generation concentrates contain no human or animal products at all. vWD = von Willebrand disease; VWF = von Willebrand factor;

Special Attributes (all ages)

LEUKOCYTE-REDUCED BLOOD PRODUCTS (Red Blood Cells, Platelets):

Indications:

- Prevention of febrile non-hemolytic transfusion reactions
- Prevention of HLA alloimmunization to HLA antigens
- Prevention of cytomegalovirus infections in patients at risk for CMV transfusion-transmitted infection (leukocyte-reduced products are considered CMV-safe)

Comments:

- All red cell and platelet blood products supplied by BloodCenter of Wisconsin are pre-storage leukocyte-reduced except autologous whole blood/red cells.
- Guidelines from AABB require that a leukocyte-reduced blood product contain fewer than 5×10^6 leukocytes to prevent non-hemolytic febrile transfusion reactions, and for other indications. At BloodCenter of Wisconsin, both leukocyte-reduced red cells and leukocyte-reduced platelets generally contain $<1 \times 10^6$ leukocytes.
- There is insufficient evidence of the role of leukocyte reduction in the prevention of transfusion-related immune modulation.

WASHED (Red Blood Cells or Platelets):

Indications:

- Minimize risk of hyperkalemia induced cardiac arrhythmias in high risk children (e.g. neonates, CV surgery, and large volume transfusions)
- Recurrent severe or allergic reactions not prevented with appropriate premedication
- History of anaphylactic reaction to blood components
- IgA deficiency with documented IgA antibody
- Maternal blood products for the mother's baby who is suspect of having NAIT (Neonatal alloimmune thrombocytopenia)

Comments:

- To provide a washed product, the red cell or platelet unit is prepared using 0.9% sodium chloride. Washing removes plasma proteins, antibodies, potassium and free hemoglobin. There is loss of some red cells during the washing process. When preparing washed

platelets 20-30% of the platelets can be lost as well as loss of platelet function due to platelet activation.

- The expiration date of a washed red cell unit is 24 hours from the time the washing process commences.
- The expiration date of a washed platelet is 4 hours from the time the washing process commences.

PHENOTYPED – MATCHED (Red Blood Cells)

Phenotypically matched red cells units are “matched” for the patient’s Rh and Kell antigens, regardless if the patient has the corresponding red cell antibodies or not. In patients who require chronic transfusions, providing phenotyped-matched blood has shown to decrease the rate of red cell alloimmunization from as high as 43% to only 2.2%.^{7,8}

Indications:

- Patients undergoing chronic transfusions such as for sickle cell disease and thalassemia.

CYTOMEGALOVIRUS SERONEGATIVE (CMV NEGATIVE) CELLULAR PRODUCTS (Red Blood Cells, Platelets)

There is currently no definitive evidence to dispute the practice of using leukocyte-reduction alone as an effective means to reduce transfusion-transmitted CMV. Therefore, leukoreduced blood need not be CMV-seronegative to prevent recipient CMV seroconversion. The use of CMV seronegative should be based on availability and site-specific policies.

Indications:

- Newborns weighing < 1500 grams
- Any intrauterine transfusion
- Allogeneic peripheral stem cell/bone marrow transplant patients or candidates who are CMV seronegative or of unknown CMV serostatus
- Known or suspected congenital immunodeficiency due to T-cell defects (DiGeorge syndrome, etc.) or other severe immune deficiencies who are CMV seronegative

Potential Indications upon Physician Request:

- Pregnant women
- CMV-seronegative patients with HIV
- Heart and lung transplant patients who are CMV seronegative
- CMV-seronegative autologous stem cell transplant patients
- Any patient for whom the physician, in consultation with the Transfusion Service physician, determines may be at risk for serious post-transfusion CMV infection

Comments:

- Leukocyte-reduced blood products are considered a safe alternative for CMV seronegative patients if CMV seronegative products are unavailable, some institutions or physicians who may choose to use leukoreduction as the sole means of prevention of transfusion-transmitted CMV disease. Waiting for CMV seronegative blood products should not delay care.
- CMV seronegative products are not required for patients who are CMV seropositive
- CMV serostatus does not need to be considered for fresh frozen plasma or cryoprecipitated AHF because these products are relatively acellular.
- Granulocyte transfusions, which are never leukocyte-reduced, should be CMV seronegative whenever possible when given to CMV seronegative patients.

IRRADIATED BLOOD PRODUCTS (Red Blood Cells, Platelets)

Irradiated blood products are indicated for the prevention of transfusion-associated graft vs. host disease (TA-GVHD). Irradiated blood products are prepared by exposure of the blood component to gamma or X-ray irradiation.

Indications:

- Intrauterine transfusions/exchange transfusions
- Infants ≤ 12 months of age
- Recipients of allogeneic or autologous bone marrow/hematopoietic progenitor cell transplants.
- Patients with hematological malignancies
- Patients with Hodgkin's lymphoma
- Known or suspected congenital immunodeficiency due to T-cell defects (e.g. DiGeorge syndrome, SCID)
- Patients who have received purine analogue drugs (such as fludarabine, cladribine) or other related chemotherapeutic drugs

- Patients with neoplastic disease or receiving chemotherapeutic agents (e.g. alemtuzumab or similar agents) considered to be at high risk for TA-GVHD by their physician
- Bone marrow/hematopoietic progenitor cell transplant donors who require homologous products
- Donation from blood relatives
- HLA-matched platelets
- Granulocyte transfusions

Comments:

- Irradiation of the product should be completed as close as possible to time of planned transfusion.
- Irradiation is not required for previously frozen products (FFP/FP24, cryoprecipitate AHF).
- There is no indication for irradiation of red blood cells or platelets for patients who are HIV positive or have AIDS.
- Use of irradiated blood components is not routinely required for solid organ transplant patients.

References:

1. Guidelines for Transfusion Therapy of Infants from Birth to Four Months of Age. New York State Council on Human Blood and Transfusion Services 2nd edition 2004.
2. Adama van Scheltema PN and Oepkes D. Intrauterine Blood Transfusion. ISBT Science Series (2010); 5: 1-6.
3. Transfusion Guidelines for Neonates and Older Children. BJH (2004); 124: 433-453.
4. Spinelle PC et al. Survey of transfusion policies in US and Canadian children's hospitals in 2008 and 2009. Transfusion (2010); 50: 2328-2335.
5. Treleaven J et al. Guidelines for the use of irradiated blood components prepared by the British Committee for Standards in Haematology blood transfusion task force. BJH (2011); 152: 35-51.
6. Guidelines for Prevention of Transfusion-Associated Graft vs. Host Disease (TA-GVHD), Australian and New Zealand Society of Blood Transfusion Ltd. 2011.
7. Josephson, CD et al. Transfusion in the patient with sickle cell disease: a critical review of the literature and transfusion guidelines. Transfus Med Rev 2007;21(2):118-133.
8. Pugh TM, Johnson ST, Gottschall JL, Curnes JS et al. Reducing red cell alloimmunization in patient with sickle cell disease – a 9 year follow-up. Transfusion 2004;44(S):135A.

References related to adults:

1. CMV Seronegative vs. Leukodepleted blood components for at risk recipients. November 2008; Joint UKBTS/NIBSC Professional Advisory Committee.
2. Guidelines on the use of irradiated blood components – BCSH Blood Transfusion Task Force 2010. (www.bcsguidelines.com)
3. Ruhl H et al. Transfusion-Associated Graft-Versus-Host Disease. *Transfusion Med Rev* (Jan 2009); 23(1): 62-71.
4. Boeckh M, Nichols WG. The Impact of CMV Serostatus of Donor and Recipient before Hematopoietic Stem Cell Transplant. *Blood* 2004; 103(6):2003-2008.
5. Bowden RA, Slichter SJ, Sayers M et al. Comparison of Filtered Leukocyte-reduced and CMV seronegative Blood Products for Prevention of TA-CMV. *Blood* 1995; 86(9):3598-3603.
6. Davey RJ, McCoy NC, SF Leitman et al. The Effect of Pre-storage Irradiation on Post-Transfusion Red Cell Survival. *Transfusion* 1992; 32(6):525-528
7. Guidelines for Irradiation of Blood and blood Components. New York State Council on Human Blood and Transfusion Services, 2nd edition; 2004.
8. Guidelines for Gamma Irradiation of Blood Components. Australian & New Zealand Society of Blood Transfusion. Revised 2003.
9. Laupacis A et al. Prevention of posttransfusion CMV in the era of universal WBC reduction: a consensus statement. *Transfusion* 2001; 41(560-569).
10. Leitman, SF, Tisdale JF, et al. Transfusion-associated GVHD after Fludarabine Therapy in a Patient with Systemic Lupus Erythematosus. *Transfusion* 2003; 43:1667-1654.
11. Vamvakas EC. Is White Blood Cell reduction Equivalent to Antibody Screening in Preventing Transmission of Cytomegalovirus by Transfusion? A Review of the Literature and Meta-Analysis. *Transfusion Med Rev* 2005; 10(3): 181-199.