Indiana University Health

Adult Transfusion Guidelines

I. Transfusion Administration: Refer to Blood Administration Policies in PolicyStat.

II. Documentation of Blood Component Orders and Indications
- A. Order requests for blood components must include an approved indication that is documented both in the clinical record and on the order set request. The appropriateness of each transfusion must be documented in the medical record as required by:
  1. The Joint Commission
  2. CAP (College of American Pathologists)
  3. AABB (formerly the American Association of Blood Banks)
  4. Medical Staff Rules and Regulations
- B. This document describes evidence-based guidelines for adult patients, and indicates the point at which, for a majority of patients, the benefits of transfusion outweigh the many risks of transfusion. Service lines that wish to implement evidence-based transfusion guidelines that are not consistent with the guidelines presented here should discuss the proposed guidelines with the Patient Blood Management Clinical Effectiveness Council.

III. Packed Red Blood Cells (PRBCs)
- A. Dosage
  1. For relief or prevention of symptomatic anemia, patients should receive the lowest effective dose.
  2. In adult patients, one unit of PRBC will increase the hemoglobin by approximately 1 g/dL (hematocrit by 3%).
  3. Single unit transfusions of PRBC are the standard adult dose.
     - a. Additional units increase the risk of transfusion related adverse events including infection.
     - b. Order a single unit, then clinically reassess the patient. For routine orders, if more than one unit is ordered, only one unit will be dispensed at a time.
     - c. Justification for additional units should be documented with the order indication.
  4. Two-unit transfusions are sometimes acceptable for patients with a hemoglobin less than 6 g/dl.
  5. Two-unit transfusions are sometimes acceptable for transfusion- dependent patients with marrow failure. However, the majority of these patients should be transfused with single units
  6. Multiple units may be dispensed in appropriate coolers to the OR, critical care areas, or the emergency department for patients with ongoing blood loss. This includes the Massive Transfusion Protocol.
- B. Acceptable Usage of PRBCs
  1. Acute Blood loss AND at least one of the following:
     - a. Blood loss exceeding 30-40% of blood volume.
     - b. Estimated blood loss greater than 30% of blood volume with hemodynamic instability unresponsive to appropriate volume resuscitation.
     - c. Massive Transfusion Protocol
  2. Hemoglobin of less than 7 g/dL (hematocrit 21%) AND one or more of the following:
     - a. Signs or symptoms of anemia such as angina, dyspnea, tachycardia,

CNS changes, unresponsive to management without transfusion.
b. Sepsis
c. Acute upper gastrointestinal hemorrhage (Note: patients with acute UGI hemorrhage should be managed without transfusion until the hemoglobin is less than 7 g/dl whenever possible)
d. Marrow suppression due to chemo or radiotherapy or primary marrow failure of erythropoiesis
e. Outpatient with bone marrow suppression or bone marrow failure (e.g. thalassemia, myelodysplasia, marrow aplasia) AND long-term transfusion dependency whose anemia cannot be managed with erythropoietic stimulating agents and/or intravenous iron as appropriate
f. Stable ischemic heart disease
g. In preparation for a surgical procedure or other intervention with the potential for significant blood loss, unresponsive to other methods of treating anemia such as intravenous iron or erythropoiesis stimulating agents plus intravenous iron.

3. Hemoglobin of less than 8 g/dL (hematocrit 24%) AND acute coronary syndrome OR evidence to support the need for increased oxygen delivery indicated by:
   a. Tachycardia and/or hypotension unresponsive to pharmacologic therapy
   b. New EKG changes
   c. Recurrent chest pain
   d. Mixed venous hemoglobin oxygen saturation less than 60% after optimization of oxygenation
   e. Acute respiratory failure, inadequate cardiac output or inadequate oxygenation

4. Patients requiring red cell exchange, hemoglobin less than 9 g/dl AND:
   a. Sickle cell anemia with a treatment protocol for red cell exchange
   b. Emergency exchange transfusion for patients with sickle cell disease
   c. Adjunct treatment in patients with babesiosis or malaria with life-threatening parasitemia
   d. Other red cell exchange protocol as approved by the Apheresis Medical Director or designee
5. Hemoglobin less than <10 g/dL in a sickle cell anemia patient undergoing surgery to bring the hemoglobin to 10 g/dl

C. Transfusion of packed red cells is contraindicated and not recommended for the following indications:
   1. For treatment of “anemia” or “low hemoglobin” in the absence of the above criteria
   2. For volume replacement alone
   3. In place of an available hematinic – any drug or therapy that improves the hemoglobin concentration such as iron, erythropoietin, etc.
   4. For enhancement of wound healing
   5. To improve general “well-being”
   6. For treatment of “lightheadedness”, unless the lightheadedness is persistent and orthostatic hypotension can be ruled out as a cause

IV. Platelets (PLT)
   A. PLT Product Definitions
      1. Random Donor Platelets (RDPLT): Whole blood-derived platelets. Approximately 6 units from different donors with the same ABO type are pooled together before coming to IU Health. These platelets are suspended in approximately 250-300 mL

of plasma.
2. Apheresis Platelet (APLT): One APLT is equivalent to approximately 6 units of pre-pooled RDPLT, reducing the risk of exposure to transfusion transmitted infection. In general, APLT has a lower risk of red cell exposure than RDPLT, decreasing the risk of alloimmunization to red cell antigens. These platelets are suspended in approximately 250-300 mL of plasma.
3. Pathogen-reduced platelets (PRPLT): Platelets that have been treated with an FDA-approved psoralen method to inactivate potential pathogens in the product. These platelets may be RDPLT or APLT. They may come suspended in plasma or platelet additive solution (PAS), which decreases the amount of plasma in the unit.

B. Almost all products at IU Health are APLT. Rarely, RDPLT may be provided. Regardless of type of PLT product dispensed, 1 unit will be the equivalent of 1 dose. Please do not order 6 units of RDPLT to replace 1 APLT. RDPLT will be pre-pooled and be equivalent to 1 APLT.

C. Dosage
1. Patients should receive the lowest effective dose to treat or prevent bleeding.
2. The standard dose for an APLT is one unit. For all orders, only one unit will be dispensed at a time. Additional units increase the risk of transfusion related adverse events. The patient's bleeding risk needs to be reassessed after each unit transfused.
3. In adult patients without platelet refractoriness, one unit of APLT will increase the platelet count 30,000-50,000/mm^3. A number of clinical conditions (splenomegaly, sepsis, DIC, active bleeding, patients on CRRT) may result in lower than expected post-transfusion platelet counts. In patients with consumptive processes it may not be possible to "transfuse up" to specific post-transfusion targets.
4. Patients that are refractory to platelet transfusion often have little to no response to additional PLT transfusions. The underlying condition of the refractoriness should be treated if possible. In some cases, HLA-Matched or Solid Phase Red Cell Adherence (SPRCA)- Crossmatched Platelets may be useful (see below); these products require additional time to procure.
5. One unit of APLT contains approximately 250-300 mL of plasma.

D. Acceptable Usage of PLT
1. Prophylactic Use of PLT (patients without bleeding or with minor bleeding, up to WHO Grade 2). **NOTE:** For patients with WHO Grade 3 or higher bleeding, refer to Section 3: Therapeutic Usage of PLT
    a. Patients undergoing chemotherapy or allogeneic stem cell transplant and without bleeding (WHO Grade 0) or with WHO Grade 1 bleeding: transfuse to maintain a platelet count at 10,000/mm^3 or above.
    b. Patients with hypoproliferative thrombocytopenia (marrow failure or suppression) and presence of minor bleeding (WHO Grade 2): transfuse to maintain a platelet count of at least 10,000 – 20,000/mm^3. Patients with additional risk factors for bleeding such as sepsis or coagulopathy may be transfused to maintain a higher threshold if the recommended 10,000-20,000/mm^3 does not result in clinical improvement of the bleed.
    c. Consider not transfusing prophylactic platelets for well patients:
        i. Who have had an autologous stem cell transplant and have no evidence of bleeding, regardless of platelet count.
        ii. With asymptomatic chronic bone marrow failure including those taking low dose oral chemotherapy or azacytidine.
    d. Do not give prophylactic platelets routinely for bone marrow biopsy, peripherally inserted central catheters (PICC)s, or traction removal of tunneled central venous catheters or cataract surgery.

2. Periprocedural Usage of PLT: Transfusion is indicated if the patient's pre-procedure platelet count is below the thresholds indicated as follows:
    a. Low bleeding risk procedures: Pre-procedure platelet count less than 20,000/mm^3. Low bleeding risk procedures include the following:
        i. Catheter exchanges (gastrostomy, biliary, nephrostomy, abscess, including gastrostomy/gastrojejunostomy conversions)
        ii. Diagnostic arteriography and arterial interventions: peripheral, sheath < 6 F, embolotherapy
        iii. Diagnostic venography and select venous interventions: pelvis and extremities
        iv. Dialysis access interventions
        v. Facet joint injections and medial branch nerve blocks (thoracic and lumbar spine)
        vi. IVC filter placement and removal
        vii. Lumbar puncture
        viii. Non-tunneled chest tube placement for pleural effusion
        ix. Non-tunneled venous access and removal (including PICC placement)
        x. Paracentesis
        xi. Peripheral nerve blocks, joint, and musculoskeletal injections
        xii. Sacroiliac joint injection and sacral lateral branch blocks
        xiii. Superficial abscess drainage or biopsy (palpable lesion, lymph node, soft tissue, breast, thyroid, superficial bone, e.g., extremities and bone marrow aspiration)
        xiv. Thoracentesis
        xv. Transjugular liver biopsy
        xvi. Trigger point injections including piriformis
        xvii. Tunneled drainage catheter placement
        xviii. Tunneled venous catheter placement/removal (including ports)
    b. Vaginal delivery in a non-bleeding pregnant patient: platelet count less than 30,000/mm^3
    c. High bleeding risk procedure: a pre-procedure platelet count less than 50,000/mm^3. High risk bleeding procedures include the following:
        i. Ablations: solid organs, bone, soft tissue, lung
        ii. Arterial interventions: > 7-F sheath, aortic, pelvic, mesenteric, CNS
        iii. Biliary interventions (including cholecystostomy tube placement)
        iv. Catheter directed thrombolysis (DVT, PE, portal vein)
        v. Deep abscess drainage (e.g., spine, soft tissue in intra-abdominal, retroperitoneal, pelvic compartments)
        vi. Gastrostomy/ gastrojejunostomy placement
        vii. IVC filter removal complex
        viii. Port vein interventions
        ix. Solid organ biopsies
        x. Spine procedures with risk of spinal or epidural hematoma (e.g., kyphoplasty, vertebroplasty, epidural injections, facet blocks cervical spine)
        xi. Trans-jugular intrahepatic portosystemic shunt
        xii. Urinary tract interventions (including nephrostomy tube placement, ureteral dilation, stone removal)
        xiii. Venous interventions: intrathoracic and CNS interventions

xiv. General surgery
xv. Gynecological surgery (including C-sections)

d. Epidural catheter insertion or removal: pre-procedure platelet count less than 80,000/mm^3
e. Neurosurgery or retinal surgery: pre-procedure platelet count less than 100,000/mm^3
f. In patients with proven significant congenital or acquired platelet functional defect, platelet transfusion should be based on laboratory assessment of platelet function. Surgery, including major surgery, such as cardiothoracic procedures, can be safely performed in patients with mild platelet inhibition medications (e.g. aspirin) without platelet transfusion.
Note: Documentation of evidence for severe platelet dysfunction must be noted in the transfusion order

3. Therapeutic Usage of PLT
   a. Post-surgical or post-procedural bleeding: platelet count <50,000/mm^3 or abnormal laboratory assessment of platelet function
   b. Significant non-procedure related bleeding: platelet count <50,000/mm^3 or abnormal laboratory assessment of platelet function
   c. Cardiac surgery with unexpected bleeding: platelet count <80,000/mm^3 or abnormal laboratory assessment of platelet function
   d. Massive hemorrhage protocol or massive transfusion protocol: by protocol if actively bleeding or platelet count <80,000/mm^3 or abnormal laboratory assessment of platelet function
   e. Neuroaxial bleeding: platelet count <100,000/mm^3 or abnormal laboratory assessment of platelet function
4. Use general hemostatic measures to treat bleeding in non-surgical patients during treatment with aspirin, P2Y12 antagonists or glycoprotein IIa/IIIb inhibitors. If necessary, consider drug cessation and reversal of the effect of co-prescribed anticoagulants.
   a. Use Tranexamic acid (TXA) or aminocaproic acid to counteract the effect of anti-platelet drugs when a risk/benefit assessment would support this. Avoid use of antifibrinolytic agents in urologic tract bleeding.
   b. Consider the use of platelet transfusion as an additional measure to those suggested above when critical bleeding is present. This includes membrane oxygenator defect secondary to ECMO or bypass surgery.

E. Other considerations with PLT
   1. Thrombotic Thrombocytopenic Purpura (TTP)/Hemolytic-Uremic Syndrome (HUS): platelet transfusions are a relative contraindication and may worsen the patient's condition. Rarely, platelet transfusion may be used for life-threatening bleeding.
   2. Heparin Induced Thrombocytopenia (HIT): platelet transfusions are a relative contraindication and may worsen the patient's condition. Rarely, platelet transfusion may be used for life- threatening bleeding.
   3. Idiopathic Immune Thrombocytopenic Purpura (ITP): platelet transfusions are generally ineffective and are not indicated unless there is life-threatening bleeding. Consider co-administration of intravenous immunoglobulin
   4. During splenectomy, platelet transfusions may be used immediately prior to and after clamping the splenic vascular pedicle.
   5. Platelet transfusion may be ineffective in a patient with systemic hypothermia less than 35 degrees Celsius (95 degrees Fahrenheit).
   6. Randomized controlled trials have not shown platelet transfusions to improve

neurologic outcomes or decrease mortality in intracranial hemorrhage in patients receiving platelet inhibitory drugs.

V. HLA-Matched or Solid Phase Red Cell Adherence (SPRCA)-Crossmatched Platelets
   A. Dosage: Same as for PLT
   B . Requests for HLA-matched and SPRCA platelets requires consultation with and approval by a transfusion medicine physician. The patient will be evaluated for specific lab findings to determine whether HLA-matched or SPRCA platelets are indicated.
   C. Indications for HLA-matched platelets: Patients requiring PLT transfusion who are immunologically refractory to random PLT transfusions as evidenced by at least two consecutive PLT transfusions with poor response within 15-60 minutes post-transfusion as documented by an inadequate corrected count increment (CCI).
   D. Contraindications: HLA and SPRCA crossmatched platelets are not effective for correcting thrombocytopenia from non-immune causes of platelet refractoriness. There are many non-immune causes of platelet refractoriness including: massive bleeding, fever, sepsis, splenic sequestration, DIC, allogeneic transplantation, medications, and microangiopathic hemolytic anemias.
   E. HLA-Matched and SPRCA-Crossmatched Platelets are usually clinically equivalent. The BB will determine the most efficient product to acquire based on the patient's laboratory findings.
   F. There will be a delay in obtaining HLA and SPRCA crossmatched platelets for patients. Communication with the BB is critical, especially for patients with anticipated ongoing needs.
   G. Patients with ongoing needs will be re-evaluated at intervals determined by a transfusion medicine physician to determine whether or not HLA-matched or SPRCA platelets are still indicated.

VI. Modifications for Blood Components
   A. CMV Safe Blood Components
      1. All PRBC and PLT products available at IU Health are pre-storage leukoreduced. Leukoreduced products are CMV Safe. Plasma components and CRYO lack cellular components and are, therefore, considered CMV Safe.
      2. Dosage: Same as for PRBC and PLT
      3. Indications
         a. Prevention of CMV transmission in immunosuppressed patients. CMV Safe PRBC and PLT provide substantial reduction in the risk of transfusion transmitted CMV infection. The risk reduction is greater than 93%. It is the recommendation of IU Health that the preferred method for providing CMV safe blood components is to use leukoreduced cellular blood products. The consensus opinion in the literature is that CMV seronegative blood does not confer greater CMV safety than leukoreduced blood components. However, this issue is still debated in the literature.
         b. Prevention of HLA/WBC alloimmunization
         c. Reduction in risk of non-hemolytic transfusion reactions
         d. Intrauterine transfusions
      4. The following components are considered CMV Safe:
         a. Leukoreduced PRBC and PLT
         b. CMV seronegative PRBC and PLT (Note: The exclusive use of CMV seronegative blood components may decrease protection against community acquired CMV infection in immunocompromised or immuno-incompetent transfusion recipients by limiting passive immunity from transfusion of blood components containing CMV antibodies).
         c. PRPLT are clinically equivalent to CMV Safe and CMV Seronegative products.

B. Irradiated Blood Products
    1. Viable lymphocytes in the transfused cellular blood products may cause transfusion associated GVHD (TA-GVHD), a usually fatal complication. Irradiation of cellular blood products with 2500 cGy inactivates lymphocytes. Pathogen-reduced PLT products are clinically equivalent as irradiated products.
    2. Red cells and platelets should be irradiated when the appropriate indications are present. Granulocyte products will always be irradiated.
    3. Fresh-frozen plasma, cryoprecipitate and clotting-factor concentrates do not contain viable lymphocytes, and therefore do not require irradiation.
    4. Acceptable Usage of Irradiation:
        a. Intrauterine transfusions
        b. Directed donations from blood relatives
        c. HLA compatible plateletpheresis products by typing or crossmatching
        d. Granulocyte transfusions.
        e. Certain patients with congenital immunodeficiency syndromes including but not limited to:
            i. DiGeorge's Syndrome
            ii. Severe combined immunodeficiency (SCID)
            iii. Wiskott-Aldrich syndrome
            iv. Other severe congenital immunodeficiencies
        f. Certain patients with (or patients at risk for) acquired immunodeficiency syndromes including but not limited to the following patient conditions:
            i. Received (or are planning to receive) hematopoietic progenitor cell transplantation – "e.g. bone marrow transplant"
            ii. Acute leukemia
            iii. Chronic lymphocytic leukemia
            iv. Waldenstrom's macroglobulinemia
            v. Lymphoma (including Hodgkin's and Non-Hodgkin's lymphoma)
            vi. Aplastic anemia
            vii. Neuroblastoma
            viii. Sarcoma
            ix. Receiving immunosuppressive agents such as fludarabine
            x. Receiving purine analogs, purine antagonists, bendamustine, alemtuzumab, and anti-thymocyte globulin
            xi. Other acquired caused of severe immunodeficiency. **Note**: The presence of acquired immune deficiency syndrome (AIDS) without other causes of immunodeficiency is generally NOT associated with increased risk for transfusion associated GVHD.

C. Washed Blood Components
    1. Only cellular components can be washed. This includes PRBC and PLT. Plasma products cannot be washed.
    2. Dosage: Same as for PRBC and PLT (**Note**: Washed products can have up to 20% loss of red cells and 33% loss of platelets during the process. Therefore, Hgb and Platelet incremental counts may not increase as much as expected with unwashed products.)
    3. Acceptable Usage requires the same criteria as for PRBC and PLT with at least one of the following additional criteria:
        a. History of severe allergic transfusion reactions/anaphylactic reactions not prevented by pretransfusion administration of antihistamines and/or corticosteroids
        b. Severe IgA deficiency with documented anti-IgA antibodies
    4. Washed red cells should never be used solely to prevent febrile reactions.

VII. Thawed Plasma (TP)
    A. Definition: Thawed plasma is derived from FFP [or PF24] that has been thawed in a closed

system and stored at 1 – 6 degrees C for 1 to 5 days.

1. Thawed plasma contains hemostatic concentrations of labile coagulation Factors V and VIII.
2. The average unit plasma has approximately 300 mL and an INR of 1.3.
3. The majority of plasma dispensed at Indiana University Health is Thawed Plasma, which is stored at refrigerated temperature for up to 5 days after thawing.

B. Dosage

1. **TP should only be considered for urgent correction of coagulopathy and INR. Pharmacologic correction of INR should be considered if there is no active bleeding and no urgency (e.g., withholding anticoagulants, vitamin K administration).**
2. A patient's INR does not correlate with their bleeding risk. Viscoelastic testing (e.g. TEG) can provide better indication of a patient's bleeding risk. Refer to Section XII for additional guidance on the use of viscoelastic testing.
3. When the INR is 1.8 or less, transfusion of plasma corrects the INR an average of only 0.1 per unit transfused, largely because the INR of blood bank plasma itself ranges between 1.1 and 1.3. Therefore, correction of an INR less than 1.8 is not indicated with the transfusion of plasma. High risk procedures may be performed with an INR in the range of 1.5-1.8 or less depending on the procedure and the patient's risk of bleeding.
4. Patients should receive the lowest dose possible to correct or prevent bleeding. Please refer to the table below to determine how much a single unit is expected to correct an elevated INR.

Pre-transfusion INR	INR Correction per Plasma Unit
1.9 – 2.6	0.1 – 0.5
2.7 – 4.9	0.3 – 1.1
5.0 – 9.9	0.8 – 2.5
10.0 – 14.0	4.0 – 6.0
14.1 – 20.0	5.8 – 8.4

5. To obtain a clinically relevant increase in procoagulants, the standard dosage of plasma should be 10 –15 mL/kg.
6. A maximum of 4 units of TP will be prepared at one time (with the exclusion of TP for the massive transfusion protocol). Transfusion of TP must be completed within 4 hours of issue from BB or removal from BB approved storage (e.g. BB monitored refrigerator; BB validated cooler).
7. For correction of coagulopathy prior to a scheduled procedure, plasma should be transfused as close in time as possible to the procedure.
    a. Several of the clotting factors have short half-lives. For example, the half-life of Factor VII is approximately 5 hours.
    b. If pre-procedure plasma transfusion is given too far in advance of a scheduled procedure, the effectiveness of the transfused plasma in correcting the coagulopathy could be diminished at the time of the surgery.
8. TP should not be used for correction of hypofibrinogenemia.

C. Acceptable Usage of TP

1. Periprocedural, prophylactic use of plasma is acceptable based on an increase in INR that cannot be corrected by Vitamin K and the procedure cannot be delayed. Note that vitamin K alone or 4-factor Prothrombin Complex Concentrate (PCC) should be used instead of plasma in patients receiving warfarin
    a. INR greater than 3, patient unresponsive to Vitamin K and undergoing paracentesis
    b. INR in the range of 2.0-3.0, patient unresponsive to Vitamin K and undergoing low-risk procedures such as:

i. Endoscopy/bronchoscopy without expected biopsy
ii. Paracentesis
iii. Thoracentesis
iv. Chest tube insertion
v. Lumbar puncture
vi. Dialysis access interventions
vii. Non-tunneled venous access and removal, including PICC placement
viii. IVC filter Placement or removal
ix. Tunneled venous catheter placement/removal, including ports
x. Tunneled drainage catheter placement
xi. Catheter exchanges (gastrostomy, biliary, nephrostomy, abscess catheter)
xii. Superficial abscess drainage or biopsy

c. INR greater than 2.0, patient unresponsive to Vitamin K and undergoing emergent surgical intervention

d. INR in the range of 1.5 – 1.8, patient unresponsive to vitamin K and undergoing high-risk procedures such as:
i. Arterial interventions: > 7-F sheath
ii. Catheter directed thrombolysis (DVT, PE, portal vein)
iii. Complex IVC filter removal
iv. Portal vein interventions
v. Transjugular intrahepatic portosystemic shunt (TIPS) (see ***Note**)
vi. Venous interventions: intrathoracic and CNS interventions
vii. Solid organ biopsies (Consider transjugular approach for liver biopsy to avoid platelet transfusion if count less than 50,000)
viii. Endoscopy or bronchoscopy with biopsy
ix. Deep abscess drainage or deep non-organ biopsies
x. Gastrostomy/gastrojejunostomy placement
xi. Spine procedures with risk of spinal or epidural hematoma (eg, kyphoplasty, vertebroplasty)
xii. Urinary tract interventions (including nephrostomy tube placement, ureteral dilation, stone removal)
a. ***Note:** TIPS and transjugular liver biopsy must often be performed at an INR > 1.8 in patients with hepatic coagulopathy. Data suggest that these patients may have normal thrombin generation and may be at lower bleeding risk than indicated by the INR. For TIPS, If INR is acutely elevated from baseline or >3.0, consider checking fibrinogen and if <100mg/dL give fibrinogen replacement (cryoprecipitate or fibrinogen concentrate).

e. INR greater than 1.7, patient unresponsive to vitamin K and undergoing:
i. Epidural placement or removal
ii. Surgery involving the neuroaxis
iii. Large-bore Tunneled CVC Insertion in Patients with Coagulopathy

2. Actively bleeding patient before coagulation studies are available
3. Patients undergoing transfusion per the massive transfusion protocol.
4. INR greater than 1.5 and intracranial hemorrhage; PCC unavailable or contraindicated
5. **Emergent** correction of coagulopathy due to warfarin therapy. Prothrombin Complex Concentrate (PCC) obtained from the pharmacy should be considered as the first line of treatment for warfarin reversal. TP should **only** be used for warfarin reversal if PCC is unavailable or contraindicated and always in conjunction with Vitamin K. (See Warfarin Reversal Guidelines)
a. Patients with significant bleeding.

b. Trauma patients or patients requiring emergent surgery or an emergent invasive procedure on Coumadin may require immediate reversal using both PCC and vitamin K.
c. Vitamin K therapy should be given without TP transfusion for non-bleeding patients with INR less than 2.0. P.O. Vitamin K shows an initial effect in 6-8 hours and major reversal in 18-24 hours. Intravenous Vitamin K should be used for urgent and emergent warfarin reversal. An initial effect may be seen in as little as 4 hours and major reversal is usually seen within 6-12 hours

6. Patients with liver failure and bleeding or those at significant risk for bleeding.
   a. Plasma transfusion is not recommended in non-bleeding cirrhotic patients.
   b. In patients with liver failure, PT/INR and PT is not predictive of bleeding. Viscoelastic testing may provide better evidence-based guidance for transfusion support for these patients. See Section XII.
   c. In cirrhotic patients undergoing major surgery or with hemorrhage, correct hypofibrinogemia to ensure a fibrinogen level greater than 175 mg/dL and consider rescue therapy with PCC. TP may be considered with PCC to avoid fluid overload.
7. Patients with documented or presumptive Antithrombin deficiency only if Antithrombin concentrates are not available or contraindicated.
8. Treatment of TTP or hemolytic HUS.
9. Rare documented deficiencies of certain complement factors.
10. Support during treatment of DIC.

D. Transfusion of plasma is not indicated for the following:
   1. For prophylactic treatment of minor coagulopathies
   2. For volume expansion
   3. For enhancement of wound healing
   4. For treatment of nutritional deficiencies
   5. For "correction" of mild to moderately prolonged PT/INR before an invasive procedure. Correction of the INR should be dependent on the bleeding risk of the procedure. An INR less than 2.0-3.0 is acceptable for moderate to low bleeding risk procedures.
   6. Correction of hypofibrinogenemia

VIII. Massive Transfusion Protocol (MTP)

A. When large amounts of hemorrhage are expected, PRBC, PLT, and TP are available for emergency release in a ratio to mimic whole blood. Please see the Massive Transfusion Protocol in PolicyStat for further details.

IX. Cryoprecipitate (Cryo)

A. Dosage
   1. Patients should receive the lowest dose possible to treat or prevent coagulopathy due to inadequate fibrinogen or one of the specific criteria listed below.
   2. The adult dose is 5-10 units.
   3. Only one or two doses of 5 units of cryoprecipitate will be prepared at one time with the exception of the following:
      a. Patients that are receiving fibrinolytics or have a fibrinogen less than 50 mg/dL may require a higher dose of cryoprecipitate to achieve hemostasis.
   4. The expected recovery from the above dosage is 50 – 100 mg/dL increase in fibrinogen.

B. Acceptable Usage (Cryo)
   1. Documented hypofibrinogenemia
      a. Fibrinogen less than 200 mg/dL and ongoing obstetrical hemorrhage
      b. Fibrinogen less than 100 mg/dL in setting such as DIC, acute leukemia

induction, cytokine release syndrome following immune cell therapy, etc.

c. Fibrinogen less than 150 mg/dL and ongoing large volume blood loss and coagulopathic bleeding in trauma

2. Von Willebrand's disease with bleeding not treatable with desmopressin and von Willebrand concentrate (intermediate purity factor VIII concentrates such as Humate P® or Alphanate®)
3. Select cases of hemophilia A unresponsive to desmopressin when factor VIII concentrates are unavailable (every effort should be made to obtain specific factor concentrates).
4. Factor XIII deficiency with active bleeding or pending invasive procedure when Factor XIII concentrates are unavailable
5. When needed for the preparation of Fibrin Glue
6. Patients who have received tPA for a stroke who subsequently require craniotomy for a hemorrhage.
7. CRYO is not standard issue in a Massive Transfusion Protocol (MTP). A separate order must be placed if needed during an MTP.

X. Consult with pharmacist for other blood derivatives and recombinant blood factors that are provided by the pharmacy.

XI. Use of Viscoelastic Testing to Guide Transfusion Decisions

A. Viscoelastic testing is available at select hospitals within the IU Health system. Consult with your laboratory's leadership team to determine the availability of viscoelastic testing.
B. The following guidelines are considered general recommendations when the results of viscoelastic testing are available:

TEG Value	Transfuse
R time > 10	FFP
K time > 3	cryoprecipitate
α angle < 53	cryoprecipitate +/- platelets
MA < 50	platelets
LY30 > 3%	tranexamic acid

XII. Intraoperative Blood Salvage and Normovolemic Hemodilution

A. Acceptable Usage: Expectation of salvage of a clinically significant volume of PRBC, and at least 100 mL of expected blood loss. The Perfusion team should be consulted if intraoperative blood salvage is considered.
B. The following are RELATIVE contraindications for intraoperative salvage, and may require additional processing such as use of a additional filters such as the Pall Leukoguard RS filter or Lipiguard SB Filter, double wash/extended processing, etc.:
    1. Possible infectious contamination of operative field (every effort should be made to avoid gross contamination of salvaged blood including temporary use of a waste suction. However, intraoperative salvage can often be carried out when these steps are taken).
    2. Possible contamination by tumor cells (Published data show no evidence of increased risk of metastatic disease. However, gross contamination with tumor should be avoided and a Leukoguard filter used along with double wash/extended

processing).
3. Possible contamination by amniotic fluid. (Published data show intraoperative cell salvage can be safely used in obstetrics. However, gross contamination with amniotic fluid should be avoided and a Leukoguard filter used along with double wash/extended processing. Care should be taken to try and exclude fetal blood from the placenta and umbilical cord).

C. If intraoperative blood salvage is considered, the Blood Bank attending physician should be consulted to discuss risks and benefits of the procedure.

XIII. Resuscitation Notes

A. Refer to the Massive Transfusion Protocol for treatment of exsanguination.
B. Hypothermia, acidemia, hypocalcemia and low flow states associated with acute hemorrhage impact the normal hemostatic mechanisms in several ways, e.g., microthrombosis (DIC), impaired platelet function (hypothermia), slowed protein kinetics (hypothermia, acidemia), impairing fibrin formation.
C. Several studies performed in actively bleeding patients have strongly suggested that efforts directed at reversing the coagulopathy with component transfusion in the face of hypothermia (T<35C) and low flow states are ineffective without first achieving better resuscitation. The Trauma Committee strongly recommends all effort be expended on achieving optimal resuscitation end points before consideration of treating the coagulopathy with component therapy.
D. Hypocalcemia may contribute to coagulopathy in patients who have been massively transfused (10 or more units of RBCs in a 24 hour period of time). Ionized calcium and electrolytes should be monitored regularly during resuscitation.

XIV. Granulocytes

A. The efficacy of granulocyte transfusion is controversial and associated with a substantial adverse risk and mortality including:
    1. Transfusion related acute lung injury
    2. Anaphylaxis and severe allergic reaction
    3. Transfusion associated GVHD
    4. Hemolytic transfusion reaction
    5. Inflammatory reaction
    6. Increased risk for transmission of infectious agents
B. Procurement of granulocytes requires advance notice and the coordination of multiple blood centers.
C. The use of granulocytes components requires consultation with the BB physician.
D. Dosage: Donors of granulocytes are stimulated by steroids, so their white blood cell (WBC) count and product yield is not as high as donors stimulated by G-CSF. Therefore, therapeutic doses are difficult to obtain for adult populations.
E. Acceptable usage requires the presence of prolonged, transient neutropenia from which the patient is expected to recover, **AND** and severe bacterial or fungal infection not controllable with appropriate antibiotic or antifungal therapy.
F. Notes:
    1. All granulocyte products are irradiated to prevent GVHD
    2. Granulocyte components cannot be leukoreduced, therefore CMV negative components should be ordered if the patient is CMV negative.
    3. HLA matched components may reduce the risk of transfusion related acute lung injury, however HLA-match is usually not a consideration given when selecting compatible components.
    4. Due to the emergent need for the product, the ordering physician must be aware that infectious disease testing is usually not done and must be waived. A release statement must be signed.

XV. Whole Blood

A. Definition: Whole blood will be available only at certain locations at IUH as group O low-titer

whole blood (LTO-WB). Since the units are group O, the plasma will be out-of-type for all non-group O patients, carrying a risk of hemolysis to these patients. Therefore, LTO-WB should only be used for emergency transfusions and MTPs.

B. The Blood Bank will provide LTO-WB for emergency transfusions and MTPs when inventory allows. If no LTO-WB is available, component therapy will be provided for emergency transfusions and MTPs. LTO-WB will not be a separate orderable product in Cerner.

C. Component therapy is recommended for all routine transfusions and for all transfusions at locations where LTO-WB is not available.

XVI. Cross-References:

Blood Administration - Adult
Blood Derivatives and Recombinant Blood Factors: Preparation, Dispensing and Administration
Massive Transfusion Protocol
Warfarin Reversal Guidelines: Factor IX Complex Concentrate (Profilnine)/Adult Trauma and Neurosurgical Emergent Warfarin Reversal Order Set, or Vit K Dosing Guidelines for Reversal of Warfarin-ADULT and PEDIATRIC

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