Republic of Rwanda
Ministry of Health

Rwanda Biomedical Centre
Healthy People, Wealthy Nation

NATIONAL DIRECTIVES ON RATIONAL USE OF BLOOD AND BLOOD COMPONENTS IN RWANDA

April 2023, Version 04

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FOREWORD

Transfusion medicine is a multidisciplinary science concerned with the wise use of blood or blood products in the treatment or prevention of disease. Transfusions are used for various medical conditions to replace lost components of the blood. Transfusion saves many life-threatening situations mainly in the maternity because of postpartum hemorrhages, in pediatrics because of anemia from malaria and other parasites and in surgery because of bleeding. In developed countries, progress in cardiac surgery and chemotherapy for cancer would be very limited without the large quantities of blood they require.

While Blood Transfusion is essential, it also carries risk. Transfusion complications including immunological accidents and Transfusion Transmitted Diseases put the patient's life in danger.

In Rwanda; 102,689 blood units of blood components have been transfused to patients in 2021, and many of those transfused are parturient and children. The most important indications for transfusion are hemorrhagic obstetrical complications, malaria, surgery and chronic diseases.

In order to meet all transfusion needs, the quantity of collected blood may increase due to constant improving of the quality and accessibility of health care services in Rwanda. In fact, at 7.8 collections/1000 population from 5.7/1000 in 2018, we are now still behind the WHO recommendation of 10/1000.Therefore, Blood Transfusion Division is dedicated to collecting enough blood for transfusion. Blood must be of the best quality: contamination risks should be minimized and attention should be paid to prevent complications.

To reach optimal blood safety, strategies are defined and implemented in order to recruit blood donors from infectious low risk groups, to make blood donors regular, to organize blood collections, to preserve, screen and process blood, to distribute it and to use it rationally and appropriately. To ensure that each precious gift of donation is used wisely, it is also necessary to have usage Guidelines.

Activities linked to blood transfusion are carried out by the Blood Transfusion Division (BTD), a division of Rwanda Biomedical Center (RBC), to which enough resources (human, financial and material) must be provided to achieve its mission and create a long-term sustainability.

In October 2018, the RBC/Blood Transfusion Division, in collaboration with different health professionals mostly involved in blood transfusion, had developed the Rwanda national guidelines for rational use of blood and blood components in Rwanda to help health professionals to transfuse blood and blood products rationally and safely to all patients in need.

However, since February 2019 up to now, there have been some changes in production of blood components in Rwanda such as introduction of cryoprecipitate AHF production, aphaeresis technique in blood components collection and automation of blood components preparation. Hence, those Guidelines needed to be revised to incorporate crucial updates and some specific blood transfusion protocols such as massive transfusion.

These revised guidelines will help health professionals to transfuse blood safely to all patients in need. Health Care Professionals are

encouraged to follow and respect faithfully all the instructions of these guidelines. At the hospital level, the staff are requested to respect the Guidelines related to rational use of blood, based on the principle that blood is used only when nothing else can be done to save a life.

Hospital transfusion committees are being set up to manage blood use in hospitals and help in reporting to Blood Transfusion Division all incidents and reactions related to blood transfusion.

I am convinced that if blood transfusion guidelines are correctly applied, the results will include better transfusion outcomes, fewer complications and reduced overall costs.

Then, I urge all the concerned persons to use appropriately these revised Guidelines so that blood therapy is put to its rational use.

Dr. Sabin NSANZIMANA
Minister of Health

Acknowledgement

The Rwanda Biomedical Center through the Blood Transfusion Division, would like to express its sincere gratitude to all organizations and persons, especially medical specialists who have contributed to the revision and finalization of the National Directives for the Rational use of blood and blood components.

These guidelines would have not been completed without the contribution of many organizations and people.
Our deepest appreciation goes to:

- Government of Rwanda
- The World Health Organization (WHO), Rwanda Office and Afro Region;
- The Centers for Disease Control and Prevention (CDC-RWANDA);
- To all Physicians, Researchers and Consultants as well as others who have actively contributed in the revision of these guidelines.

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List of abbreviations

AABB : American Association of Blood Banks
AHF : Anti Hemophilic Factor
AHTR : Acute hemolytic transfusion reaction
AIDS : Acquired Immunodeficiency Syndrome
BTD : Blood Transfusion Division
BP : Blood Pressure
CDC : Centers for Disease Control and Prevention
CHUB : Centre Hospitalier Universitaire de Butare
CHUK : Centre Hospitalier Universitaire de Kigali
CXR : Chest X-Ray
CVP : Central Venous Pressure
DDAVP : Desmopressin
DH : District Hospital
DIC : Disseminated Intravascular Coagulopathy
dL : Deciliter
ED : Emergency Department
FBC : Full Blood Count
FFP : Fresh Frozen Plasma
GI : Gastro-Intestinal
Gr : Gram
GVHD : Graft-Versus-Host Disease
JVP : Jugular Venous Pressure
LFTs : Liver Function Tests
HBV : Hepatitis B Virus
Hct : Hematocrit
HCV : Hepatitis C Virus
HELLP : Hemolytic anemia, Elevated Liver enzymes and Low Platelet count
Hgb : Hemoglobin
HIV : Human Immunodeficiency Virus
HLA : Human Leucocytes Antigens
HUS : Hemolytic Uremic Syndrome

ICU	: Intensive Care Unit
INR	: International Normalized Ratio
KFH	: King Faysal Hospital
KG	: Kilogram
KPH	**:** Kacyiru Police Hospital
LDH	: Lactate dehydrogenase
µL	: Microliter
MBTP	: Massive Blood Transfusion Protocol
MCH	: Maternal and Child health
mL	: Milliliter
NCDs	: Non-Communicable Diseases
UR	: University of Rwanda
Plt	: Platelet+250 784 220 290
PT	: Prothrombin Time
PTT	: Partial Thromboplastin Time
RBC	: Rwanda Biomedical Center
RBCs	: Red Blood Cells
RFTs	: Renal Function Tests
RMH	: Rwanda Military Hospital
SAGM	: Salt Adenine Guanine Mannitol
TACO	: Transfusion Associated Circulatory Overload
TBV	: Total Blood Volume
TMS	: Transfusion Medicine Specialist
TPR	: Temperature, Pulse, Respiration
TRALI	: Transfusion Related Acute Lung Injury
TTP	: Thrombotic Thrombocytopenic Purpura
USA	: United States of America
WB	: Whole blood
WBC	: White Blood Cells
WHO	: World Health Organization
PIH	: Partners In Health

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INTRODUCTION

These revised directives provide guidance to clinicians as well as other health professionals involved in blood transfusion on how to use rationally blood & blood components in Rwanda; which means safe blood components should be transfused only to treat a condition leading to significant morbidity or mortality that cannot be prevented or managed effectively by other means.

The risks associated with blood transfusion relate to the blood product itself and the donor, in particular, the transmission risk of infectious diseases, such as hepatitis B and C, syphilis and HIV/ AIDS. Blood Transfusion is also associated with immunological risks which may be acute or delayed.

The Blood Transfusion Division minimizes the infectious risk transmission in the following ways:

- Recruitment of donors from low-risk groups,
- Administration of a donor history questionnaire to potential donors before donation,
- The pre-donation medical examination to identify and exclude subjects at risk for infection,
- Screening all blood donations for Transfusion Transmissible Infections (HIV, hepatitis B and C, syphilis),
- And finally, by implementation of a well-established quality management system and quality control.

Even though these measures are respected, the transfusion risk is never reduced to zero because of the following obstacles:

- The sensitivity of the biological tests which, although very high, is not absolute.
- The window period which defines the period between the infection and the appearance of detectable serologic markers; these can take from few weeks to several months.

Given these known and hypothetical risks of transfusion, as well as the cost, liability and workload involved with this therapy, directives on the rational use of blood & Blood Components in Rwanda are paramount.

1. BLOOD COMPONENT THERAPY

1.1. Red blood cells

Description

Red cells are obtained by the centrifugation of whole blood followed by aseptic removal of the plasma supernatant. After this separation, a storage solution (e.g., SAGM) is generally added to red blood cells, allowing a storage period of 42 days at +2 to +6 °C.

Each unit contains about 200ml of packed red cells. Pediatric doses may be prepared by aseptically dividing a RBC unit into several smaller units. One donation can result in the production of several units which can be used by the same patient. This preparation is available from the BTD by request.

Indications for RBC in Adults

- ✓ **Hb < 6g/dl in the setting of**:
  - Normal or high plasma volume and with heart failure,
  - Severe chronic anemia with signs of decompensation (fatigue, intolerance, etc.)
  - Anemia in Late pregnancy, with fatigue, tachypnea when non responsive to iron and folic acid
- ✓ **Hb<7gr/dl** for ICU patients with unstable hemodynamics
- ✓ **Hb<8gr/dl** in orthopedic patients in perioperative period, active GI bleeding.

- ✓ **Hb≤8gr/dl** Cardiac patients scheduled for cardiac and none cardiac surgery
- ✓ **Acute bleeding greater than or equal to 25% blood volume** (trauma, massive bleeding during surgery) sufficient to produce signs of hypovolemia unresponsive to crystalloid or colloid infusions regardless of hemoglobin level. (Note: Blood volume (mL) = weight (kg) x 70 mL/kg)

Note:

- For patients with severe sepsis and septic shock, it is recommended to use intravenous fluids, rather than RBC transfusions as first-line therapy for the restoration of tissue perfusion.
- A restrictive strategy of pRBC transfusion (transfusion when the **Hb <7g/dl**) is recommended in treating septic patients.
- A higher transfusion trigger (transfusion when the Hb falls below 10g/dl) may be beneficial in patients with ischemic stroke, traumatic brain injury with cerebral ischemia, acute coronary syndrome (ACS), in the early stages of severe sepsis or in case a surgical intervention is planned for septic patients.
- For post-operative patients a cut off Hb of **<8g/dl** or presence of symptoms of inadequate oxygen delivery (chest pain of cardiac origin, congestive heart failure), transfusion with PRBCs is considered.
- For patients with Hb<6g/dl without signs of decompensation, identification and treatment of the cause should be the priority **rather than transfusion**

Indications for RBC in neonates and children

Neonatal

Respiratory status	Age of the neonate	Hemoglobin threshold
ventilated	< 1 week >1week	Hb <12gr /dl Hb <11gr/dl
On O_2/ CPAP	<1 week >1week	Hb <10gr /dl Hb <9gr/dl
Stable and off O_2	>1week	Hb <8gr/dl

Children

- ✓ Hb<6gr/dl with or without cardiopulmonary decompensation

- ✓ Depending on the clinical situations, and children with the following conditions:
  - ➢ Heart Failure < 8 gr/ dl
  - ➢ Severe malnutrition Hb ≤ 4 gr/ dl or ≤ 5 gr/dl with signs of respiratory distress (blood should be given with 24hrs of admission)
  - ➢ Acute severe bleeding-analogous (refer to massive transfusion)

- ✓ **Patients on chemotherapy:** Hb≤7gr/dl or Hb<9gr/dl with signs of decompensation

Dosing

A dose of 1 unit of compatible Red Blood Cells will increase the hemoglobin level in an average sized adult who is not bleeding or hemolyzing by approximately **1 g/dL or Hct by 3 %.**

In neonates, a dose of 10-15 mL/kg is generally given. This dose using CPD-SAGM packed red cells with hematocrit of approximately 60 % will increase the hemoglobin by about **3 g/dL**.

Administration

It is done intravenously using an adequate catheter and transfusion set to prevent mechanical damage and hemolysis of RBCs.

Depending on clinical circumstances of the patient, the normal duration of the infusion for an adult is between 30 minutes at a rate of 120 drops per minute and 4 hours at a rate of 20 drops per minute. For pediatric patients, the transfusion rate varies between 2 and 5 ml/kg/hour. The transfusion rate may be increased for individuals in hypovolemic shock.

1.2. Fresh Frozen Plasma (FFP)

Description

FFP 8 hours

- ✓ FFP (Fresh Frozen plasma) 8 hours is obtained by aseptically separating plasma from RBCs after centrifugation within 8 hours of collection, frozen and stored at ≤ - 30 °C.

FP 24 hours

- ✓ FP (Frozen plasma) 24 is obtained by aseptically separating plasma from RBCs after centrifugation within 24 hours of collection, frozen and stored at ≤ - 30 °C.

Storage

The maximum duration of storage is 12 months at ≤ - 30°C; the duration period can be increased depending on the temperature.

Indications for FFP/FP in adults

Considering first using other volume replacement - crystalloids which can substitute blood products as both can restore blood pressure to the patient in shock after acute blood loss and these products are free of any viral transmission risk.

- ✓ Clinical Disseminated Intravascular Coagulopathy (DIC),
- ✓ Acute hemorrhages secondary to coagulation factor deficiency (INR greater than 1.5 and elevated PT), including bleeding on Coumadin/Warfarin therapy
- ✓ As part of treatment of severe hemorrhages with liver failure,
- ✓ Massive transfusion (with coagulopathy bleeding),
- ✓ Thrombotic Thrombocytopenic Purpura (TTP) or Hemolytic Uremic Syndrome (HUS) with active bleeding.

Indications for FFP in pediatrics

- ✓ The indications for FFP are generally the same as in adult,
  - o However simple prolongation of INR<2.0 in a newborn is not an indication as all infants are born with a deficiency of vitamin K dependent factors.
- ✓ Burns and bleeding with severe hyperproteinemia.

Notes

- ✓ In liver disease, there is no benefit of FFP transfusions in patients with an INR less than 1.7
- ✓ FFP is not indicated as immediate reversal of warfarin toxicity

Dose

- ✓ **Adult and children**: 10-15 mL/kg body weight. Do not transfuse unless the pretransfusion PT is 1.5 times greater than the normal mean value or the INR is greater than 1.5.

- ✓ **Expected result**: **Adult**: In a 70 kg adult, each 250-300 ml unit will increase the activity of plasma clotting factors by about 4-5%, and fibrinogen by about 10 mg/dL.
- ✓ **Children**: Expect significant shortening of the per-transfusion PT if it is greater than 1.5 times the normal mean value and if the INR is greater than 1.5.

Administration

The FFP must be thawed quickly in an appropriate plasma thawer at 37°C and transfused with a blood component administration set with a standard filter at a flow rate of 5-10 ml/min. After thawing, the FFP must be used within 24 hours if stored at 4°C. Refreezing is prohibited.

1.3. Platelet Concentrates

Platelets can be obtained using different methods:

Pheresis platelets (plateletpheresis"); a platelet concentrates (250-400 mL) obtained by plateletpheresis (thrombapheresis or thrombocytapheresis) of a single donor who is connected to a blood processor for 1½ hours, collecting enough platelets for an effective transfusion adult dose.

Whole blood-derived platelet concentrates; a platelet concentrate (45-65 mL) separated from a whole blood donation by centrifugation. **4 to 6** units are needed to make an effective transfusion adult dose. Both techniques are used in Rwanda.

Each random donor platelet concentrate (derived from whole blood donation) contains greater than $5x10^{10}$ platelets.

A dose of six contains approximately 3 $x10^{11}$ platelets while one unit from plateletpheresis also contains approximately 3 $x10^{11}$ platelets. One adult therapeutic dose typically increases the platelet count by at least 30-60 x 10^9/liter (30 000 - 60 000 platelets/µL).

Storage:

At the blood bank: 5 days maximum if stored at 20-24°C with slow continuous agitation.
It should be immediately used after delivery to the requesting department.
Without agitation, platelets can remain intact within 24 hours, but it is always necessary to respect the temperature of storage (ambient temperature).

Indications for platelets in adults

- Platelet count ≤ 10,000 plts/µL to all patients who are chronically thrombocytopenic due to failure of production.
- Platelet count ≤20,000plts/ µL in case of elective central venous catheter insertion
- Thrombocytopenia with Platelet count < 50,000/µL in patient with
  - active bleeding
  - impending major surgery,
  - Lumbar puncture
- Thrombocytopenia with platelets count <70,000/ µL in patients undergo neurosurgery, retino-surgery, Spinal surgery
- Platelet dysfunction with normal platelets count.
  - Due to anti platelets drugs: Aspirin, Plavix
  - Due to congenital disorder of platelet function (Bernard Soulier, Glantzmans thrombasthenia, etc)

Indications for platelets in neonates and pediatrics

Neonatal

- Platelet count < 100,000/µL in a sick premature infant or prior to a neurologic invasive procedure or surgery, cardiovascular surgery, or other major surgery.
- A prophylactic transfusion trigger of < 50,000/µL for a <32 week Premature at risk for intraventricular hemorrhage
- Platelet count < 20,000/µL in regular newborn nursery

Other pediatric

- Platelet count < 10,000/µL
- Platelet count < 20,000/µL in patient with severe mucositis, DIC, coagulopathy, splenomegaly, anticoagulant therapy, lumbar puncture, or higher likelihood of bleeding
- Platelet < 50,000/µL impending surgery,
- Platelet count < 50,000/µL in patient with active bleeding
- Platelet dysfunction with normal platelets count.
  - Due to anti platelets drugs: Aspirin, Plavix
  - Due to congenital disorder of platelet function (Bernard Soulier, Glantzmans etc)

Note:

- In case of major hemorrhage and massive transfusion the target of platelet count should >75000/mcl
- For cancer patients the threshold level for platelets transfusion

- varies according to the patients' diagnosis, clinical condition, and treatment modalities.
- In case of microangiopathic hemolytic anemia (TTP, HUS) and platelets sequestration (e.g.: Hypersplenism.), transfusion of platelet is not recommended unless active bleeding.

Dosing

- 4 to 6 random donor platelet concentrates are commonly used in adults.
- For children, one platelet concentrate unit per 10 kg body weight.
- For Aphaeresis units: 1 unit of 240-300ml for an adult
- For neonates and infants, 5-10 ml per kg body weight is commonly used in any preparation of platelets.
- One platelet concentrate increases the platelet count by about 10,000/μL
- One unit of apheresis platelets increase the platelets count up to 50,000/ μL

NB: Platelets refractoriness will be defined as inadequate rise in platelets counts as measured within 6hours of platelets transfusion.

Causes may include: Immune and none immune mediated

Administration

Platelet concentrates are transfused through a blood component administration set using standard filter (pore size: 170-260 μ) with a flow rate of 5-10 ml/min.

N.B: In neonates and pediatrics consider to give the total volume in 30 min and above.
Like red cell components, administration of the platelets must follow the rule of the compatibility of ABO and Rhesus systems between the donor and the recipient.

1.4. Cryoprecipitate AHF (Cryoprecipitate)

Description

Cryoprecipitate antihemophilic factor (AHF), also known as cryoprecipitate (Cryo) are produced by thawing fresh frozen plasma slowly in refrigerated conditions (1-6 C) until all but a small precipitate is thawed. The cold thawed product is centrifuged in the cold leaving the precipitated fibrinogen and factor VIII at the bottom of the bag.

The supernatant is removed leaving the cold-precipitated protein plus 10-15 mL plasma to be refrozen and stored frozen at -18 °C or colder for 12 months. Cryoprecipitates contain Factor VIII, fibrinogen, von Willebrand Factor and Factor XIII.

Content

One unit contains 150-250 mg of fibrinogen, 40-70% von Willebrand Factor, 80-120 units Factor VIII and 20-30% Factor XIII.

Volume

Approximately 5-20 mL per unit.

Storage

Cryoprecipitate AHF is stored at –18 °C or colder for up to 1 year. A unit of thawed Cryo can be stored up to 6 hours at room temperature. After multiple units are pooled prior to transfusion they must be used within 4 hours at room temperature storage.

Indications for Cryoprecipitate Adults and Children

- Active bleeding associated with Fibrinogen deficiencies (<100mg/dl) and factor XIII deficiency.
- Patients with hemophilia or von Willebrands disease who are bleeding and when bleeding is unresponsive to desmopressin (DDAVP) or prophylactically prior to surgery.
- Targeted fibrinogen level must be above 100mg/dl

Dose

- **Adult:** One unit (5-20 ml) of cryoprecipitate per 10 kg body weight increases the fibrinogen level in the recipient by approximately 40-50 mg/dl
- **Children**: 1 to 2 units/10 kg.
- **Expected result**: **Adult:** One unit will increase Factor VIII activity by approximately 4% and fibrinogen by approximately
- 7-10 mg/dl in a 70 kg adult.
- **Children**: 1 to 2 units/10 kg will raise fibrinogen level by approximately 60 to 100 mg/dl.

Table 1: Summary on indications, dosing & storage for blood components

Typical indications in which BLOOD COMPONENTS should be ordered:		Dosing, Dose response and storage conditions:			
Blood component	**Indications**	**Dose & Transfusion duration**	**Dose response**	**Storage**	**Expiration**
RBCs (HCT 50-70%) (200ml/ bag)	-Hgb < 6g/dL in case of anemia with intolerance signs -Bleeding exceeding 25% of total blood volume -Hb<7gr/dl for ICU patients with unstable hemodynamics -Hb<8gr/dl in orthopedic patients in perioperative period, active GI bleeding. -Hb≤8gr/dl Cardiac patients scheduled for cardiac and none cardiac surgery In children -Hb<6gr/dl with or without -Hb< 8 gr/dl cardiopulmonary decompensation and heart failure -Hb ≤ 4 gr/ dl in malnutrition ≤ 5 gr/dl with signs of respiratory distress (blood should be given with 24hrs of admission) -Hb≤7gr/dl or Hb<9gr/dl: Patients on chemotherapy with signs of decompensation	5-10mL/ kg **(in ≤ 4h)**	↑ Hgb by 1-2g/dL (adult),3g/dl in children	2-6 Celsius	42 days

Typical indications in which BLOOD COMPONENTS should be ordered:		**Dosing, Dose response and storage conditions:**			
Blood component	**Indications**	**Dose & Transfusion duration**	**Dose response**	**Storage**	**Expiration**
Platelets:	Thrombocytopenia when:	5 mL/kg	↑Platelets	20-24 C	5 days
Whole blood	-PLT count < 10,000/mm^3	(or 1 whole	by	with	
derived	-PLT count < 50,000/mm^3	blood-derived	30,000 -	continuous	
(5.5x1010PLT/	with bleeding or scheduled	unit/10kg)	50,000/µL	gentle	
1 unit),	for major surgery	(4 to 6 WB		agitation	
(50ml/bag) OR Apheresis platelets (3.3x10^{11} PLT/1 unit) **250 ml / bag**	bleeding time - Documented platelet dysfunction	derived units or 1 apheresis unit for an adult) (in 20-30mn)			

Typical indications in which BLOOD COMPONENTS should be ordered:		Dosing, Dose response and storage conditions:			
Blood component	**Indications**	**Dose & Transfusion duration**	**Dose response**	**Storage**	**Expiration**
FFP (thawed plasma at 37 C) (300 ml / bag)	-Replacement of isolated or multiple clotting factor deficiencies (Factors II, V, X, XI), PT & PTT > 1.5 normal -End-stage liver disease -DIC, Massive blood transfusion -Treatment of TTP or HUS causing active bleeding -Anticoagulant overdose (coumadin), prolonged INR	10-15 mL/kg **(in 20-30 mn)**	↑Fibrinogen by about 10mg/dL ↑ Plasma clotting factors by about 4-5%	≤ –18 C	1 year
Cryoprecipitate AHF (5-20 ml/ bag)	-Hypofibrinogenemia (≤ 100mg/dL) -Dysfibrinogenemia -Hemophilia A or Von Willebrand disease - Massive hemorrhage	1 unit / 7-10 kg **(in 30-60 mn)**	↑ Fibrinogen level by about 40-50 mg/dL	≤ –18 C	1 year

Note: When writing a transfusion indication, refer to the predefined indications onto Hem vigilance system. If a physician finds that the transfusion indication of the patient was not pre-defined, he/she writes clearly a new transfusion indication.

2. MASSIVE BLOOD TRANSFUSION PROTOCOL (MBTP)

2.1. Introduction

In order to streamline the management of blood transfusion requirements in major bleeding episodes occurring in adult patients within transfusing facilities in Rwanda and assist the interactions of the hospital team treating the patient and the blood products supplying service, a massive transfusion protocol has been established. It should be noted that any instance of massive blood transfusion may have unique clinical features and the Protocol may need to be tailored to the individual patient circumstances.

It applies to all transfusing facilities. It also applies to the management of massively bleeding patients requiring massive blood transfusion. The MBTP can be initiated by any physician. The MBTP is a complex set of concurrent processes which require effective leadership within a functioning multidisciplinary team.

2.2. Definition

There is no universal definition of MBTP but in adult a MBTP is considered when there is a need of transfusion of more than 4PRBCs within 1h or 10PRBCs within 24hours.

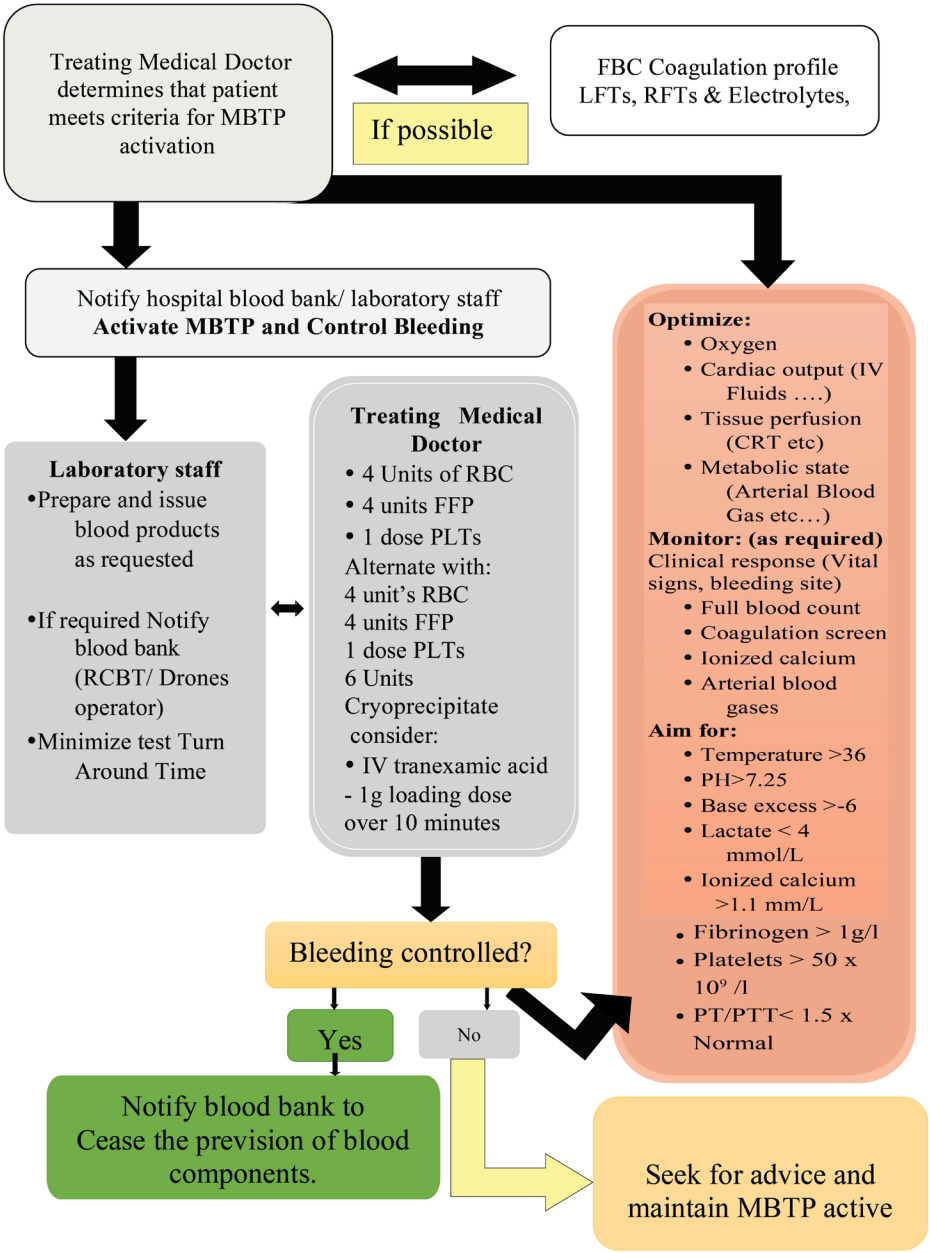
Definitions of MBT suggested for use in children are transfusion of >50% TBV in 3 h, transfusion >100% TBV in 24 h or transfusion support to replace on-going blood loss of >10% TBV/min

The definitions that use the period of 24 h are not useful during management of active blood loss, therefore the dynamic definitions, which identify rapid blood transfusion are better suited for use in day-to-day practice.

2.3. Rationale for Massive Blood Transfusion Protocol

In case of massive bleeding, transfusing fresh whole blood would seem ideal but the time required to conduct safety tests on blood is long enough to cause significant depletion of coagulation factors and platelets considering that each type of blood component requires their optimal storage conditions. Therefore, administering RBCs, coagulation factors and platelets together maintains the physiological constitution of blood and prevents deficit of one or more constituents. Massive Blood Transfusion Protocol well implemented leads to safe and judicious use of blood components.

Figure 1: Flowchart of Massive Blood Transfusion Protocol (MBTP)



2.4. When to activate a MBTP:

- Treating medical doctor activates a MBTP when:
  - A patient is having massive bleeding and she/he expects to transfuse the

- Patient more than 4units of PRBCs within one hour.
  - There is ongoing Blood loss rate of 150 ml / min.
  - There is a Half of TBV (Total Blood Volume) replaced over 3 hours
  - When 1 TBV replaced over 24 hours
  - 10 RBCs transfused over 24 hours or from time of ED admission to ICU transfer.

NOTE: **For patients with chronic conditions that are causing chronic anemia, there is no way of activating a MBTP, only PRBCs are indicated.**

2.5. Preparation for massive transfusion

- Large bore intravenous (IV) access: Two peripheral IV cannula or special wide bore cannula (insertion sheath) can be sited in neck veins such as the internal jugular vein. In emergency situations, canulation of external jugular vein, intraosseous veins and internal saphenous vein may be considered.
- Warming devices: In-line fluid warmers and surface warmers
- Continuous core temperature monitoring
- Noninvasive blood pressure, Heart rate, SpO2 monitoring
- Invasive arterial pressure monitoring if available
- Adequate amount of colloid (gelatins), crystalloid, infusion sets and IV calcium preparations

- Communication with blood bank about emerging massive blood loss situation.
- Adequate manpower for sending samples for investigations and getting blood and blood products
- Desirable Point-of-care testing: Arterial blood gas (ABG) and thromboelastographic (TEG). ABG with hemoglobin (Hb), electrolyte and lactate levels, repeated hourly, are useful in directing therapy
- Rapid infusion pumps or pressure bags to speed the fluid infusion rate
- Postoperative intensive care or High Dependent Unit: Mechanical ventilation and continuous hemodynamics monitoring are usually required due to occurrence of circulatory overload and hemodynamic/biochemical instability.

2.6. Targets of resuscitation in massive blood loss

- Mean arterial pressure (MAP) around 60 mmHg, systolic arterial pressure 80-100 mmHg (in hypertensive patients one may need to target higher MAP)
  - Hb 7-9 g/dl
  - Urine output target:
    - For adult: 0.5ml-1.5ml/kg/h
    - For a child: 1-2ml/kg/h

2.7. The following are possible complications of massive transfusion and their management

Complication	Management
Hypothermia.	Warming all IV fluids (not more than at 40 degree celcius) and by the use of forced air convection warming blankets to reduce radiant heat loss
- Dilutional coagulopathy.	**Fresh frozen plasma, platelet concentrate, and cryoprecipitate** are considered the mainstay hemostatic therapies
- Hypocalcaemia,	slow i.v. injection of calcium gluconate 10% (5 ml) over 10minutes
- Hypomagnesaemia	IV magnesium 2g in 1 hour
- Citrate toxicity.	-Treat life-threatening hypocalcemia with IV calcium (either calcium gluconate or chloride) -optimise cardiac output and liver function to enhance citrate clearance.

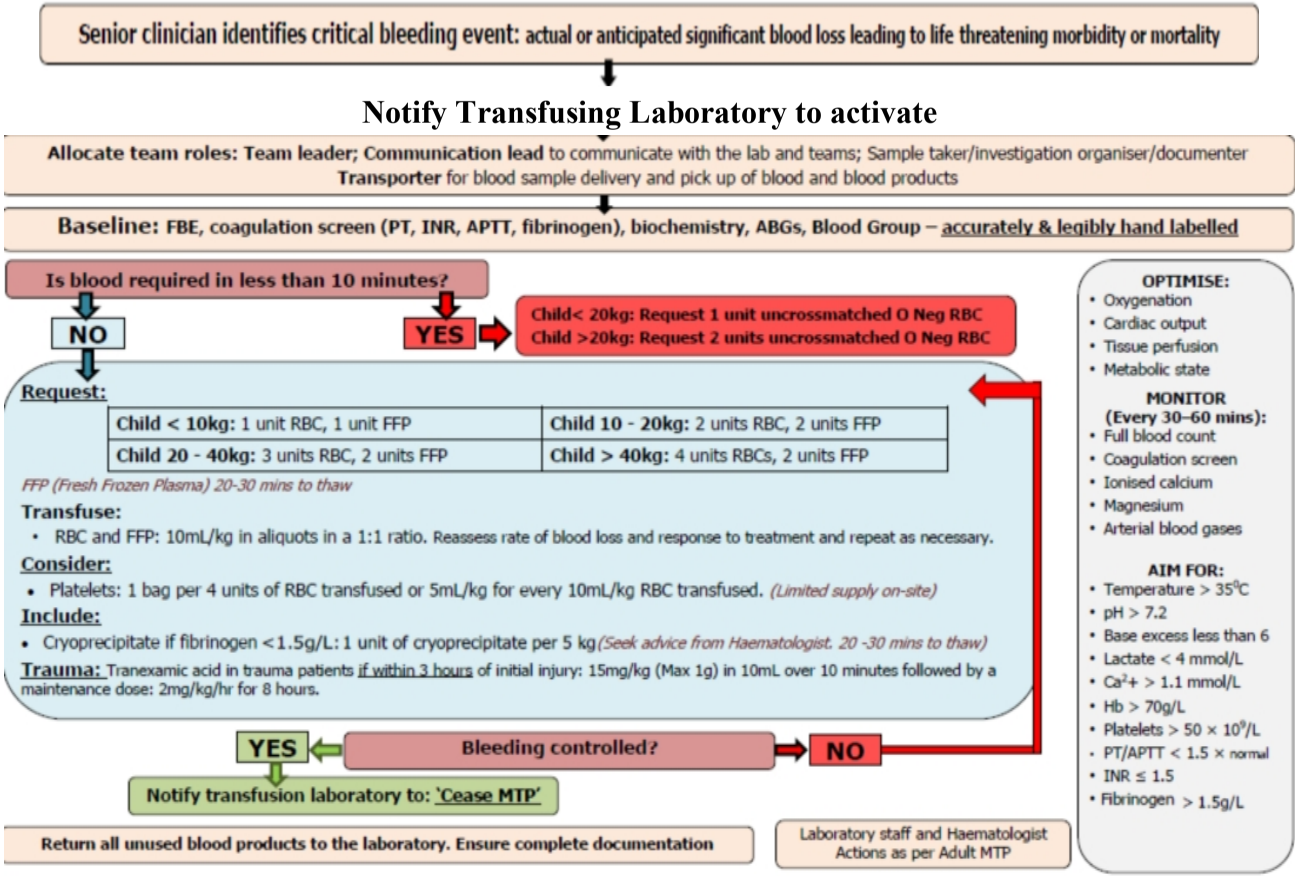
- Citrate toxicity.	-Treat life-threatening hypocalcemia with IV calcium (either calcium gluconate or chloride) -optimise cardiac output and liver function to enhance citrate clearance.
Metabolic acidosis.	Improves after adequate fluid resuscitation

Hyperkalaemia	Potassium shifting
Hypokalaemia.	IV KCl 40milequ in one hour and then reassess
Immune haemolysis	
Air embolism.	

2.8. MASSIVE TRANSFUSION IN PEDIATRICS

Definition:

- Massive transfusion in the pediatric population was defined as the transfusion of blood components equaling one or more blood volumes within a 24-hour time frame or half of a blood volume in 12 hours.
- The definition of pediatric massive transfusion is empiric based on a review of blood use patterns at our hospital
- Generally accepted blood volume conversion factors are:
  - 100 mL/kg for premature neonates
  - 90 mL/kg for mature neonates
  - 80 mL/kg for infants and
  - 70 mL/kg to 80 mL/kg for older children.
- In older, adult-sized children, massive transfusion was defined as greater than 10 U of PRBCs in 24 hours.


Senior clinician identifies critical bleeding event: actual or anticipated significant blood loss leading to life threatening morbidity or mortality
Notify Transfusing Laboratory to activate
Allocate team roles: Team leader; Communication lead to communicate with the lab and teams; Sample taker/investigation organiser/documenter
Transporter for blood sample delivery and pick up of blood and blood products
Baseline: FBE, coagulation screen (PT, INR, APTT, fibrinogen), biochemistry, ABGs, Blood Group – accurately & legibly hand labelled
Is blood required in less than 10 minutes?
NO
YES
Child< 20kg: Request 1 unit uncrossmatched O Neg RBC
Child >20kg: Request 2 units uncrossmatched O Neg RBC
Request:
Child < 10kg: 1 unit RBC, 1 unit FFP
Child 10 - 20kg: 2 units RBC, 2 units FFP
Child 20 - 40kg: 3 units RBC, 2 units FFP
Child > 40kg: 4 units RBCs, 2 units FFP
FFP (Fresh Frozen Plasma) 20-30 mins to thaw
Transfuse:
RBC and FFP: 10mL/kg in aliquots in a 1:1 ratio. Reassess rate of blood loss and response to treatment and repeat as necessary.
Consider:
Platelets: 1 bag per 4 units of RBC transfused or 5mL/kg for every 10mL/kg RBC transfused. (Limited supply on-site)
Include:
Cryoprecipitate if fibrinogen <1.5g/L: 1 unit of cryoprecipitate per 5 kg (Seek advice from Haematologist. 20 -30 mins to thaw)
Trauma: Tranexamic acid in trauma patients if within 3 hours of initial injury: 15mg/kg (Max 1g) in 10mL over 10 minutes followed by a maintenance dose: 2mg/kg/hr for 8 hours.
YES
Bleeding controlled?
NO
Notify transfusion laboratory to: 'Cease MTP'
Return all unused blood products to the laboratory. Ensure complete documentation
Laboratory staff and Haematologist Actions as per Adult MTP
OPTIMISE:
Oxygenation
Cardiac output
Tissue perfusion
Metabolic state
MONITOR (Every 30–60 mins):
Full blood count
Coagulation screen
Ionised calcium
Magnesium
Arterial blood gases
AIM FOR:
Temperature > 35°C
pH > 7.2
Base excess less than 6
Lactate < 4 mmol/L
Ca2+ > 1.1 mmol/L
Hb > 70g/L
Platelets > 50 × 10⁹/L
PT/APTT < 1.5 × normal
INR ≤ 1.5
Fibrinogen > 1.5g/L

Paediatric MTP Dosing Guide

Blood Products

													ADULT
Approximate Weight (kg)	1	3	4	5	6-7 6	8-9 8	10-11 10	12-14 13	15-18 16	19-22 20	23-28 26	29-36 32	>40
Approximate Age	Prem newborn	Newborn	Newborn	2 mos	4 mos	8 mos	1 yr	2 yr	4 yr	6 yr	8 yr	10yr	12 yr
Administer RBC and FFP 1:1 in weight appropriate volumes to maintain haemostasis and blood pressure. For every 20 mL/kg blood volume loss give:													
RBC @ 10 mL/kg (1 unit RBC ~ 280 mL)	10 mL	30 mL	40 mL	50 mL	60 mL	80 mL	100 mL	130 mL	160 mL	200 mL	260 mL	1 unit	1 unit
FFP (thawed plasma) @ 10 mL/kg (1 unit FFP ~ 300 mL)	10 mL	30 mL	40 mL	50 mL	60 mL	80 mL	100 mL	130 mL	160 mL	200 mL	260 mL	1 unit	1 unit
Platelets @ 5 mL/kg (Variable volume product)	5 mL	15 mL	20 mL	25 mL	30 mL	40 mL	50 mL	65 mL	80 mL	100 mL	130 mL	1 pooled per 4 RBC/FFP	1 pooled bag per 4 RBC/FFP

Product specifications	**RBC** Adult: 220 - 280mL Pedi: 50 -100mL (not routinely on-site)	**FFP** Adult: 250 -310mL Pedi: 60-80 mL (not routinely on-site)	**Platelets** 100 – 400mL	**Cryoprecipitate** 30 – 60mL

- Transfuse all fresh blood products (RBC, FFP, Platelets Cryoprecipitate) through a 170 to 200 micron filter.
- If a syringe is used fresh blood products must be drawn into the syringe via 170-200 micron filter.
- A fresh giving set is required for platelets.
- IV fluids that contain calcium or dextrose must not be used to prime or flush blood administration sets or be infused concurrently with blood or blood products.

Tranexamic acid Based on weight, enter values in Alaris pump		**Trauma only** Consider only if within 3 hours of initial injury Administer BOLUS DOSE (15mg/kg over 10 minutes- maximum 1g) then MAINTENANCE DOSE (2mg/kg/h for 8 hours)										
Approximate weight (kg)		3	4	5	6	8	10	13	16	20	26	32
Loading dose		45 mg	60 mg	75 mg	90 mg	120 mg	150 mg	195 mg	240 mg	300mg	390 mg	480 mg
Maintenance dose/hr		6mg	8 mg	10mg	12 mg	16 mg	20 mg	26 mg	32 mg	40 mg	52 mg	64 mg

3. ADVERSE TRANSFUSION REACTIONS

An adverse drug reaction is an unexpected or unintended effect resulting from blood transfusion.

Often patients who receive blood transfusion experience no adverse reaction.

However minor to severe complication do occasionally occur and need prompt action.

The complications of blood transfusion can be conveniently divided into acute and delayed, immunological and non-immunological categories

Table 2: Types, Symptoms & Signs, Prevention and Management

Type/Cause	Signs/Symptoms	Prevention	Treatment
Febrile (non-hemolytic) Transfusion Reaction (FNHTR) FNHTR are most frequently due to the transfusion of blood components containing	Unexplained fever ≥38°C and a temperature rise of at least 1°C but <2°C from pre-transfusion	If previously documented FNHTR give Paracetamol (appropriate dose) prior to transfusion	-Stop the Transfusion -Check label and recipient identity -Send Hemovigilance notification to Blood Bank -Antipyretic (eg. Paracetamol)

white cells to patients sensitized to white cell antigens. Antibodies are usually against HLA antigens, or sometimes against granulocyte and platelet-specific antigens; they are stimulated by previous transfusions or pregnancies. Cytokines released from white cells during storage may also be pyrogenic	baseline, chills, rigors May be present: nausea, flushing, anxiety, headache, back pain, and/or angina, tachycardia, hypertension or occasionally hypo-tension		and monitor closely check for compatibility, antibody screen and DA, haptoglobins -Steroids are not appropriate treatment for minor reactions

Type/Cause	Signs/Symptoms	Prevention	Treatment
Allergic Reaction Mild Allergic Reactions are mediated by IgE antibodies, usually against plasma proteins or other allergens present in donor plasma	Erythematous rash with itching, urticaria (hives Periorbital itch, erythema and edema, Conjunctival edema, Chills and rigors, groin pain and angina, and tachycardia	For recurrent mild reactions, prophylaxis with antihistamine to alleviate symptoms, e.g.: desloratadine 10mg or Cetirizine 10mg po Routine prophylaxis for all recipients before transfusion is not indicated	-Stop transfusion -Check label and recipient identity -Replace IV set and give IV Maintenance fluid to keep vein open -Antihistamine, e.g.: Desloratadine 5mg or Cetirizine 10mg po, Promethazine 25- 50 mg IV infusion (max rate 25 mg/min) if moderate -Increased monitoring, eg.: BP,15–30min -Send Hemovigilance notification to BB -Give steroids (Prednisolone, Hydrocortisone)

Type/Cause	Signs/Symptoms	Prevention	Treatment
Allergic Reaction -More common with Plasma and Platelet Components -Onset: from commencement to 4 hrs	Erythematous rash with itching, urticaria (hives), Angioedema, Periorbital itch, erythema and oedema, Conjunctival oedema, Minor oedema of lips, tongue and uvula, May be present: Cough, Hypotension and tachycardia, Dyspnea, Chills and rigors, Loin pain and angina, Severe anxiety	For recurrent mild reactions, prophylaxis with antihistamine to alleviate symptoms, eg Loratadine 10mg or Cetirizine 10mg po Routine prophylaxis for all recipients before transfusion is not indicated	-Stop transfusion -Check label and recipient identity - Replace IV set and give saline to keep vein open and/or maintain BP -Antihistamine, eg Loratadine 10mg or Cetirizine 10mg po, Promethazine 25- 50 mg IV (max rate 25 mg/min) if moderate -Increased monitoring, eg BP,15 – 30min -Send Hemovigilance notification to BB -Hydrocortisone may be considered

Type/Cause	Signs/Symptoms	Prevention	Treatment
Anaphylactic/Anaphylactoid Allergic Reaction (severe) Anaphylaxis is an acute, life-threatening emergency associated with shock or severe hypo-tension. Components with a high plasma component such as platelets or FFP are most likely to be implicated, but such reactions may occur with all blood components, as they all contain some plasma in the recipient reacting with a plasma protein in a blood component -IgA -Haptoglobin -Other plasma protein	**Life-threatening reaction**: Widespread urticaria with skin flushing and itching and angina, Severe anxiety, chills and rigors, cough, diarrhea, change in mental status, stridor, change in voice, respiratory distress, hypotension tachycardia and wheezing **Note**: Respiratory symptoms may dominate in anaesthetized recipients	Discuss with BB Physician before requesting: -IgA deficient blood/blood products may be appropriate if recipient is known to have absolute IgA deficiency or to have anti-IgA -Washed cellular components may be indicated where the cause of the reaction is not identified	Stop transfusion Check label and recipient identity Adrenalin 1:1000 IM and repeat at 5- 10 min intervals until symptoms improvement and MAP>65: Adult: 0.5mg / 0.5 ml IM Children 0.01mg/kg IM; min dose 0.1mL, max dose 0.5mL -Replace IV set and give crystalloid boluses (10ml/kg- 20 mL/kg, until MAP >65 / resolution of shock - Hydrocortisone 4mg/kg (200-400 mg IV) -Consider H1-antihistamine, eg Loratadine or Cetirizine 10 mg po for itch or angioedema. -H2-antihistamine, e.g., Ranitidine may be added for severe reactions. -Note: Sedating antihistamines, e.g., Promethazine contraindicated -ICU liaison -Send Hemovigilance notification to Blood Bank

Type/Cause	Signs/Symptoms	Prevention	Treatment
Hypotensive Reaction Reactions that are similar to severe allergic reactions but only have severe hypotension It is more common in patients on ACE inhibitors	Hypotension – fall in systolic BP >30 mm Hg during or within 1 h of completing transfusion and systolic BP ≤ 80 mm Hg. Or reduction of 20% from baseline in pediatric population	Withhold ACE inhibitors 12 hours before transfusion if blood transfusion is not needed urgently	-Stop transfusion -Replace the IV infusion set and infuse saline to manage BP -Symptomatic management until resolved -Send Hemovigilance notification to Blood Bank

Type/Cause	Signs/Symptoms	Prevention	Treatment
Acute Hemolytic Reaction Severe reactions may occur early in transfusion (15 minutes). Milder reactions may present later, but usually before end of transfusion Immediate intravascular red cell destruction is the most dangerous type of HTR; it is associated with activation of the full complement cascade by IgM antibodies and is practically always due to ABO-incompatible blood transfusions (hemolytic anti-A, B, anti-A or anti-B present mainly in the recipient or, rarely, in the donor plasma)	Some or all of – Unexplained fever >1°C, Chills, rigors, Pain up arm, Chest, abdominal or low back pain, Dyspnea, Tachycardia, Hypotension, shock, Hemovigilance, and hemoglobinuria, Oliguria with dark urine or anuria, Nausea, vomiting, Diarrhea, Pallor, jaundice, Bleeding (due to DIC)	-Check well recipients ID (2 persons) and labeling of pre- transfusion blood sample at recipients' side -Careful monitoring of recipient for first 15 min of each unit transfused -Store and handle-blood components within specifications	-Stop transfusion -Check label and recipient identify -Replace IV set and start normal saline -Treat shock and maintain blood pressure with IV saline infusion Investigate possible DIC and treat if clinically significant bleeding Diuretic, eg Furosemide 1-2 mg/kg IV and/or Mannitol, may help maintain urine flow -Hydrocortisone may be considered -Samples to assess renal and liver function, DIC and hemolysis, eg full blood count, unconjugated bilirubin, LDH, coombs test and haptoglobin, reticulocyte count -Send Hemovigilance notification to Blood Bank

Type/Cause	Signs/Symptoms	Prevention	Treatment
Transfusion related sepsis This complication can rapidly be fatal and may occur in particular with platelet components, which are stored at 22–24 ◦C, rather than with red cells, which are refrigerated at 2–6 ◦C. These reactions can either be due to the septicemia itself, to endotoxins, or both. The patient can present dramatically with collapse, high fever, shock and DIC	-Rigor, chills, fever Shock, usually within minutes of starting transfusion -Respiratory distress, wheezing and oxygen desaturation -Nausea, vomiting Explosive diarrhea may occur with Yersinia enterocolitica sepsis -Most common infecting agents: staphylococcal species (platelet components), gram negative species (red cell components)	Collect, store and handle blood components within specifications Inspect products for any visual abnormality or defect in unit container before transfusing: -a visibly clumped platelet component -an unusually dark red cells component -Punctured or leaking bag	-Stop transfusion -Replace IV set; give saline to maintain BP and/or keep vein open -Send Hemovigilance notification to Blood Bank -Notify Blood Bank by phone and contact TMS urgently -Obtain blood cultures from recipient if sepsis suspected then, -Give antibiotics: a broad-spectrum within the first hour. **Note:** - Blood Bank will arrange urgent Gram stain and cultures on blood component and report any positive findings -Follow the sepsis guideline

Type/Cause	Signs/Symptoms	Prevention	Treatment
TACO: Transfusion Associated Circulatory Overload Rapid onset after infusion of a volume of fluid that is clinically significant for the affected recipient. -Main risk factors: Elderly recipient with impaired cardiovascular state or renal impairment Infusion too rapid for recipient - Volume infused too great, especially if normovolaemic	-Increased blood pressure -Rapid bounding pulse -Respiratory distress with raised resp. rate, dyspnea, cough, pink frothy sputum, crepitations and oxygen desaturation consistent with pulmonary oedema Raised JVP and CVP Nausea Acute or worsening pulmonary oedema on CXR Restlessness, anxiety	Restrictive transfusion practice Monitor fluid balance esp. in elderly and children, and recipients with cardiovascular or renal disease Transfuse at a rate appropriate for recipient Give a diuretic immediately **prior** to a transfusion if cardiovascular reserve is impaired or a large transfusion is required Avoid elective transfusions at night Always prescribe pediatric transfusion dose in mL, **not** in Units.	-Stop transfusion -Seek urgent medical assessment -Sit recipient upright with legs over side of bed, administer oxygen, diuretic (Furosemide 1-2 mg/kg IV), Noninvasive ventilation (CPAP)/Invasive ventilation Send Hemovigilance notification to Blood Bank

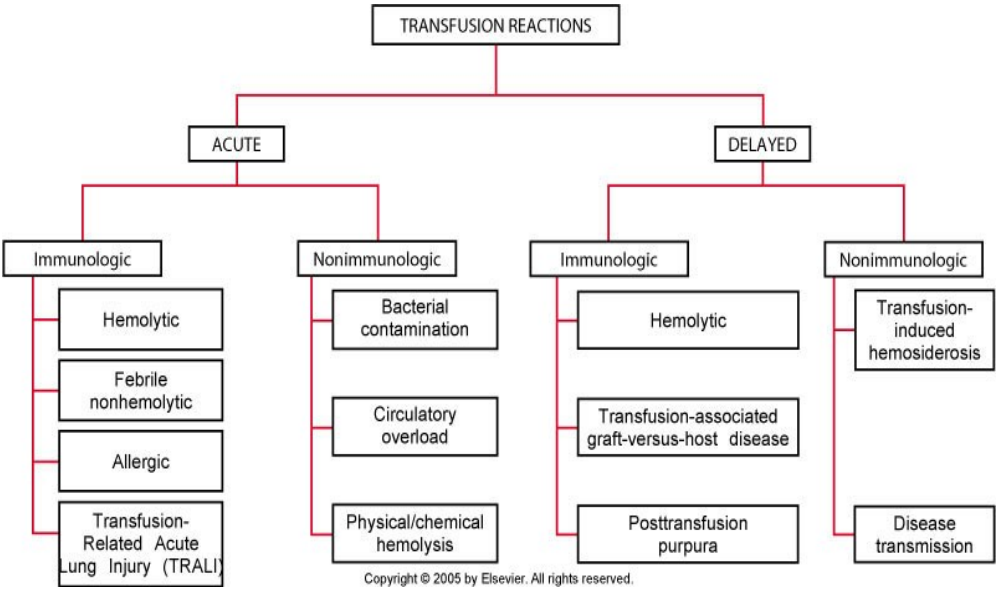
Type/Cause	Signs/Symptoms	Prevention	Treatment
Post Transfusion Purpura PTP is a rare complication of blood transfusion, characterized by sudden onset of severe thrombocytopenia 7–10 days following transfusion of, usually, red cells. The patients are mostly female with always a history of previous blood transfusions or pregnancies	Severe thrombocytopenia often with purpura and possibly other bleeding Thrombocytopenia will persist for 1 - 2 weeks	• Restrictive transfusion practice • Notify Blood Bank and TMS promptly so that relevant investigations can be initiated. Further transfusions will require selected components. Note: Delay may occur for supply of cellular blood products.	-Consult Transfusion Medicine Specialist or Hematologist if a recipient of cellular blood components develops an unexpected severe thrombocytopenia in the following 1-2 weeks -Test for HPA antibodies -If not bleeding – monitor -If clinically significant bleeding – intravenous immunoglobulin is recommended -Platelet transfusion is not recommended and should only be considered in life-threatening bleeding. -If life-threatening bleeding – platelet components lacking the relevant HPA antigen are desirable. (If HPA typing is available)

Type/Cause	Signs/Symptoms	Prevention	Treatment
TRALI: Transfusion Associated Lung Injury **Frequency: <1:5,000** Onset within the first 6 hours following transfusion of plasma or plasma containing cellular components TRALI is non-cardiogenic pulmonary oedema, presenting during or within 6 hours of transfusion and not attributable to any other cause of acute lung injury. The reaction is due in most cases to passive transfer of leucoagglutinin's (mostly anti-HLA class I or class II or, more rarely, granulocyte antibodies, i.e. anti-HNA) in donor plasma, reacting with granulocytes in the recipient's lung, leading to complement activation, endothelial and epithelial injury, alveolar damage and inflammatory changes, mediated by anaphylatoxins, cytokines and other inflammatory mediators.	• Onset of severe dyspnea, hypoxia and frothy sputum, cough progressing to respiratory failure • CXR shows bilateral infiltrates • If the reaction occurs during anesthesia the lungs become very stiff from rapidly developing pulmonary exudate • Absence of left atrial hypertension (circulatory overload)	• Restrictive transfusion practice o Transfuse with Male-only FFP o HLA-antibody testing of apheresis platelet donors - Notify Blood Bank so that donor(s) can be assessed for relevant antibodies and implicated donor(s) withdrawn from the active donor panel	• Intensive care management for respiratory failure -Diuretics are contraindicated -Steroids are not usually helpful -Send Hemovigilance notification to Blood Bank -Notify Blood Bank by phone to quarantine other blood components from the same donor and contact a transfusion medicine Specialist urgently. -Defer permanently the concerned donor from donors list -Tissue typing samples will be required (HLA typing) -BTD To be notified too

Type/Cause	Signs/Symptoms	Prevention	Treatment
Transfusion associated Graft versus Host Disease (TA-GVHD) TA-GVHD is a very rare, but usually fatal, complication of blood transfusion. It is caused by transfusion of viable donor lymphocytes with engraftment and clonal expansion of HLA compatible donor lymphocytes in the recipient Sensitization to red cell antigens: As only the ABO and RhD antigens are routinely matched for the selection of blood, sensitization can occur to other red cell antigens following transfusion. Although the D antigen is the most immunogenic, other antibodies can form with alloimmunization being more likely in multiramified patients. Red cell antibodies can also develop following pregnancy.	- Clinical syndrome like" fever, skin rash, diarrhea, impaired liver function and pancytopenia 7 to 14 days after transfusion	• Irradiate cellular blood components to inactivate residual lymphocytes Transfusion of full matched and compatible blood components	-Consult with a Hematologist and Transfusion Medicine Specialist to investigate and establish diagnosis and treatment. -Send Hemovigilance notification to Blood Bank

Type/Cause	Signs/Symptoms	Prevention	Treatment
Post transfusion Iron overload (Hemosiderosis) Is a very real complication of repeated blood transfusions, seen more commonly as long-term blood transfusion therapy improves the survival of patients suffering from some chronic anemias.	Iron overload is generally present after approximately 20 units of blood have been transfused to an average-sized adult.		-Check for ferritin level, T2-MRI of liver and heart if suspected liver and heart iron deposition. - It is routine practice to give chelation once ferritin level is >1500Microgram/L

Figure 2: Classification of Transfusion Reactions



NOTE: Adverse Events Reporting

When an adverse event is discovered on a blood transfusion recipient, the patient physician must report it on the Transfusion reaction report form. The form must be transmitted to the hospital laboratory and the latter record it onto the Hemovigilance system.

4. ALTERNATIVES TO BLOOD TRANSFUSION

4.1. Introduction

ALTERNATIVES TO ALLOGENIC BLOOD TRANSFUSION

There is a number of alternatives to allogeneic blood transfusion. They are usually used in selected type of situation (none available blood for transfusion, patient's belief, absolute contraindication to transfusion. It is important to note that many of the measures outlined below require careful planning and are not possible in emergency settings or at short notice.

1. Pre-operative Autologous Donations (PAD)

This is an option for patients who are undergoing elective surgery and whose
intra- operative blood requirements can be reasonably accurately predicted (e.g. Hip joint arthroplasty).

1.1. Indications to PAD

- ✓ The patients should be in good general health
- ✓ Suitable candidates must be able to tolerate the standard donation
- ✓ Withdrawal of 450ml of blood and the longer-term reduction in hemoglobin levels.
- ✓ They must weigh >50kgs
- ✓ Have a hemoglobin level >12g/dl for females and >13 g/dl for males
- ✓ Age between 18 and 65 years of age.
- – It is recommended to collect up to 2 autologous units in a healthy donor.

– To obtain more than one unit, i.e. 4-5 units, draw units at weekly intervals, with the

✓ Last unit drawn at least one week prior to surgery.
– Autologous donations may be collected up to 72 hours preoperatively.
– Prescribe oral iron supplement before the first phlebotomy and continue until surgery

1.2. Contra-indications to PAD

✓ Severe cardiac disease
✓ Severe pulmonary disease
✓ Bacteremia
✓ Poorly controlled Insulin dependent diabetes mellitus

1.3. Management of autologous donated blood

✓ The patient's clinician should initiate requests for autologous donations and refer the patient to the BTD service in good time before the operation.

✓ The units MUST be reserved exclusively for the patient who donated them and will not be made available for another patient, document and discard the unit.

✓ All autologous donations are also tested for markers of transfusion transmissible infections and compatibility testing to ensure no error at the blood bank.

2. Acute Normovolaemic Haemodilution (Preoperative Isovolaemic Haemodilution)

- ✓ This entails the removal of one or more blood units from a patient before or shortly after induction of anesthesia and simultaneous replacement with equal volumes of intravenous fluid (Crystalloid 1:3; Colloid 1:1) so that there is no change in the circulating blood volume followed by the return of the blood as dictated by the intra-operative blood loss or be used post-operative.

- ✓ The preoperative Hb and PCV may fall without adverse effects, provided that the circulating volume is maintained at all time. Patients with cardiac diseases must be evaluated before their Hb or PCV is reduced by this means.

- ✓ This procedure of preoperative isovolaemic haemodilution is the responsibility of the anesthetist/Surgeons and the transfusion service will have little role to play other than possibly provision of suitable blood collection systems. The units collected are properly labelled and stored at room temperature for up to 8 hours, unused units must be stored within 8 hours at 1-6oC and outdates in 24hours.

2.1. Indications for Acute Normovolaemic Haemodilution

- ✓ Good initial hematocrit
- ✓ Expected blood loss 900 to 1000mls
- ✓ Healthy young adults
- ✓ Vascular surgery
- ✓ Jehovah's Witness

2.2 Contraindications for Acute Normovolaemia Haemodilution

- ✓ Cardiac illness
- ✓ Impaired renal function
- ✓ Hemoglobin less than 11g/dl
- ✓ Low concentrations of coagulant proteins
- ✓ Lack of appropriate monitoring capacity
- ✓ Inadequate vascular access

3. Intra-operative Blood Salvage

- ✓ Intra-operative blood salvage should be practiced only in operating theatres with adequate facilities, appropriately trained staff and adequate quality assurance. The latter includes careful monitoring, and adherence to written standard procedures. The most commonly used technique is to employ so-called cell savers that aspirate the shed blood, saline wash the blood and return it to the patient. There are three phases during intra operative blood salvage: Collection, Washing, and Re-infusion.

- ✓ Collection of red blood cells (RBCs): requires a double-lumen suction device. One lumen suctions blood from the operative field and the other lumen adds a predetermined volume of heparinized saline to the salvaged blood. The anticoagulated blood is filtered, collected and centrifuged.

- ✓ The RBCs are then washed and filtered across a semi-permeable membrane, removing free hemoglobin, plasma, platelets, white blood cells, and heparin.

- ✓ The salvaged RBCs are then re-suspended in normal saline (hematocrit of 50–80%).

- ✓ Salvaged RBCs may be transfused immediately or within 6 hours. Suitable for any surgical procedure associated with significant blood loss from clean wounds e.g. abdominal, thoracic cavity, cardiac and vascular surgery, orthopedic, gunshot or stab wounds procedures.

- ✓ Blood must not be used if the estimated period of bleeding at the site is six hours or more or has contamination of bowel contents or by pancreatic juice or the presence of sepsis or malignancy topical hemostatic agents such as thrombin or microfibrillar collagen have been used. Recovered blood from these sites should not be used as micro thrombi may embolise to critical organs.

3.1. Indications for intraoperative Blood Salvage

- ✓ Anticipated blood loss of 1000 ml or 20% estimated blood volume.
- ✓ Patients with low hemoglobin
- ✓ Patient with increased risk of bleeding
- ✓ Patients with multiple antibodies or rare blood types
- ✓ Patients with objections to receiving allogeneic blood

The technique is contraindicated in patients with sepsis, contaminated surgery (bowel surgery, malignant disease) and in obstetric cases.

4. Pharmacologic Interventions

These are topically applied agents and systemically administered drugs that may, in specific settings, decrease blood loss.

4.1. Medications to reduce bleeding

- ✓ Collagen hemostatic pads, thrombin sprays and fibrin glue: These products are applied directly to the wound (sprayed or in powder form).
- ✓ Aminocaproic acid and Tranexamic acid: A couple of trials have been published demonstrating efficacy in reducing blood loss post-cardiac surgery when these antifibrinolytics agents have been administered.

These agents are frequently used in Hemophilia care provided bleeding does not involve the urinary tract.

4.2. Medications to stimulate red cell production

Erythropoietin: It is the recommended treatment for the anemia of renal disease; also effective for the anemia induced by anti-retroviral agents.

Parenteral Iron Preparation: It needs to be remembered that in patients who have documented iron deficiency but whom, for various reasons, cannot take or tolerate oral iron compounds, the option of parenteral iron is available before resorting to transfusion. There are two registered preparations: an iron polymaltose compound for intramuscular injection and an iron sucrose compound for intravenous use. Both can cause allergic reactions including anaphylaxis.

***NOTE": These medications can be given to optimize HB in patients who refuse to consent for blood transfusion such as Jehovah Witness, personal belief etc. In case of such situation, minimizing blood loss intraoperatively (when surgery is needed becomes critica*l**

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