

# Overview of blood components and their preparation

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## ABSTRACT

The whole blood which is a mixture of cells, colloids and crystalloids can be separated into different blood components namely packed red blood cell (PRBC) concentrate, platelet concentrate, fresh frozen plasma and cryoprecipitate. Each blood component is used for a different indication; thus the component separation has maximized the utility of one whole blood unit. Different components need different storage conditions and temperature requirements for therapeutic efficacy. A variety of equipments to maintain suitable ambient conditions during storage and transportation are in vogue. The blood components being foreign to a patient may produce adverse effects that may range from mild allergic manifestations to fatal reactions. Such reactions are usually caused by plasma proteins, leucocytes, red cell antigens, plasma and other pathogens. To avoid and reduce such complications, blood products are modified as leukoreduced products, irradiated products, volume reduced products, saline washed products and pathogen inactivated products. The maintenance of blood inventory forms a major concern of blood banking particularly of rare blood groups routinely and common blood groups during disasters. PRBCs can be stored for years using cryopreservation techniques. New researches in red cell cultures and blood substitutes herald new era in blood banking.

**Key words:** Blood, blood component transfusion, blood components, erythrocyte transfusion, fresh frozen plasma, leukocyte transfusion, lymphocyte transfusion, platelet concentrate, platelet transfusion, red cell concentrate

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## INTRODUCTION

Blood is a lifesaving liquid organ. Whole blood is a mixture of cellular elements, colloids and crystalloids. As different blood components have different relative density, sediment rate and size they can be separated when centrifugal force is applied.<sup>[1]</sup>

In increasing order, the specific gravity of blood components is plasma, platelets, leucocytes (Buffy Coat [BC]) and packed red blood cells (PRBCs). Functional efficiency of each component is dependent on appropriate processing and proper storage. To utilise one blood unit appropriately and rationally, component therapy is to be adapted universally.<sup>[1]</sup>

The components are prepared by centrifugation of one unit of whole blood. Single component required can also be collected by apheresis procedure in blood donors.

## Selection of blood donors

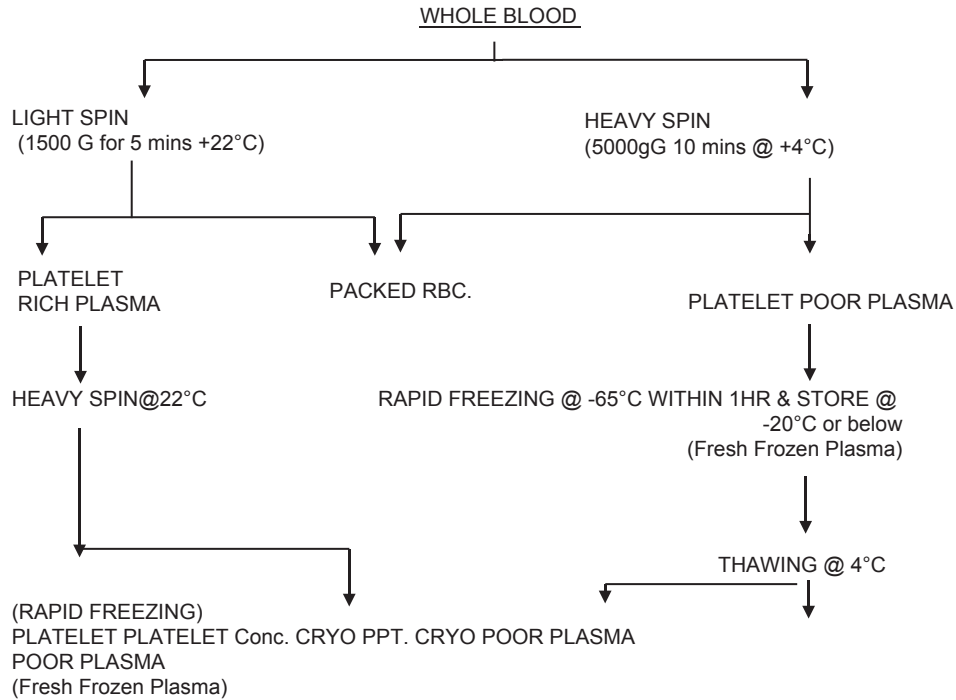
Voluntary fit donor for either whole blood or Apheresis collection is selected as per the criteria laid down by drug controlling authorities and National AIDS Control Organisation.<sup>[2]</sup>

## WHOLE BLOOD TO COMPONENTS

Blood component preparation was developed in 1960 to separate blood products from one unit whole blood by a specialised equipment called as refrigerated centrifuge.<sup>[3]</sup> Preparing only PRBC and fresh frozen plasma (FFP) is by single-step heavy spin centrifugation; however preparing platelet concentrates (PLTCs), PRBC concentrates and FFP is by two step centrifugation. The two main procedures of preparing PLTC are either by platelet-rich plasma (PRP) method or BC method. The algorithm for the separation by the two methods is given as Algorithm no. 1 and 2. PRP method is simple,

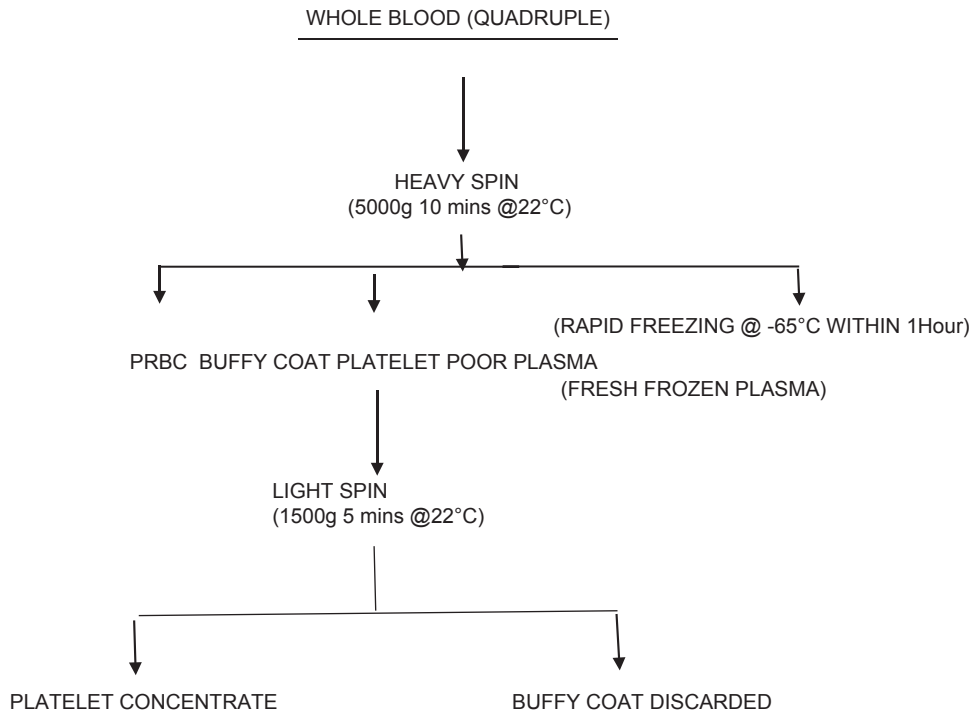
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An Algorithm for Component Preparation by PRP method



Algorithm No: 1

Buffy coat method



Algorithm No: 2

easily done manually and comparatively cheaper, but platelet and plasma yield is less. BC is a better method

but complicated if done manually and hence needs automation.

The main components are PRBC, PLTC or random donor platelet (RDP), FFP, cryoprecipitate, cryo poor plasma (CPP) and Plasma fractionation products. The last are produced only at the pharmaceutical industries end.

## GENERAL PRINCIPLES OF COMPONENT PREPARATION

The Whole blood is collected as 350 ml or 450 ml in double/triple/quadruple or penta bags with CPDA-1 or additive solution. After blood collection, components should be separated within 5 - 8 hours. Component room should be a separate sanitised room. All precautions to avoid red cell contamination have to be taken such as tapping the segment ends, proper balancing of opposite bags, following standard programs and protocols described in the manual of refrigerated centrifuge manufacturer. The programme is run with mainly two spins-heavy spin (e.g., 5000 G for 10-15 min) and light spin (e.g., 1500 G for 5-7 min). The heavy and light spin configuration varies with manufacturer and model. Here 'G' is relative centrifugal force calculated using revolutions per minute and rotor length. Use of totally automated component separator instrument will allow for the preparation of low volume BCs with a recovery of 90% of whole blood platelets.<sup>[4]</sup>

## COMPONENT COLLECTION BY APHERESIS PROCEDURE

Apheresis is a procedure where required single or more than one component is collected, and the rest of blood components are returned back to the donor.

The working principle of apheresis equipment is either by centrifugation (different specific gravity) or by filtration (different size). The most commonly used equipments use the centrifugation principle and also give leucodepleted products. In this method, fixed quantity of blood is collected in a bolus called as Extracorporeal volume (ECV) and the required component (e.g. Platelets) is separated and collected in the collection bag and the other components (e.g. red blood cells, leucocytes and plasma) are returned back to the donor. Centrifugation apheresis equipments are classified as 'intermittent and continuous working'.

The *Intermittent* equipment uses single vein access for both collection and return. One cycle consists of-one ECV whole blood collection in kit bowl, centrifugation

of bowl to separate components, collection of required component (platelets) in collection bag and finally return other constituents like red cells, leucocytes and plasma to donor. This cycle is repeated till therapeutic dose is attained.

In continuous working equipment, two simultaneous phlebotomies are done: One for the collection and other for the return. The collection, centrifugation, component collection and return occur continuously and simultaneously. Each type has its own advantage and limitation.

The ultimate goal of the procedure is not to overshoot ECV collection more than 15% of total blood volume (TBV). To avoid hypovolemia at any point ECV should not reduce beyond 20% of TBV and the final product should not exceed 15% ECV of TBV.

The various components that can be collected are - double unit red cell collection (red cells), single donor platelet (SDP) harvesting platelets, leucapheresis (harvesting granulocytes, peripheral blood haematopoietic stem cell), plasmapheresis (collecting normal plasma) and therapeutic plasma exchange (for exchanging with normal plasma after collecting and discarding patient's plasma).

### General guidelines

Apart from being fit as per the whole blood donation criteria, additional criteria to be met for apheresis donors include prominent accessible vein for withstanding apheresis procedure and weight more than 55 kg.

In spite of strict guidelines for donors of apheresis procedures, advanced equipments like continuous apheresis equipment have allowed complicated procedures (like therapeutic erythrocytapheresis and leucapheresis of small children for thalassemia and leukaemia respectively) to be performed safely in children weighing 11-25 kg without increased morbidity<sup>[5]</sup>

The donor should be asked to sign a consent form in the language which he understands after being explained the procedure and the risks involved.<sup>[2]</sup>

Certain investigations should be done and all parameters should be within the acceptable range prior to subjecting the donor for apheresis procedure such as complete blood count, total proteins including albumin, globulin, same ABO grouping. (if necessary same Rh typing

and negative atypical antibody status), transfusion transmitted disease screening (mandatory and to be non reactive). minor cross match (to be compatible, If necessary major should be compatible in case of red cell contaminated product).

#### For double unit red cell collection

Donors should have the haemoglobin level of 13.5 g/dl or more, weigh more than 65 kg. and the interval between the two procedures should be 6 months.

#### For plateletpheresis

- Donor's platelet count should be 150,000/mm<sup>3</sup> or more and total white cell count, and differential count should be within normal limits<sup>[2]</sup>
- Donors who have ingested aspirin or similar antiplatelet drugs in the last 72 h and clopidogrel or ticlopidine, the plateletpheresis should be deferred for 3 and 14 full medication-free days, respectively. Plateletpheresis should not be done on donors with personal and family history of bleeding tendency
- In a donor who undergoes plateletpheresis, the procedure can be repeated after 48 h. This is restricted to a maximum of two procedures per month and 24 procedures in 1 year.

#### Leucapheresis

- Granulocyte concentrate is collected mainly by apheresis and indications are rare; One such indication is to support patients with abnormal neutrophil function and persistent infection<sup>[6]</sup>
- Peripheral blood stem cells (PBSC) are harvested using continuous or intermittent cell separator. Minimum yield should be  $2 \times 10^6$  CD34 cells or  $2 \times 10^8$  MNCS/kg body weight of the recipient<sup>[2]</sup>
- Donors for leucapheresis, both autologous and allogeneic PBSC harvest may receive drugs like growth factors (G-CSF), hydroxyl ethyl starch, dexamethasone etc., to facilitate this harvesting. Some donors may have adverse reactions to such drugs. Adequate precautions to manage such situation have to be taken or donors may have to be rejected in some cases.

#### Plasmapheresis

Any donor who has undergone plasmapheresis can undergo 'serial' Plasmapheresis provided, before each procedure:

- The haemoglobin level is not below 12 g/dl or haematocrit 36% and total serum protein not below 6 g/dl

- The maximum plasma that can be collected per procedure is 500 ml in a donor weighing more than 55 kg
- Any fit donor can undergo a maximum of two procedures per week and 24 procedures in 1 year.<sup>[2]</sup>

#### Multicomponent blood collection by apheresis

Apheresis procedure allows the collection of different blood components from the same donor during a single session. RBC units can be concurrently collected with plasma and/or SDP units.<sup>[7]</sup>

Donors should be observed closely during apheresis for adverse events such as citrate toxicity manifested as perioral paresthesia, tingling, twitches and headache, fainting attacks, tachycardia, dyspnoea etc., The donors should be tested appropriately to detect impending cytopenia. Red blood cell loss incidental to the procedure should be no more than 25 ml per week.<sup>[2]</sup>

The various Blood components that can be prepared from component preparation or apheresis procedures are as follows:

- PRBCs, double unit red cell (apheresis)
- PLTC or RDP, SDP (apheresis)
- Granulocyte concentrates (now very uncommon), autologous or allogeneic peripheral blood hematopoietic stem cell collection-PBHSC (apheresis)
- FFP, cryoprecipitate, CPP.

Plasma Fractionation Products are produced in the pharmaceutical industry from FFP. At present, plasma fractionation is driven by demand for two protein concentrates-albumin and immunoglobulin.<sup>[8]</sup> (Refer Table 1 for composition and indications of use of various plasma products.<sup>[9]</sup>)

#### Other human plasma derivatives<sup>[10]</sup>

These include FEIBA (factor VIII bypassing activity) concentrate, Antithrombin, Fibrinogen, Fibrin sealant (FS), Protein C, C1 esterase inhibitor,

Blood products can be modified to make blood transfusion safer and accessible to avoid adverse transfusion reactions in patients susceptible for them. The products can also be modified for better therapeutic outcomes by leucodepletion, volume depletion, irradiation, cryopreservation, rejuvenation, etc.

**Table 1: Various plasma products and their indications**

Product	Composition	Indication
Albumin	5% or 25%	Volume expansion; fluid mobilization
Factor VIII	Factor VIII	Haemophilia A; von Willebrand's disease (selected products only)
Concentrates Recombinant Human factor VIII	Some fibrinogen and von Willebrand factor	
Factor IX complex, X	Factor II, VII, IX, minimal amounts of other proteins	Hereditary factor II, IX, or X deficiency, factor VIII inhibitor
Factor IX concentrate		
Immunoglobulins	IgG antibodies, for IV or IM use	Treatment of hypoglobulinaemia or agammaglobinemia, immune-thrombocytopenia (IV preparation only)
Rh immune globulin	IgG anti-D preparation	Prevention of HDN due to D antigen

HDN – Haemolytic disease of the newborn; IM – Intramuscular; IV – Intravenous

### Packed red blood cell or platelet concentrate with buffy coat removed

By adding additive solutions (ADSOL) or saline, adenine, glucose and mannitol solution (SAGM) PRBC can be stored for 42 days. Since BC contains most leucocytes, during the preparation of components by BC method, if entire BC is discarded then each PRBC and PLTC unit will have leucocytes  $<1.2 \times 10^9$ . Such products are called leucocyte reduced but not leucocyte depleted. Leucocyte depletion is achieved only by filtration.

The main advantages of BC removal are micro aggregate formation during storage is greatly reduced and febrile non-haemolytic transfusion reactions (FNHTR) are reduced without any extra effort.

In terms of safety and cost-effectiveness, the most rational approach seems to be to recommend the use of buffy-coat-depleted RBC to prevent FNHTR in low-risk patients, while leucoreduction by filtration should be restricted to patients with the well-known indications.<sup>[11]</sup>

### Leucodepletion of blood components

#### Definition

Each leucocyte depleted blood product viz-PRBC or single dose platelet or adult therapeutic dose platelet should contain leucocytes  $<5 \times 10^6$  per unit to prevent alloimmunisation to leucocyte antigens in patients where transfusions are likely to be ongoing.<sup>[12]</sup> This is achieved by three methods:

- Pre storage: Immediate filtration within 48 h from collection before or after component separation.

Advantages of pre storage are:

- Complete quality assurance
- Process is done when leucocytes have not dissociated or broken or cytokine released. Hence expected benefits are almost 100%
- No storage lesions and shelf life is unchanged.

Disadvantages are:

- Leucodepletion irrespective of demands adds to cost and time
- Need well-trained dedicated technical staff.

- On demand also called as Lab side-This is done only on demand. Bags with built in filters ensure a closed system when used with sterile connecting device (SCD) and are also easy to operate
- Pre transfusion also called as bedside: This is done by spiking blood component bag with a specialized transfusion set having leucocyte filter with continuous leucoreduction during transfusion. Here the effect of cytokines cannot be avoided.

### Recommended indications for leukoreduction (groups/principles)

- Patients needing transfusion and had at least two episodes FNHTR in previous transfusion
- In haematopoietic stem cell transplant recipients requiring transfusions
- To avoid post transfusion CMV infection in immunocompromised patients
- All neonatal and paediatric transfusions for children less than a year.<sup>[12]</sup>

### Possible indications (groups/principles)

- To avoid human leucocyte antigen (HLA) alloimmunisation in patients requiring multiple transfusions who may develop platelet refractoriness
- To avoid immunomodulation in recipients and prospective recipients of solid organ (kidney), haematopoietic stem cell transplant and patients with malignancies.

### Packed red cell concentrate/fresh frozen plasma/single donor platelet aliquots

- The PRBC dose for neonates and infants is 15 ml/kg. The total blood requirement for a child may be as low as 25-100 ml and the child may also require multiple transfusions. This can be achieved by aliquoting one PRBC unit (About 200 ml) into Pedi-packs. This will avoid multiple donor exposures to the patient and also helps to maintain an inventory
- PRBC aliquots or volume reduced components may be required in patients with fluid overload and in candidates susceptible for transfusion-associated circulatory overload (TACO).

### Platelet and cryoprecipitate pooling

6-10 units of group-specific platelets or non-group specific cryoprecipitate can be pooled using SCD to make one unit of a therapeutic dose. The pooled platelets can be volume reduced to prevent TACO.

Single donor blood components have long been regarded as the gold standard in transfusion medicine because they are associated with lower risks for transmission of viral or bacterial infections to transfusion recipients than pooled blood components.<sup>[13]</sup>

### Cryopreservation

- Frozen red cell concentrate, or cryopreserved PRBC:  
Red cells can be frozen after treating with cryoprotective solutions and can be stored for 10 years, if storage temperature is maintained below  $-65^{\circ}\text{C}$ . The final product before transfusion should be free of cryoprotective agent, with minimal signs of haemolysis and yield at least 80% of the originally frozen cells.<sup>[14]</sup>
- Platelet cryopreservation:  
Cryopreservation of platelets is mainly used for autologous transfusions for a few selected patients who are refractory to allogeneic platelets.
- Peripheral blood haematopoietic stem cells are also cryopreserved for autologous or allogeneic transplants if required to be stored beyond 3 days.

### Rejuvenation of packed red blood cell

To rejuvenate the loss of intra-cellular levels of 2,3-DPG and ATP due to storage, rejuvenation solutions can be used particularly in paediatric patients and in massive transfusions like exchange transfusions. Rejuvenation solutions are mainly available in USA and are FDA approved.<sup>[14]</sup>

### Platelet gel

The term platelet gel (PG) is applied to products with the consistency of gelatin-like material, which is generated when thrombin and calcium are added to PRP.<sup>[15]</sup> PG is used in reconstructive and orthopedic procedures. Similar blood-derived biomaterials include FS (also called fibrin glue), PG, platelet fibrin glue.

### Irradiated blood products

The common blood products that are irradiated are: PRBC, platelets and granulocyte concentrates. Irradiation is necessary and mandatory in following conditions:

- Gamma radiation of cellular blood components is to prevent transfusion associated graft vs host disease<sup>[16]</sup>  
E.g. Immunosuppressed or compromised patients but not in patients with AIDS, all neonate exchange transfusions, intrauterine transfusions, all donations from first or second-degree relatives and all HLA-selected components.
- For aplastic anaemia patients receiving immunosuppressive therapy with anti-thymocyte globulin. Platelets can be irradiated at any stage while storage and shelf life remains same
- All granulocyte components should be irradiated before issue and transfused with minimum delay.<sup>[17]</sup> The minimum dose achieved in the irradiated unit should be 25 Gy, with no part of the unit receiving more than 50 Gy.<sup>[16]</sup>

### Packed red blood cell or platelet concentrate, saline washed

Saline washed red cells are a specialised component prepared only on demand for patients with antibodies to plasma protein (e.g., anti-IgA) and those who have severe allergic reactions when transfused with blood products.<sup>[11]</sup> This a cheaper method than both Leuco and Plasma depletion. The same can be prepared from PRBC after Leuco reduction or BC removal. The saline washing is done thrice or four times either by

manual or automated methods. The final product should be PRBC suspended in saline with <0.5 g protein per unit. The same principle of washing PLTC holds good for the treatment of neonatal alloimmune thrombocytopenia.<sup>[11]</sup>

### Photopheresis

Photopheresis is another variation of apheresis in which the white cell component is exposed to ultraviolet radiation *ex vivo*. In this technique, a photoactive dye such as psoralen (8-methoxypsoralen or 8 MOP) is taken by mouth. Several hours later, the apheresis procedure is performed. *Ex vivo*, the separated white cell component is exposed to ultraviolet radiation causing drug activation. The only clearly accepted indication for photopheresis is in the treatment of cutaneous T-cell lymphoma where dramatic remissions in skin lesions are often observed.<sup>[18]</sup>

### Pathogen inactivation

Reduction of pathogens is usually done for plasma and plasma fractionation products. The Ethanol used in cold alcohol fractionation is by itself an effective virucidal and antimicrobial agent.

### ADDITIONAL PROCESSES

- Heat-Pasteurisation, dry heat in the final container, steam treatment of dry product in the presence of steam under pressure
- Chemical-Treatment of FFP with methylene blue (MBFFP) or solvent detergent (SDFFP)
- Low pH 5 (low-pH) treatment ( $\pm$ pH 4.0) with or without pepsin 6 is used in the viral inactivation of immunoglobulin solutions
- Beta propiolactone treatment followed by UV irradiation.

Filtration using filters of appropriate pore size (nanofiltration) removes viruses with a protein membrane but not those with a lipid envelope. Aseptic membrane filtration (0.22 nm) is used to remove micro-organisms and sterilise bulk products prior to filling ampoules/final product containers.<sup>[1,19]</sup>

The other agents used for pathogen inactivation for platelets and plasma are Psoralen or Riboflavin with ultraviolet light treatment. Pathogen inactivation of components containing red blood cells presents a challenging dilemma. In such situations, S303 (Helinx),

a small molecule designed for pathogen inactivation is being successfully tried.<sup>[20]</sup>

**Table 2: Storage and expiration requirements of RBC components**

Component	Storage	Expiration
PRBC-component, apheresis and leucodepleted	4±2°C	CPDA-1: 35 days AS: 42 days
RBCs irradiated		Open system: 24 h Original expiration or 28 days from date of irradiation, whichever earlier To avoid hyperkalemia in neonates-24 h
Saline washed		24 h
Frozen RBCs 40% glycerol or 20% glycerol	≤-65°C if 40% glycerol; ≤-120°C if 20% glycerol	10 years
Deglycerolized RBCs	4±2°C	Open system: 24 h Closed system: 14 days
Rejuvenated RBCs		CPDA-1: 24 h AS-1: freeze after rejuvenation at ≤42 days
Washed rejuvenated RBCs and deglycerolized rejuvenated RBCs		24 h
Frozen rejuvenated RBC	≤-65°C	10 years
		AS-1: 3 years

AS – Additive solution; RBC – Red blood cell; PRBC – Packed red blood cell concentrate; CPDA – Citrate phosphate dextrose adenine

**Table 3: Storage and expiration requirements of platelet components**

Component	Storage	Expiration
Platelets	20-24°C with continuous	24 h to 5 days depending on collection system
Platelets irradiated	gentle agitation	Open system: 4 h
Platelets leucocytes reduced		Closed system: No change in expiration date
Pooled platelets (open or closed system)		Open system: 4 h Closed system: Expiration date should be earliest expiration date in pool
Pooled platelets leucocytes reduced		Open system: 4 h Closed system: 4 h after pooling or 5 days following collection using an approved FDA system
Apheresis platelets		24 h to 5 days depending on collection system
Apheresis platelets irradiated		No change from original expiration date
Apheresis platelets leucocytes reduced		Open system: 4 h Closed system: 5 days or 7 days if in an approved FDA-monitored program

FDA – Food and drug administration

**Blood substitutes**

Large number of drugs are being used as blood substitutes like haemoglobin preparations, haemostatic agents and plasma expanders. Recently, progress in culture techniques and proof of principle studies in animal models have allowed proposing red blood cells generated in culture (cRBCs) as a potential novel blood substitutes.<sup>[21]</sup>

**STORAGE AND EXPIRATION**

Whole blood is collected currently in containers manufactured from polyolefin or polyvinyl chloride (PVC) that is thinner or plasticised with different compounds such as triethyl hexyl trimellitate and butyryl-tri-hexyl citrate. These bags provide nearly twice the oxygen permeability of first-generation-Di ethyl hexyl phthalate plasticized PVC containers and also maintain pH more than 6 for better platelet survival and function.<sup>[22]</sup> The need for proper component storage is to preserve the biological function of the constituents, decrease their metabolic activities, and reduce bacterial growth of the blood components.

As per standard guidelines<sup>[22]</sup> the storage temperature for red cells is between +2°C and +6°C, for Platelets and leucocytes-between +20°C and +24°C and for plasma products, below -18°C.

All components are to be stored in three compartments or equipments, the Untested components, the Tested and safe to be issued components and the Tested unsafe or quarantined components for discarding.<sup>[23]</sup>

In addition separate equipment is required for keeping safe cross-matched units if available. During the transport, the components can be stored for a maximum of 24 h if maintained at suggested temperatures. PRBC must be maintained between +2°C to +10°C. All components are routinely stored between +20°C and +24°C and also shipped at same temperatures.All frozen components should be transported in a manner to maintain their frozen state.

The temperature changes can be monitored and documented either through indicators fixed on units or checking each component manually for any deterioration. The cold chain maintenance for all blood components should extend to the point of transfusion.<sup>[24]</sup>

The storage and transport equipments used are: Refrigerators (+4 ± 2°C):For storage of whole blood and PRBC and for storage of thawed FFP and other plasma products, Platelet incubator-agitators (+22 ± 2°C) with agitation speed at 60 cycles per minute-For storage of all type of platelet products, Deep freezers (-80°C): For freezing FFP or frozen blood constituents. Rapid freezing can be achieved by Mechanical blast freezers and storage of frozen PRBC or Platelets below -65°C or even colder, Freezers (-40°C): Storage of all plasma products below -30°C or even colder and Transport boxes: Transport boxes are used for transportation of blood or blood components for a short duration between two storage sites. Even blood mobiles have built in cold chain storage devices with backup power. The details of the storage requirements are enlisted in Tables 2-5.<sup>[24]</sup> ‘The decision to transfuse should be preceded by careful evaluation of the clinical condition of each individual patient and not be based exclusively on laboratory results. Transfusion medicine in a hospital setting is mainly focused to ensure that ‘the right blood is given to the right patient in the right time and at the right place’.<sup>[25]</sup>

**SUMMARY**

Haemovigilance (making blood transfusion-a safe practice) is the safe transfusion of blood and blood components and is achieved by ensuring quality assurance at every stage, well-trained technical personnel, proper collection, proper storage, use of

**Table 4: Storage and expiration requirements of granulocyte components**

Component	Storage	Expiration
Apheresis granulocytes	20-24°C without agitation	24 h
Apheresis granulocytes irradiated		

**Table 5: Storage and expiration requirements of plasma components**

Component	Storage	Expiration
FFP	≤-18°C	12 months
Plasma frozen within 24 h after phlebotomy		
Apheresis FFP		
Cryoprecipitated AHF		
Liquid plasma	4±2°C	5 days after expiration of RBCs
Thawed cryoprecipitated AHF	20-24 C	Open system or pooled: 4 h Single unit: 6 h
Cryoprecipitate reduced plasma (after thawing)	4±2°C	5 days
FFP (after thawing)	4±2°C	For coagulation 6 h or others 24 h

FFP – Fresh frozen plasma; AHF – Antihemophilic factor



quality products, properly calibrated equipments, quality reagents and kits and finally proper documentation.

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## Announcement

### Dr. TN Jha and Dr. KP Chansoriya Travel Grant

For the year 2014 the Dr. TN Jha and Dr. KP Chansoriya travel grant will be awarded to the participants from 15 states. All the states can select their candidate during their annual conference and send them with the recommendation of the Secretary. Only one candidate is allowed from each state. In case if two states have a combined annual meet but separate as per the records, have to select one candidate from each state. If more than 15 states recommend the candidates for the award, selection will be made on first come first served basis.

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