"UNDERSTANDING BLOOD COMPONENTS AND THEIR CLINICAL USE"

Dr Kusum Thakur, MD
Senior Consultant & HOD
Transfusion medicine
Cum
President ISBTI
Punjab Chapter

Shrimann Superspeciality Hospital Jalandhar

NATIONAL AWARDS

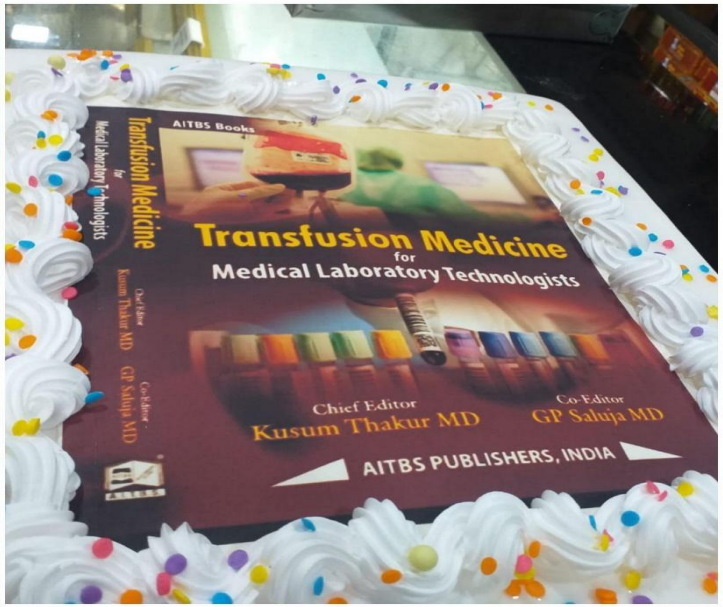
Conferred with National **“JR Jolly award”** by ISBTI in November 2017 at Kota.

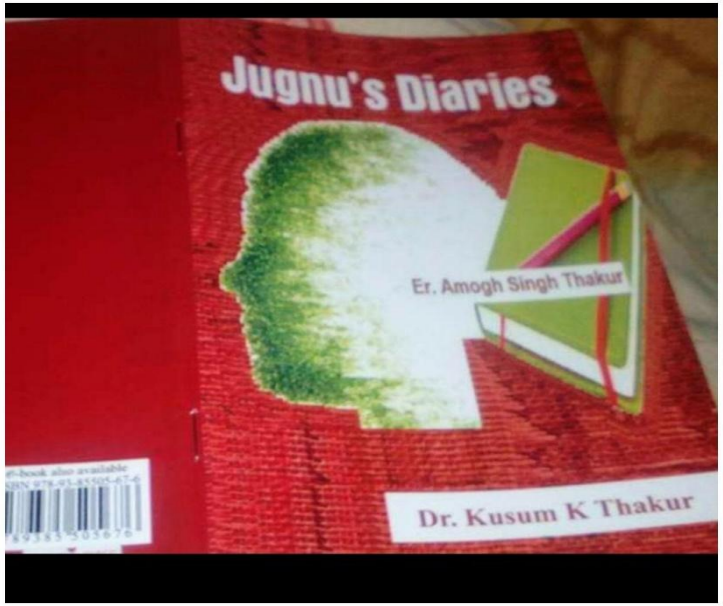
Conferred with National

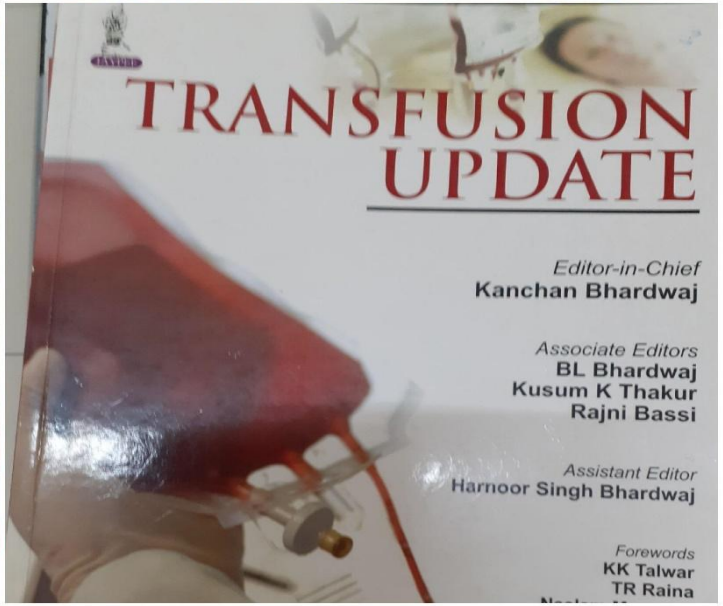
“Life Time Achievement Award” by ISBTI in February 2021 at Chennai during TRANSCON-2020.

Conferred with National “Covid Warrior Award” by ISBTI in February 2021 at Chennai.

BOOKS PUBLISHED



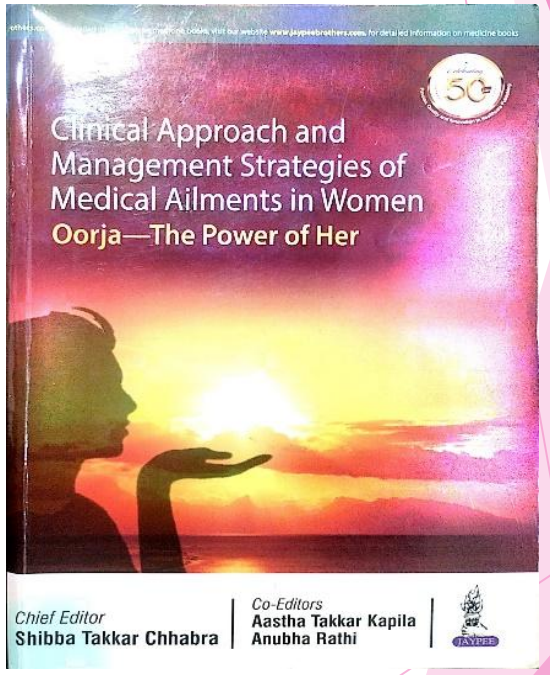




BOOK CHAPTERS CONTRIBUTED

Six chapters in different published books

1. “Role of PRP in Regenerative Medicine”
2. “Ethical issues in Transfusion Medicine.”
3. “Introduction to Transfusion Medicines (Blood centre)”.
4. “Common Techniques in Transfusion Medicine”.
5. “Platelet Rich Plasma Therapy”.
6. “Women and Transfusion Medicine” in Oorja the Power of Her.



BLOOD COMPONENTS

LEARNING OUTCOMES

- Why, What and How?
- Blood Components Preparation
- Equipment required
- Types of components
- Clinical use of components

TERMINOLOGY

- *Blood product:* Any therapeutic substance prepared from human blood.

- *Whole blood:* Unseparated blood collected into an approved container

containing an anticoagulant-preservative solution.

- *Blood components:*

1. A constituent of blood, separated from whole blood by PRP method:
    - Red blood cells
    - Plasma
    - Platelet concentrates
    - White blood cells

2. Cryoprecipitate, prepared from fresh frozen plasma, which is rich in Factor VIII and fibrinogen.

DEFINITIONS CONT….

- *Plasma derivative:* Human plasma proteins prepared under pharmaceutical manufacturing conditions, such as:
  - Albumin
  - Coagulation factor concentrates
  - Immunoglobulins

- Apheresis: a method of collecting red cells, white cells, plasma or platelets directly from the donor and returning back rest of blood components, usually by a mechanical method.
  - Erytherocytopheresis
  - Plateletpheresis
  - Plasmapheresis
  - leucocytopheresis

DEFINITIONS CONT….

Blood Component Therapy is a therapeutic use of blood components rather than whole blood,

- To treat a specific deficiency
- To avoid volume overload
- To reduce Transfusion Transmissible Infections
- To minimize transfusion reactions.

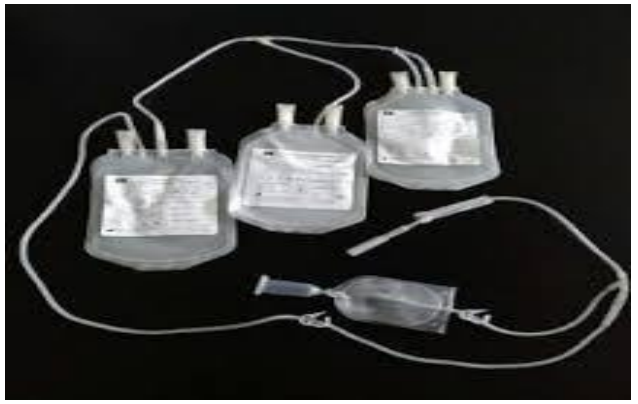
WHY BLOOD COMPONENTS ?

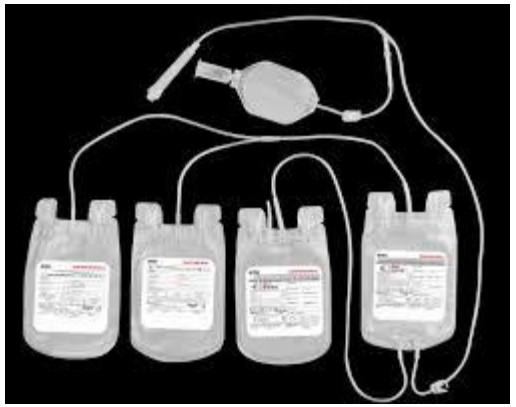
- Rational use of the scarce resource.
- Transfusion of the desired component.
- Improved quality and functional capacity of each blood component.
- Optimization of storage of blood components.
- Reduced risk of Transfusion Reactions.
- Reduced risk of Transfusion Transmitted Infections (TTIs).

HOW COMPONENTS PREPARED?

LIST OF EQUIPMENT REQUIRED

- Double, Triple, Quadruple Bags and LD Bags
- Stripper
- Weighing balance
- Rubber tube pieces
- Refrigerated centrifuge
- Plasma expresser
- Blood Bank Refrigerator
- Deep Freezers
- Platelet incubator and agitator
- Special equipment for special blood component
- Laminar airflow
- Sterile Connecting Device






Thermo


XS1010


ANI
TERUMO PENPOL

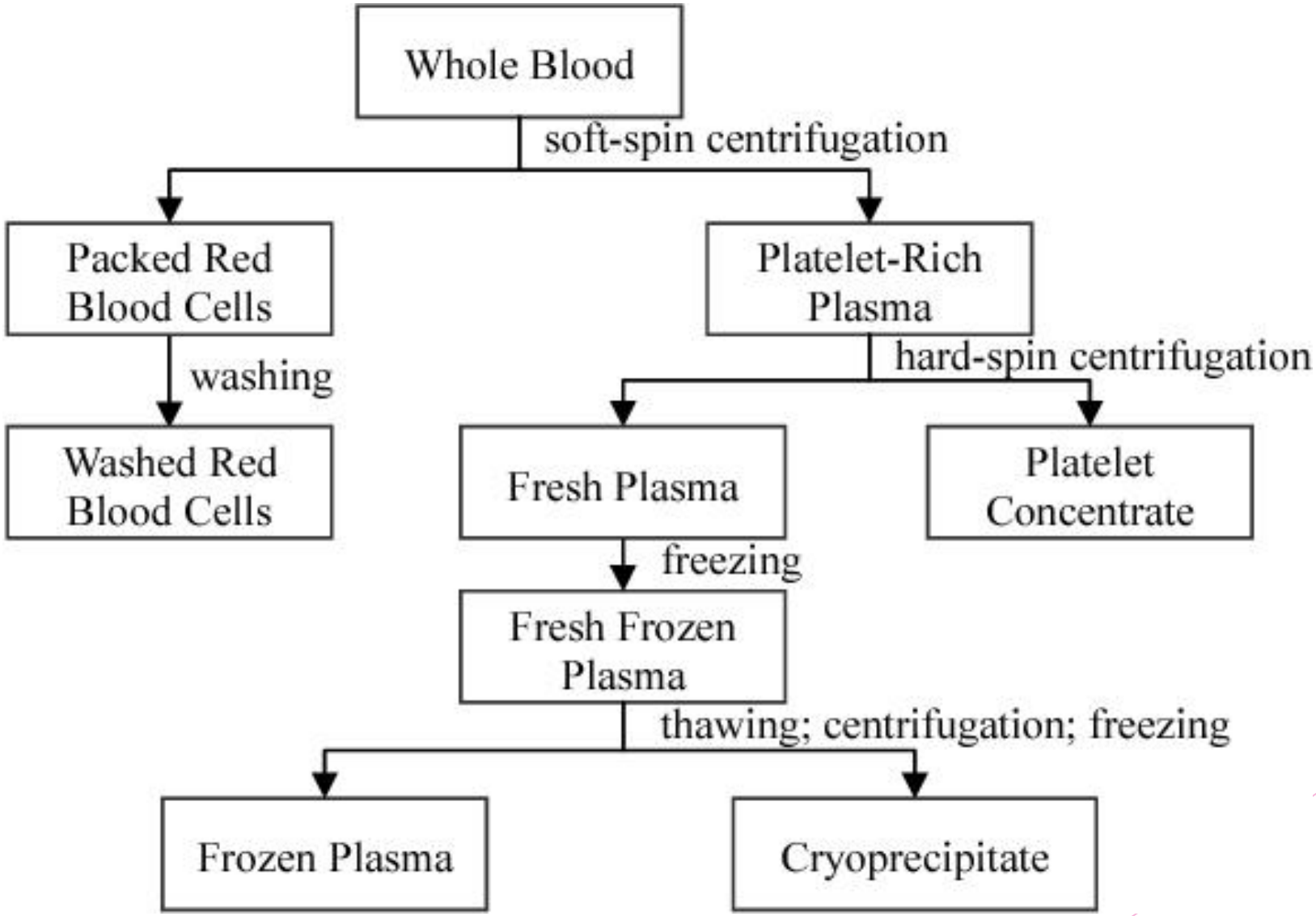

DF80U

PRINCIPLE OF CENTRIFUGATION

Blood Component	Specific Gravity
WB	1.053
PRBC without AS	1.08
PRBC with AS	1.06
Platelet Concentrates	1.03
Plasma	1.02

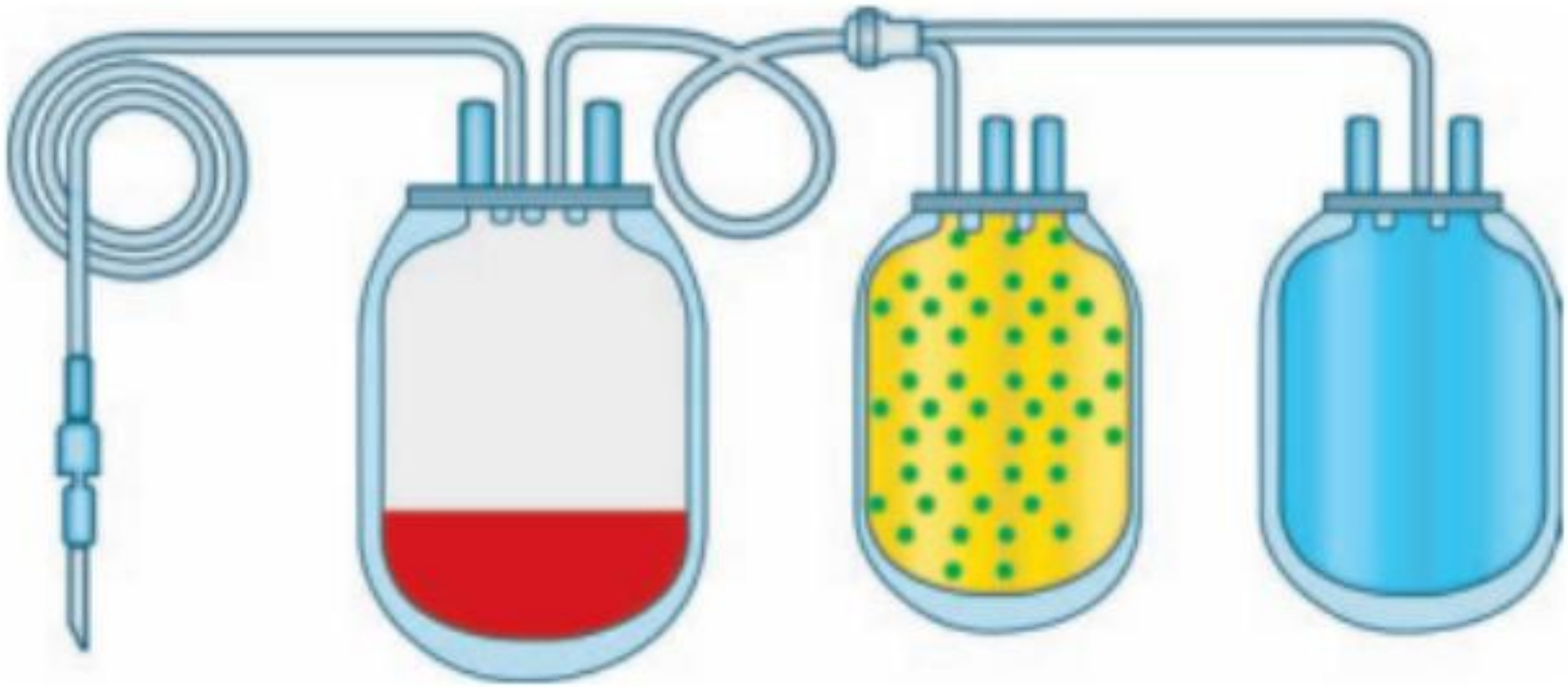
Blood Components settle down according to their specific gravities, higher the density(PRBC) early to settle down

BLOOD COMPONENTS PREPARATION?



BLOOD COMPONENTS PREPARATION VIDEO BY NBTC

PREPARATION OF BLOOD COMPONENTS IN TRIPLE BAG



PRBC

PRP

SAGM

BLOOD COMPONENTS STORAGE

BLOOD COMPONENT	STORAGE TEMPERATURE	LENGTH OF STORAGE
Whole blood (for transfusion as whole blood)	2-6^{0}C±1^{0}C	≤35 days with adenine supplemented anticoagulant (CPDA)
Whole blood (for component preparation)	1-6^{0}C 22± 2^{0}C (if to be used for the preparation of platelets	Up to 8 hour before use Up to 24 hour before use
Red cells	2-6^{0}C±1^{0}C	≤35 days
Red cells in additive solution (SAGM)	2-6^{0}C	≤ 42 days in adenine supplemented anticoagulant (CPDA)
Plasma , Fresh Frozen	-18 to-80^{0}C	1year
Liquid plasma	2-6^{0}C	40days
Plasma, thawed	Thawed between 30-37^{0}C	Transfused as soas possible
Plasma, cryoprecipitate depleted	-18 to-25^{0}C	4 years
Platelets (single unit concentrates, Buff coat removed, apheresis)	22± 2^{0}C	5 days (close system) with continuous flatbed gently agitation < 6 hour (after open system)
Platelet , pooled	22± 2^{0}C	5days (Closed system) 24 hrs. (open system)
Cryoprecipitate	--18 to-25^{0}C	1 year

WHOLE BLOOD

INDICATION

Source material for blood component preparation

Rarely used for transfusion EXCEPT

- Resuscitate severe traumatic haemorrhage when platelets are not available in a military setting or exchange transfusion

DESCRIPTION

WB units collected in blood bags containing

- Citrate Phosphate Dextrose (CPD) - shelf life of 21 days when stored at 2-60 C
- Citrate Phosphate Dextrose Adenine (CPDA-1) solution - shelf life is 35 days

WB storage at 2-6 C

- Labile coagulation factors deteriorate rapidly
- Platelets activated, lose functionality and viability

WHOLE BLOOD (CONT....)

DESCRIPTION

- Up to 510 ml total volume (this volume may vary in accordance with local (policies)
- 450 ml donor blood
- 63 ml anticoagulant
- Haemoglobin approximately 12 g/ml
- Haematocrit 35 (45%)
- No functional platelets
- No labile coagulation factors (V and VIII)

INDICATIONS

- Red cell replacement in acute blood loss with hypovolaemia
- Exchange transfusion
- Patients needing red cell transfusions where red cell concentrates or
- suspensions are not available

RECONSTITUTED WHOLE BLOOD?

- Indicated in Neonatal exchange transfusions
- Pooling two components
  - Group O RBCs + Group AB plasma
  - • With or without irradiation
  - • With or without washing

What are various blood components?

Cellular blood components

❖ Packed red blood cells

- Packed red blood cells in additive solutions
- **Modified packed red blood cells**
  - Saline washed red cells
  - Leucodepleted red cells
  - Irradiated red cells
  - Frozen packed red blood cells
  - Packed red cell aliquot

Platelets

Random donor platelet concentrates
Pooled platelets concentrate
Modified platelets concentrate
- Leucodepleted platelet concentrate
- Irradiated platelets concentrate
- Washed platelet concentrate
- Platelets suspended in additive solution
- Cryo preserved platelet concentrate

Single donor apheresis platelets

Granulocyte concentrates

- Pooled buffy coat derived
- Apheresis derived

What are Various Blood Components? (contd)

Plasma blood components

- Fresh frozen plasma (FFP)
- Cryo-poor plasma
- Liquid plasma
- Recovered plasma/Source Plasma
- Pooled Plasma
- Frozen dried plasma
- Pathogen inactivated plasma

PACKED RED BLOOD CELLS (PRBCS)

They May also be called '**Red cell concentrates**', 'concentrated red cells' or 'plasma-reduced blood'.

DESCRIPTION

- 150–200 ml red cells from which most of the plasma has been removed
- Hemoglobin approximately 20 g/100 ml (not less than 45 g per unit)
- Haematocrit 55–75%

INDICATIONS

- Replacement of red cells in anemic patients with impaired oxygenation.
- Use with crystalloid replacement fluids or colloid solution in acute blood loss.

MODIFIED PRBCS?

- Saline washed red cells
- Irradiated red blood cell
- Buffy coat reduced red blood cells with AS(Additive Solution)
- Leuco-reduced PRBCs by filters
- Frozen/Cryopreserved PRBCs
- Packed red cells aliquots

SALINE WASHED PRBCS

DESCRIPTION

Washing WITH NORMAL SALINE

- Removes electrolytes and 99% of plasma proteins
- Removes 85% of the leucocytes from PRBCs - not enough to prevent alloimmunization

- Red cells washed in open system - used within 24 hours (to avoid bacterial contamination)
- RBCs washed in closed system - 14 days

INDICATION

In patients who have repeated severe allergic reactions to standard red cells.

IRRADIATED RED BLOOD CELLS

DESCRIPTION

To prevent transfusion-associated graft versus host disease (TAGVHD)

- Inactivation of T lymphocytes of donor
- Using gamma rays (from caesium 137/cobalt 60) or X rays (from linear accelerators/standalone units). 25 Gray (Gy) at centre of the bag, while a minimum of 15 Gy dose at periphery
- Irradiation sensitive labels should be used
- Irradiation → efflux of potassium from red cells - store for 28 expiry date (whichever earlier)

INDICATIONS

- Neonatal and foetal recipients of intrauterine transfusions
- Selected immunocompromised recipients
- Cellular components from a blood relative
- Bone marrow/progenitor cells transplantation patients

BUFFY COAT REDUCED RED BLOOD CELLS WITH AS

Removing plasma and BC following centrifugation of whole blood with the subsequent resuspension of the red cells in an additive Solution

DESCRIPTION

- Additive Solution(AS) - sodium chloride, adenine, glucose, mannitol, carbonate, citrate, phosphate, or guanosine in varying combinations and amounts
- A red cell suspension or concentrate containing <5 x 10_6 white cells per pack, prepared by filtration through a leucocyte-depleting filter.
- Hemoglobin concentration and hematocrit depend on whether the product is red cell concentrate or red cell suspension.
- Leucocyte depletion removes the risk of transmission of cytomegalovirus (CMV).
- The volume of AS depends on volume of WB 100:450/80:350
- The addition of AS increases shelf life to 42 days

ADVANTAGES LEUCOREDUCED PRBCS

- Prevents
  - Febrile non-haemolytic transfusion reactions (FNHTR)
  - HLA alloimmunization in multi-transfused patients
  - Transmission of leucotropic viruses, especially cytomegalovirus (CMV).
- Prepared by several methods.

  Filters is the preferred method:
  - Pre-storage,
  - Before issue
  - Bedside.

INDICATIONS OF LD PRBCS

Red cell components from which WBCs are removed off are Indicated in;

Patients who have experienced two or more previous febrile non hemolytic transfusion reactions to red cell transfusion like multi transfused patients e.g thalassemia.

PACKED RED CELLS ALIQUOTS

INDICATION

Small volume transfusions for paediatric patients

DESCRIPTION

- Multiple pack systems/ or a sterile connecting device
- The expiration date of the smaller RBC units is the same as the original unit as a closed system has been maintained in multiple pack system
- Sterile connecting device - transfer bags / tubing with integrally attached syringes

Advantages:

- Limited donor exposure
- Decreased blood wastage
- Prevention of circulatory overload.
- The expiration date of the aliquot RBC unit here also is the same original unit as a closed system has been maintained.

FROZEN/CRYOPRESERVED PRBCS

Red cells are stable for prolonged periods in a frozen state (10 years)

DESCRIPTION

- Always preserved with cryo protective agents - avoid red cell dehydration and intracellular ice
- Glycerol - most commonly used cryo protective agent (cost effective and safe)
- Slow constant mixing - failure leads to excessive haemolysis and poor red cell recovery when the unit is thawed
- Frozen RBCs can be stored for 10 years

INDICATIONS

- To preserve units of blood with rare phenotypes
- To build blood inventory for emergency use in disasters

CRYOPRESERVATION WITH GLYCEROL

Parameters	High-Concentration Glycerol (40%)	Low-Concentration Glycerol (20%)
Glycerol concentration	40%	20%
Freezing rate	Slow	Rapid
Requirement of controlled Freezing rate	No	Yes
Initial freezing temperature	-80˚C	-196˚C
Type of freezer	Mechanical	Liquid nitrogen
Maximum Storage temperature	-65˚C	-120˚C
Thawing and Refreezing	Possible	Critical
Storage Bag	Polyvinyl chloride, polyolefin	Polyolefin
Shipping+	Dry ice	Liquid nitrogen
Special deglycerolizing equipment required	Yes	No
Deglycerolizing time	20-40 minutes	30 minutes

RECOVERY OF FROZEN RBC

- Thawed at 37°C with gentle agitation taking about 10 minutes for complete thawing
- Glycerol must be removed gradually from thawed RBCs by washing with sterile saline solutions of decreasing osmolality to avoid red cell haemolysis
- Suspended in 0.9% sodium chloride → 0.2% dextrose solution
- Usually open system - only 24 hours when stored at 1-6 C
- Automated closed systems available

Final product should be:

- Free of cryo-protective agent
- Minimum of hemolysis
- Yield at least 80% of the RBCs originally frozen

PLASMA

DESCRIPTION

- From whole blood collections (differential centrifugation) / Apheresis
- WB collection time < 13-15 minutes for 350-450 ml blood bag (poor flow leads to the consumption of coagulation factors)
- Once collected, such whole blood units should be transported in ice or gel packs, maintaining a temperature below 10 C - frozen rapidly to maintain coagulation factor activity especially labile coagulation factors such as FVIII and FV, which deteriorate rapidly if stored at 2-6 C
- Plasma contains proteins such as coagulation factors, albumin and immunoglobulins
- Source material for plasma derivatives.

BLAST FREEZE AT -80 DEGREE CENTIGRADE

- Freshly prepared plasma is put at -80°C in deep freezer to preserve labile coagulations factors like factor V and Factor VIII. This is called blast freeze.
- Then it is stored at -20°C to -40°C and thawed later at the time of need.

MODIFIED PLASMA

- Fresh frozen plasma
- Pathogen inactivated plasma
- PF 24
- Freeze-dried pooled plasma
- Liquid plasma
- Cryoprecipitate-depleted/poor Plasma
- Recovered plasma/ Source plasma
- Pooled plasma

FRESH FROZEN PLASMA

DESCRIPTION

- Pack containing the plasma separated from one whole blood donation within 6 hours of collection and then rapidly frozen to –25˚C or colder
- Contains normal plasma levels of stable clotting factors, albumin and Immunoglobulin
- Factor VIII level at least 70% of normal fresh plasma level
- Ideally, the time taken to freeze the plasma to a core temperature (center of pack) less than -30˚C should not exceed 1 hour from the time freezing is commenced
- Shelf life of 1 year when stored at a temperature less than -30˚C PVC bags should be handled with care to prevent breakage during handling and transport as they are brittle at such low temperatures
- Plasma thawed at 37˚C in a water bath or plasma thawing baths
- Once thawed, FFP can be stored for 24 hours at 1-6˚C
- Avoid preparing from multiparous female donors - prevents TRALI

INDICATIONS

- Replacement of multiple coagulation factor deficiencies in

  - Liver disease
  - Warfarin anticoagulant overdose
  - Depletion of coagulation factors in patients receiving large volume transfusions.
  - Disseminated intravascular coagulation (DIC)
  - Thrombotic thrombocytopenic purpura (TTP)

PATHOGEN INACTIVATED PLASMA

DESCRIPTION

Plasma treated with methylene blue/ultraviolet light inactivation to reduce the risk of HIV, hepatitis B and hepatitis C. The 'inactivation' of other viruses, such as hepatitis A and human parvovirus B19 is less effective. The cost of these products is considerably higher than conventional fresh frozen plasma.

- Methylene blue, psoralen (amotosalen /ultraviolet A), riboflavin, and solvent/detergent (SD).
- Solvent/detergent (SD) and psoralen (amotosalen/ultraviolet A) →US-FDA
- Methylene blue (MB) Added to thawed FFP, followed by its activation using visible light.
- Nucleic acid strand breakage or lipid peroxidation - modification of surrounding membrane proteins.
- Plasma is refrozen after the removal of MB using filter
- 15-20% less factor VIII and fibrinogen than untreated plasma.

PATHOGEN INACTIVATED PLASMA (CONTD)

- Amotosalen Added to plasma prepared from whole blood or by apheresis, followed by its activation using UV-A light.
- Frozen for storage after removing amotosalen using an adsorption device
- Does not affect the activity levels of coagulation and antithrombotic factors

PATHOGEN INACTIVATED PLASMA

- Riboflavin (vitamin B2), followed by UV light illumination (Mirasol system) for 6-10 minutes
  - Riboflavin is a naturally occurring vitamin and does not require removal
  - Released or frozen for storage
  - Coagulation and anticoagulation proteins are found to be well preserved
- 1% tri-n-butyl phosphate and 1% Triton X-100
  - Inactivates lipid enveloped viruses by disrupting and destroying the lipid bilayer membranes required for cell adhesion and receptor binding to initiate an infection.
  - Coagulation factor levels are decreased by approximately 10% - 20%

INDICATION OF PATHOGEN INACTIVATED BLOOD COMPONENTS

- Pathogen inactivation technologies may make the blood supply safer by broadly eliminating infectious organisms such as malaria or Zika virus without the need to screen for specific pathogens.
- Another potential benefit is in reducing the need to irradiate blood products to prevent transfusion-associated graft-versus-host disease (TA-GVHD)

PF 24

DESCRIPTION

- Plasma frozen within 24 hours after phlebotomy - PF24
- Shelf life of 24 hours at 1-6 C
- Plasma held at room temperature up to 24 hours after phlebotomy before freezing - PF24 RT24\
- Major difference between FFP and FP24 is that FFP is separated from a unit of whole blood and frozen at -18oC within 8 hours after collection, whereas a unit of FP24 is frozen within 8 to 24 hours after collection.

INDICATION

- FP24 was created to cope with increasing plasma demand and the noted incidence of Transfusion Related Lung Injury (TRALI), with its suspected association with plasma from multiparous women having elevated anti-HLA and anti-neutrophil antibodies.

FROZEN-DRIED POOLED PLASMA

DESCRIPTION

Plasma from many donors pooled before freeze-drying. No virus inactivation step so the risk of transmitting infection is multiplied many times. This is an obsolete product that should not be used.

INDICATION

Dried plasma provides an alternative for early plasma transfusion in the resuscitation of hemorrhagic shock in environments where fresh frozen plasma is not immediately available.

LIQUID PLASMA

DESCRIPTION

- Plasma separated from a whole blood unit and stored at +4°C.
- No labile coagulation factors: i.e. Factors V and VIII.
- Storage at 1-6°C for up to 5 days beyond the whole blood's expiration date

INDICATION

Liquid Plasma does not need to be thawed (obviously) prior to transfusion, so it can be quite useful in “the initial treatment of patients who are undergoing massive transfusion”

CRYOPRECIPITATE-DEPLETED/POOR PLASMA

DESCRIPTION

Plasma from which approximately half the fibrinogen and Factor VIII has been removed as cryoprecipitate, but which contains all the other plasma constituents.

INDICATION

Cryoprecipitate-poor Plasma contains all coagulation factors except von Willebrand's factor and factor VIII. Therefore, it can be used in the treatment of rodenticide toxicity as well as the replacement of proteins (albumin and immunoglobulins).

RECOVERED PLASMA/ SOURCE PLASMA

DESCRIPTION

Recovered plasma is produced by separating donated whole blood into cellular components and plasma. It is plasma for manufacturer and processed into derivatives such as immunoglobulins, albumin etc.

Source plasma is collected through apheresis, a process that takes only plasma from the donor while the cellular components are returned also known as plasmapheresis.

INDICATIONS

Source plasma and recovered plasma are used to produce therapies that treat people with rare, chronic diseases and disorders such as primary immunodeficiency, hemophilia and a genetic lung disease, as well as in the treatment of trauma, burns and shock.

POOLED PLASMA

DESCRIPTION

- Done for therapeutic plasma exchange
- Multiple litres for single procedure
- Pooling up to 3 litres at a time (large bag)

INDICATION

Intravenous immunoglobulin (IVIG) is derived from pooled human plasma and contains immunoglobulin (Ig) G of all subclasses and allotypes but only minimal amounts of IgM and IgA. It can be used in patients with primary and secondary immunodeficiency syndromes and a variety of autoimmune disorders.

CRYOPRECIPITATE

DESCRIPTION

- Prepared from fresh frozen plasma by collecting the precipitate formed during
- controlled thawing and re-suspending it in 10–20 ml plasma
- Contains about half of the Factor VIII and fibrinogen in the donated whole blood: e.g. Factor VIII: 80–100 i.u./pack; fibrinogen: 150–300 mg/pack

INDICATIONS

- As an alternative to Factor VIII concentrate in the treatment of inherited deficiencies of:
  - Von Willebrand Factor (von Willebrand's disease)
  - Factor VIII (haemophilia A)
  - Factor XIII
- As a source of fibrinogen in acquired coagulopathies: e.g. disseminated intravascular coagulation (DIC)

PLATELET CONCENTRATES
(PREPARED FROM WHOLE BLOOD DONATIONS)

DESCRIPTION

- Single donor unit in a volume of 50–60 ml of plasma should contain:
- At least 55 x 109 platelets
- <1.2 x 109 red cells
- <0.12 x 109 leucocytes

INDICATIONS

- Treatment of bleeding due to:
  - Thrombocytopenia
  - Platelet function defects
- Prevention of bleeding due to thrombocytopenia, such as in bone marrow failure

PLATELET CONCENTRATES
(COLLECTED BY PLATELET APHERESIS)

DESCRIPTION

- Volume 150–300 ml
- Platelet content 150–500 x 109, equivalent to 3–10 single donations
- Platelet content, volume of plasma and leucocyte contamination depend on the collection procedure

INDICATIONS

- Platelet concentrates collected by apheresis are, generally, equivalent to the same dose of platelet concentrates prepared from whole blood
- If a specially typed, compatible donor is required for the patient, several doses may be obtained from the selected donor

GRANULOCYTES(WHITE BLOOD CELLS)

- Although it is possible to prepare granulocytes from whole fresh blood but current practice is to collect granulocytes by apheresis.
- Granulocyte transfusion is **indicated** in severe neutropenic patients with bacterial or fungal infection unresponsive to appropriate antimicrobial therapy.
- Granulocyte transfusion cannot be used indefinitely and should not be used if a patient's own neutrophil production is not expected to recover.

QUALITY CONTROL OF BLOOD COMPONENTS

Must be done right from **vein of donor to vein of patient** like right from cleaning phlebotomy site to transfuse patient at ward level. Includes;

- Material management
- Equipment management
- Process management
- Documents and records
- Monitoring and assessment
- Process improvement

REFERENCES

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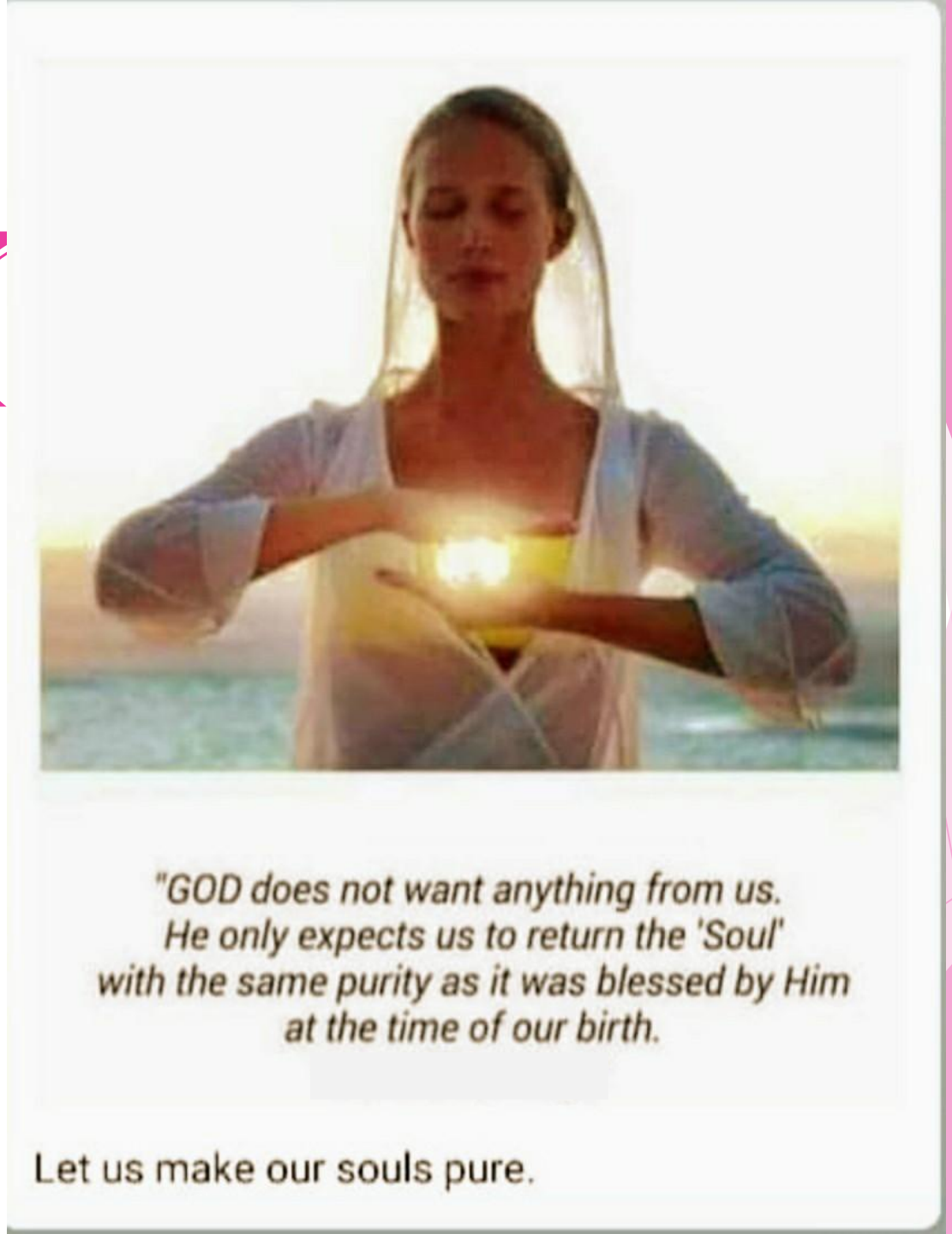
- "Modern Blood Banking & Transfusion Practices"; 6th Edition, By Denise M. Harmening.
- "Technical manual AABB"; 18th Edition, By Mark K Fung .
- "Transfusion Medicine Technical Manual" 3rd Edition By RK saran.
- "Transfusion Medicine For Medical Laboratory Technologists"; 1st Edition, By Dr. Kusum Thakur.

CONCLUSION

- ✓ – RIGHT BLOOD COMPONENT
- – RIGHT QUANTITY
- – RIGHT QUALITY
- – RIGHT PATIENT
- – RIGHT TIME
- – RIGHT COST

THANK YOU


"GOD does not want anything from us.
He only expects us to return the 'Soul'
with the same purity as it was blessed by Him
at the time of our birth.
Let us make our souls pure.