Essential of Blood Component Therapy

Definition

- *Blood component*:A blood component is a portion of blood which is separable by physical or mechanical means, such as differential centrifugation
- *Blood fractions:* It is a derivative of plasma obtained by chemical processes, e.g. alcohol precipitation.
- *Blood products*=blood components +Plasma fractions

Requirements for component preparation

- Blood donor
- Hardware
- Plastic bag
- Temperature
- Mechanical/ ‘g’ force
- Specific gravity of blood component
- Good manufacturing practice
- Safe transfusion practice

Blood donor selection

- All units collected by D&C act criteria.
- Criteria for whole blood collection:
  *collected within 8-10 min.
  *processed within 6-8 hours
  *constantly mixing, 450±10 ml
  *no aspirin within 48 hours
  *QC in collection (weight monitor)

Blood donor selection (*cont*...)

- Type of donors(paid, professional, captive, relative, fringe motivated VD, altruistic VD, autologous, directed, apheresis).
- Donor selection for apheresis: consent, duration, TTD testing, RBC loss/ product cross match, Multiple product collection

Hardware

- Refrigerated centrifuge (inductn. motor)
- Deep freeze (-30^{o} & -80^{o} C; double door/ horizontal)
- Blast freezer
- Refrigerated water bath.
- Platelet shaker/ incubator
- Plasma expresser, sealer, balance, Wt.
- Cell separator machine.

Plastic bags

- Closed system.
- Double, triple, quadruple, top-bottom.
- Plastics (DEHP, butyldehyde, leaching)
- O_2 permeation (platelet 3-5 days).
- Extreme of temp. (-196^o to +37^o C).
- Withstand high centrifugal force.

Temperature

- -196^{o} C =For RBC, Platelet, stem cell
- -80 to-30^{o}C=For FFP, Cryoppt., CPP.
- + 4^{o} C =For RBC liquid preservation
- + 22^{o} C =For platelet preservation.
- + 37^{o} C =Transfusion of component
- + 60^{o} C =Dry heat viral inactivation
- +160^{o} C =Dry heat sterilization.
- +1200^{o} C =Plasma incineration.

Mechanical ('g') force

- Gravitational force:
  *Overnight hanging.
- Mechanical force
  *Refrigerated centrifuge (induction motor)
  *Cell separator (intermittent/ continuous)

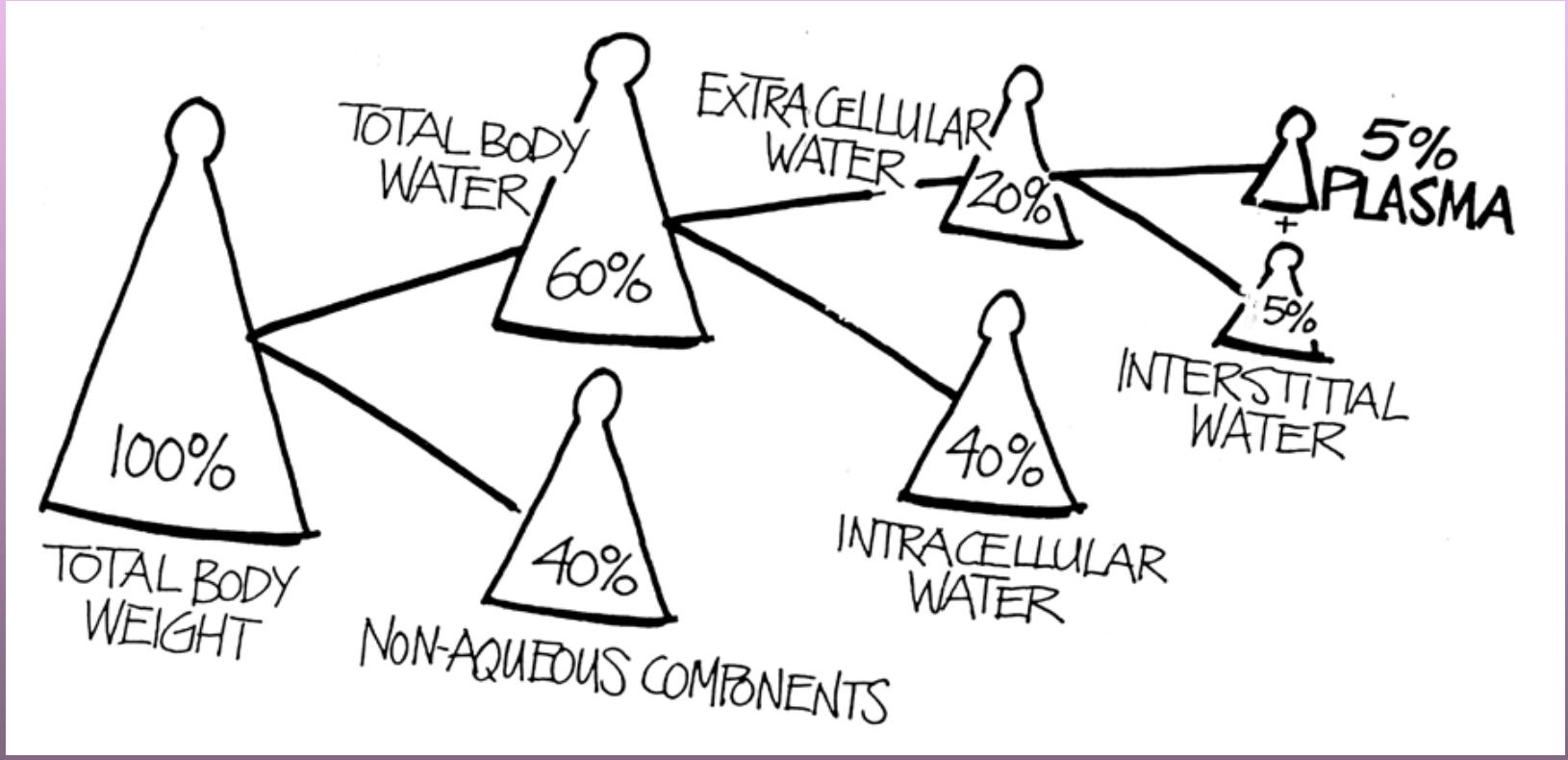
Mean density of blood components

- Plasma : 1.026
- Platelet : 1.058
- Monocyte : 1.062
- Lymphocyte : 1.070
- Neutrophil : 1.082
- Red cells : 1.100

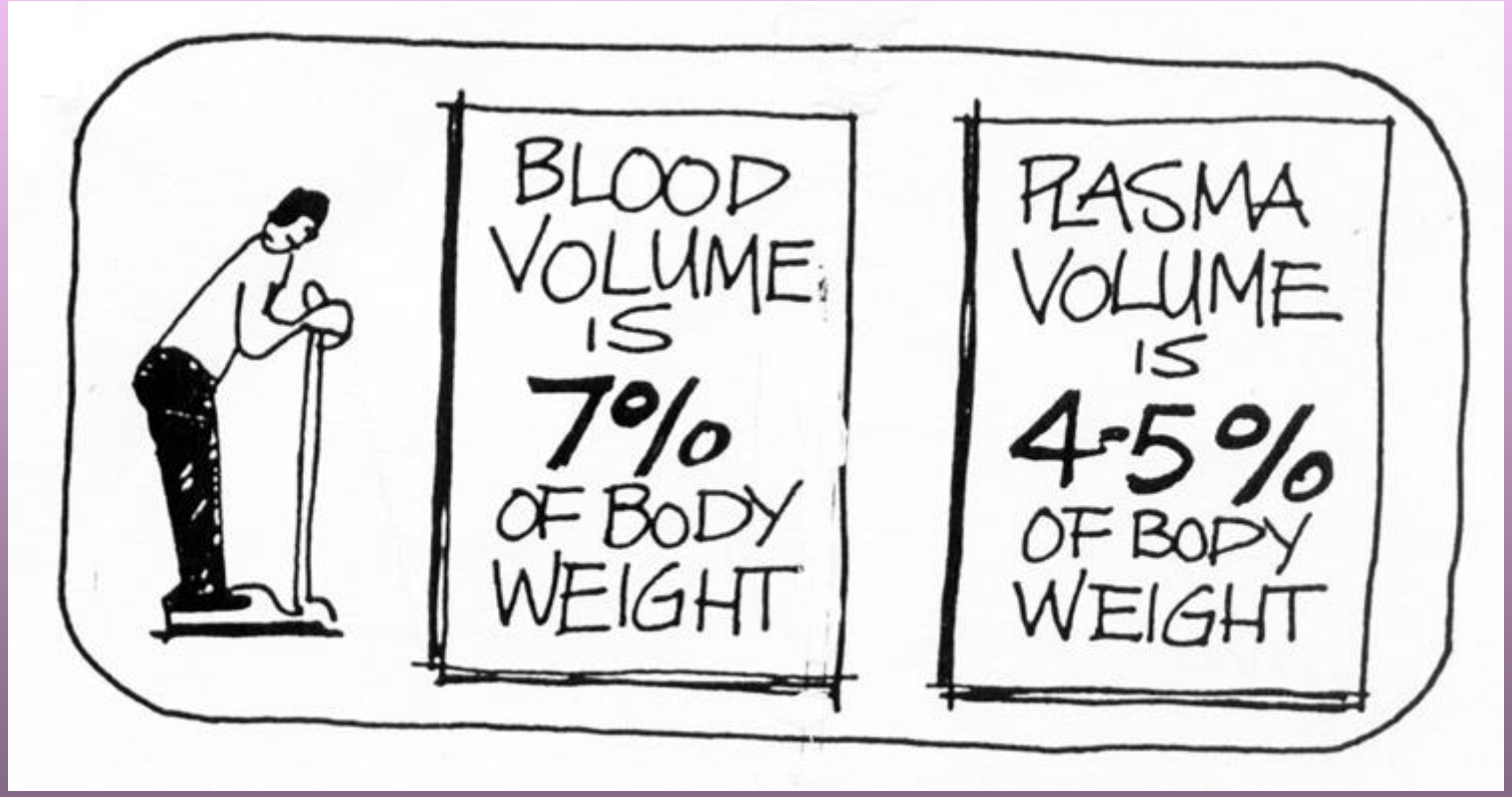
Blood components

Blood components	Plasma derivates
O_2 carrying components • Red blood cells • Leukopoor blood • Frozen thawed red blood **Platelet products** • Platelet rich plasma(PRP) • Platelet concentrate (PC) **Plasma product** • Fresh frozen plasma (FFP) • Frozen plasma • Cryoprecipitate • Stored liquid plasma	**Coagulation factor conc.** • Factor VIII conc. • Factor IX complex conc **Oncotic agent** • Albumin • Plasma protein fraction:PPF **Immune serum globulin** • Hepatitis B immune-globulin • Rh immune-globulin • Varicella-Zoster Ig. • Tetanus immune globulin

Plasma & body weight



Blood volume



Blood components that carry O_2

Red blood cell suspension	Other products capable of carrying O_2
•Red blood cells •Leukocyte poor blood •Frozen thawed RBC •Irradiated RBC •Washed RBC	•Perflourochemical •Modified hemoglobin

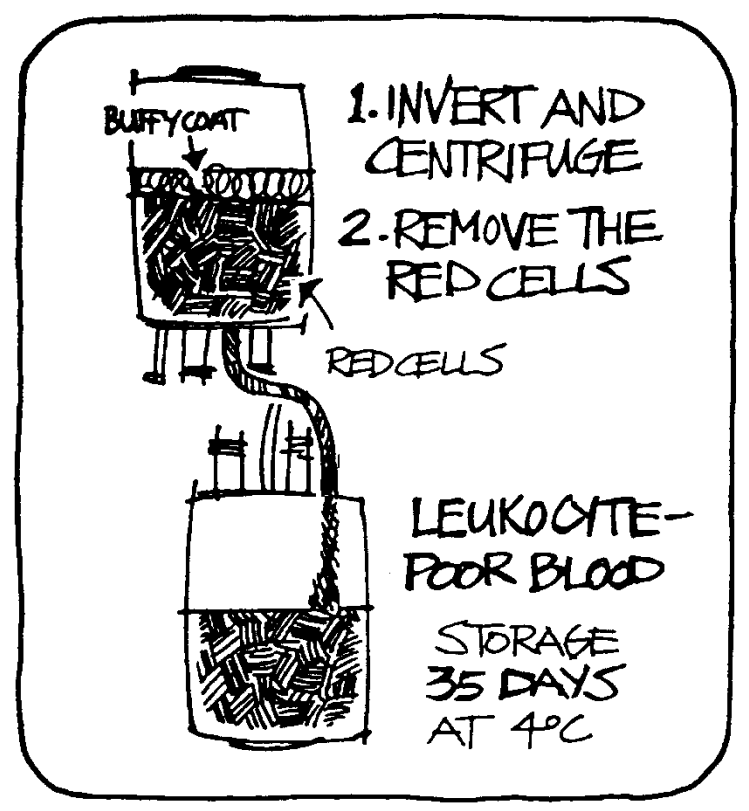
Red blood cells

- Source: by product.
- Preparation: Hard/ light centrifugation
- Shelf life:35 ($CPDA_1$)& 45(SAGM) days
- Preservation: $+4^oC$
- Indication: to increase O_2 carrying capacity
- Contraindication: None.

Leukocyte-poor RBC.

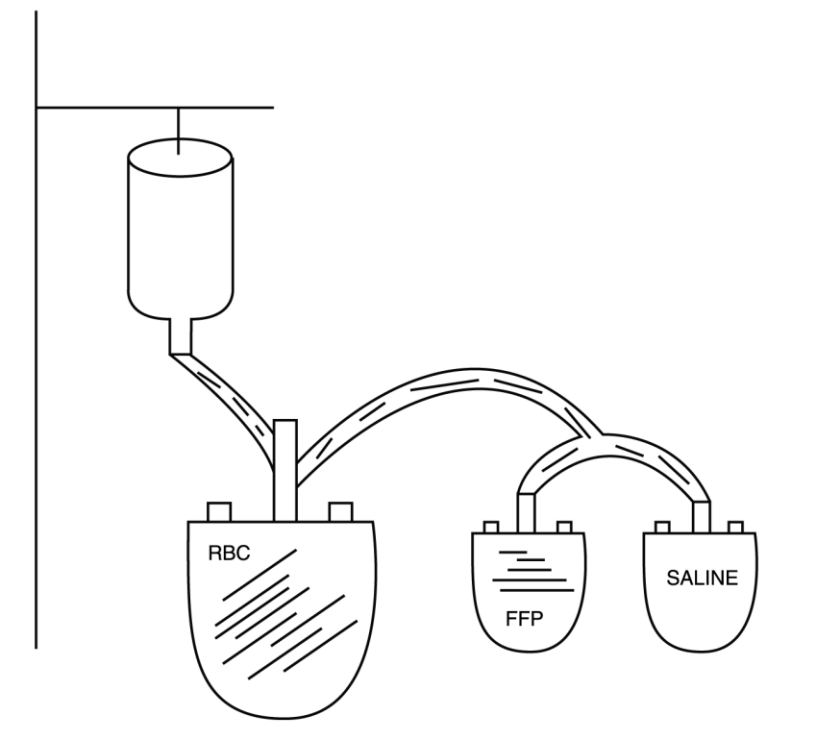
- Source: pre-storage or bed-side.
- Preparation: Inverted centrifugation, Washed RBC, Sedimentation, Deglycerolized RBC, Automated blood component extractor, Filtration.
- WBC reduction:80-99.9%
- Indication: NHFTR prevention, leukocyte immunization, CMV transmission.

Inverted centrifugation



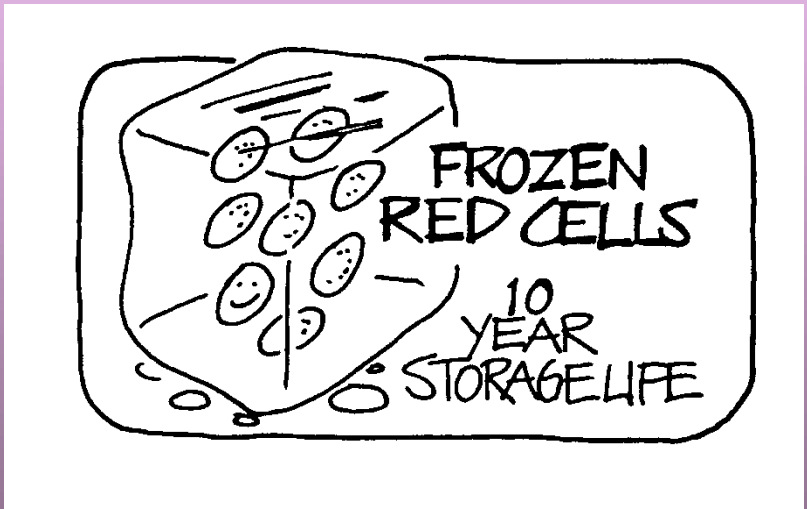
- Blood units centrifuged inverted.
- *Use*: to prevent FNHTR
- *Adv*: Simple technique, no extra equipment.
- *Disadv*: poor leuko-depletion, no accuracy, viscosity.

Saline washed RBC



- NaCl added, centrifugd, resuspended in NaCl.
- *Use*:FNHTR, allergic Tx reaction, IgA deficiency
- *Adv*:Simple tech, low viscosity.
- *Disadv*:Open system, poor leukodepletion.

Frozen deglycerolized RBC

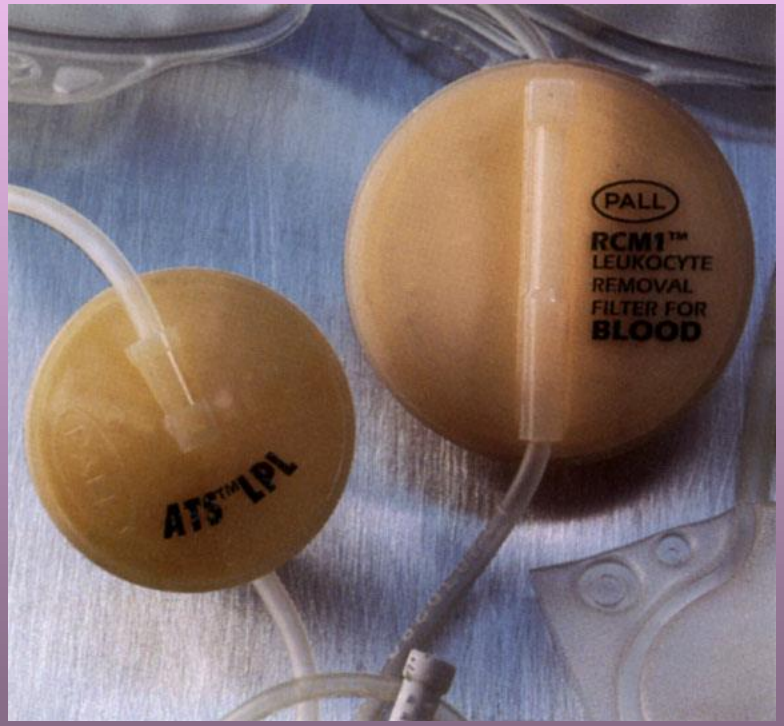


- RBC is frozen in glycerol washed & resuspend in NaCl before Tx.
- Use:Rare blood group, autologous Tx, multiple allo-antibody.
- Adv:storage 10 yrs, rare situations.
- Disadv:Special tech, open system.

Automated blood component extractor

- Blood collected in quard bags,LD by buffycoat/ PRP method, 1 log reduction.
- Use:FNHTR, prevents alloimmunization.
- Adv:High yield, no RBC contamination, 3 min operation (12 sensors), automated, data transfr

Leukocyte filters



- Pre-storage (better for QC)/ bed side filtran; web & pores retain WBC (99.9%)
- QC:$5x10^6$WBC in all units tested.
- Adv:Immunization preventn, FNHTR, CMV transmission.
- Disadv: cost.

Platelet concentrate

- Source: Random donor & Apheresis.
- Preparation:
  *Random donor= PRP & buffy coat
  *Apheresis=intermittent or continuous type machine.
- Increment: RDP=$5.5x10^{10}$, SDP=$3x10^{11}$
- Temp: 22^{o} C, pH: 6.0 to7.4.
- Indications: Decreased production, severe bleeding, DIC, Plt. alloimmunization.

Throbocytopenia & probable risk of bleeding

Platelet count (per cmm)	Risk of bleeding
$<5 \times 10^3$	Life threating bleeding is a possibility.
$5\text{-}20 \times 10^3$	Increased likelihood of spontaneous bleeding.
$20\text{-}50 \times 10^3$	Increased likelihood of bleeding in trauma, surgery, gast. ulcer etc
$>50 \times 10^3$	Bleeding rarely occurs

Fresh frozen plasma

- Source: Whole blood within 6-8 hours.
- Preparation:
  *By centrifugation or by apheresis.
  *Blast/ flat/ ethanol bath freezing.
- Temp: -30^{o} C for 1 year.
- Indication: Patient requiring coagulation factors.

Coagulation factors available per unit of FFP

Factors	Average levels/ unit of FFP
• **Fibrinogen**	**2.41 Gm.**
• **Factor II**	**1.03 u/ml**
• **Factor V**	**0.64 u/ml**
• **Factor VII**	**1.21 u/ml**
• **Factor VIII**	**0.85 u/ml**
• **Factor IX**	**0.91 u/ml**
• **Factor X**	**1.25 u/ml**
• **Factor XI**	**0.79 u/ml**
• **Antithrombin III**	**104%**

Clinical indications of FFP

Definite indication	Conditional uses	No justification
• **Replacement of F.deficiency** • **Reversal of Warfarin action** • **Vit.K deficiency with bleeding** • **Acute DIC** • **TTP** • **Inherited Coagulatn. Deficiency**	• **Massive transfusion** • **Liver disease** • **Cardiopulmonary by-pass surgery**	• **Hypovolaemia** • **Plasma exchange** • **Nutritional support & protein loosing state**

Cryoprecipitated AHF

- It is the insoluble part of the FFP after thawing.
- Rich in F.VIII, fibrinogen, Ig & others.
- Storage at –40º C. for 1 year.
- About 15 ml contains about 80-120 IU of F.VIII, no group specificity.
- Indication: To replace F.VIII, fibrinogen

Use of components in various indications

Deficiency	Blood product indicated
• **Fibrinogen**	**Cryoppt., stored plasma**
• **Factor V**	**FFP, Frozen plasma**
• **Factor VII**	**Factor IX complex conc., stored plasma**
• **Factor VIII**	**Factor VIII conc., cryoppt.**
• **Factor vW**	**Cryoppt., FFP.**
• **Factor IX**	**Factor IX concentrate.**
• **Factor X**	**Stored plasma.**
• **Factor XI**	**Stored plasma.**
• **Factor XIII**	**Stored plasma.**

Single donor plasma

- Source: After cryoppt. removal, outdated FFP, 5 days after WB expiry.
- Preparation: Hard spin & cryoppt. Removal; Thawed FFP; Hard spin & remove plasma from expired WB.
- Shelf life: 5 years at –20^{o} C.
- Indication: Protein (vol?) replacement.

Blood irradiation & TA-GvHD

- Implicated blood components:
  - * Whole blood/ RBC/ Filtered RBC.
  - * Fresh plasma.
  - * Platelets.
  - * RBC & Platelets treated with 15-20 Gy.
  - * Leukocyte form healthy donors.
- Blood components not implicated:
  - * Fresh frozen plasma.
  - * Frozen deglycerolized RBC.
  - * Clotting factor concentrate.

Indications for Irradiated Blood

- Absolute indications:
  BMT, biological relatives, I.U.Tx., Cong. immune deficiency, granulocyte Tx.
- Relative indications:
  Premature infant, NHL, Solid organ (non kidney) transplant, Nonhem malignancies
- Controversial use:
  Pregnancy, aplastics, HLA matched Tx, general onco & surg. Patients, neonates.

Fibrin-glue

- Source: Cryoppt. & thrombin (human/ bovine).
- Preparation: Liquid cryoppt. & thrombin is applied on surface
- Shelf life: Two years
- Indications:suturing, raw surface, epithelial bleeding

Good manufacturing practice

- “Do what is written, write down what you do”.
- SOP in all Labs, revision 6 monthly, signed & authorized by comp. Authority
- QA: 1% of total units, 75% product to conform with standard, monthly audit.
- EQAS:Local, regional, NACO, WHO.

Safe transfusion practice

- Developing guideline for rational use of blood (guidelines to real users).
- Clinician awareness & training sessions
- Transfusion with definite indications.
- Setting up hospital transfusion committee.
- Ensuring availability of blood/ components
- Promoting blood component therapy.
- Managing inventory of blood & component.