

Blood Transfusion Basic Concepts,
Blood Transfusion in ICU and
Anaesthesia

- Introduction
- Indications
- Components
- Hazards
- ?????

- Anesthesiologists, the perioperative physicians, are major users of blood and blood products.
- Therefore thorough knowledge of transfusion practices becomes imperative in this speciality.

Hemostasis following trauma/ surgery dependent on

- Vascular spasm
- Formation of platelet plug (primary hemostasis)
- Coagulation of blood (secondary hemostasis)

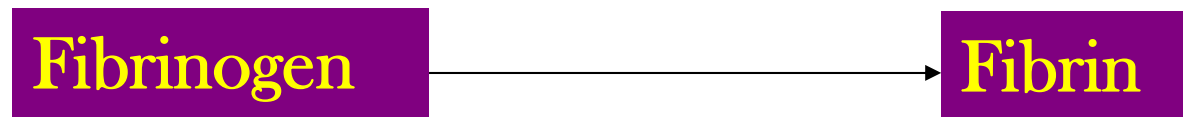
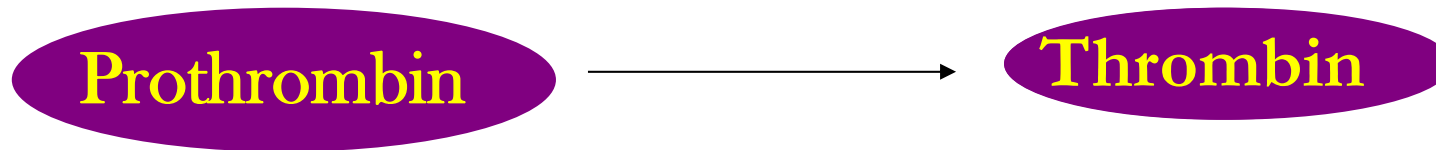
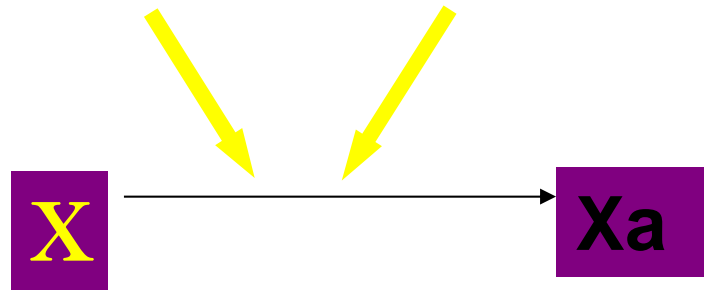
Normal Coagulation Factors

- I- FIBRINOGEN
- II-PROTHROMBIN
- III-TISSUE THROMBOPLASTIN
- IV-CALCIUM
- V-PROACCELERIN
- VII-PROCONVERTIN
- VIII-ANTIHEMOPHILIC FACTOR
- IX-CHRISTMAS FACTOR
- X-STUART FACTOR
- XI-PLASMA THRMBOPLASTIN ANTECEDENT
- XII- HAGEMAN FACTOR
- XIII-FIBRIN STABILIZING FACTOR

Coagulation Pathway

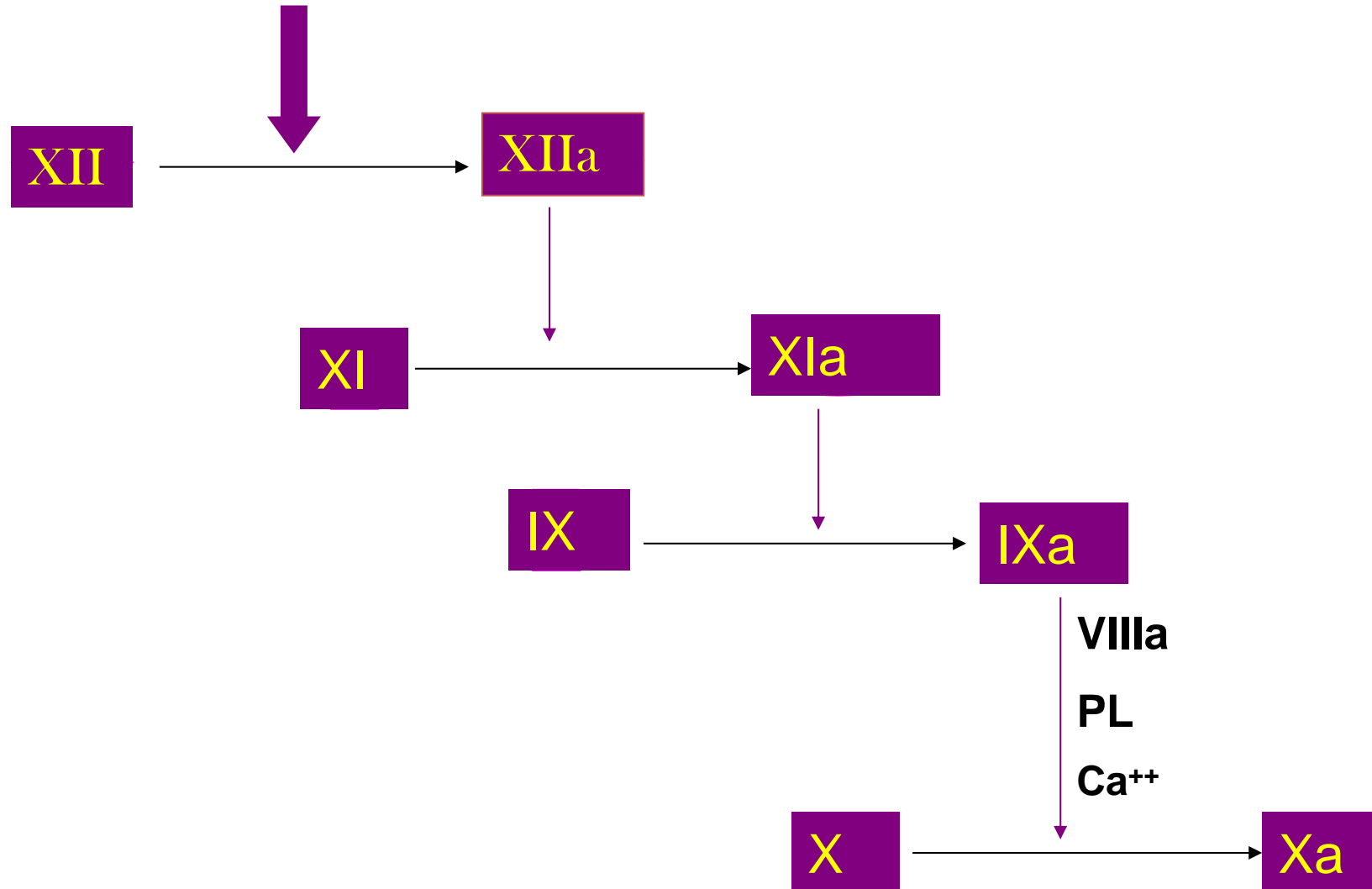
Intrinsic pathway
(Contact)

Extrinsic pathway
(Tissue factor)



Intrinsic Pathway

Contact (Eg: with glass)



When To Transfuse

1. Monitor blood loss –

- Visual assessment of the surgical field
- Blood loss $>25\%$ of total blood volume
- MABL
 - a. estimate blood volume
 - b. RBC volume at preop hematocrit
 - c. RBC volume at hematocrit 30%
 - d. RBC volume lost when hematocrit is 30% = $b - c$.
 - e. $MABL = 3 \times d$.

When To Transfuse

2. Monitor for inadequate perfusion & oxygenation of vital organs.

- Sr. lactate $> 2\text{meq/lit}$
- O_2 extraction 50% . (O_2 extraction = $\text{Sa O}_2 - \text{Scv O}_2$.)
- $\text{U/O} < 0.5\text{ml /kg/ hr.}$
- BP, HR, O_2 saturation, ABG

When To Transfuse

3. ASA guidelines (2006) transfusion indicators

- Transfusion rarely indicated when Hb > 10 gm/dl and almost always indicated when Hb < 6 gm/dl
- Patients with Hb b/w 6-10 gm/dl should be based on patient risk for complications of inappropriate oxygenation, rate and magnitude of ongoing bleeding and patient intravascular volume status

Use of single Hb trigger for all pt not recommended.

When appropriate, preop autologous blood donation, intra op and post op blood recovery, acute normovolumic hemodilution and measures to decrease blood loss may be beneficial

Compatibility Testing

1. ABO-RH TYPING

- Most important as most severe transfusion reactions are due to ABO incompatibility.
- Donor blood gp which pt can receive

DONOR	RECIPIENT
O	O, A, B, AB
A	A, AB
B	B, AB
AB	AB

Compatibility Testing

2.CROSS MATCHING

- Trial transfusion – donor RBCs mixed with recipient serum

Three phases

- Immediate phase
 1. At room temp
 2. Checks against errors in ABO typing
 3. Takes 1 to 5 min

COMPATIBILITY TESTING

2. CROSS MATCHING

- Incubation phase
 1. Detects antibodies that cause sensitisation but not agglutination
 2. Takes 30-45min
 - Antiglobulin phase
- Detects antibodies to other blood group systems.

COMPATIBILITY TESTING

3. ANTIBODY SCREENING

- Trial transfusion b/w recipient serum and commercially supplied RBCs that are specifically selected to contain optimal number of RBC antigens
- Used to detect in the serum presence of antibodies associated with non ABO hemolytic reactions.
- Done to prevent reactions between transfused donor units.

Compatibility Testing

- **Compatible transfusion with**

ABO-Rh typing – 99.8%

Antibody screening – 99.94%

Cross matching – 99.95%

EMERGENCY TRANSFUSION

- Infuse crystalloids/ colloids
- Draw blood for typing and cross matching
- Type specific of type O Rh –ve cells
- Type O Rh +ve cells for males or postmenopausal females without h/o transfusion.

Maximum Surgical Blood Ordering Schedule

- Most hospital make a list of their most commonly performed surgeries and the maximum number of units that can be cross matched preoperatively
- Cross match to transfusion ratio of <math><2.5:1</math> is acceptable

Efficacy Of Transfusion

- Defined by the US Food And Drugs Administration as survival of 70% or more of RBCs 24hrs after the transfusion

Storage Of Blood

1.CPDA-1-

Can store blood for 35 days

Most commonly used anticoagulant preservative

Blood stored at 1-6°C (assists preservation by slowing rate of glycolysis.

C- citrate – anticoagulant (binds to Ca)

P- phosphate – buffer

D- dextrose – red cell energy source.

A- adenine – prolongs RBC survival by allowing RBCs to resynthesize ATP.

Storage of blood

2. ADSOL – Adenine , glucose, mannitol, sodium choride.
- Blood can be stored for 42 days.
3. Nutricel – glucose, adenine , citrate, phosphate and sodium chloride
4. Optisol – dextrose, adenine , sod chloride, mannitol

Changes In Stored Blood

- Glucose → lactate
- H⁺ accumulates and plasma pH decreases
- Na⁺/K⁺ pump stimulated → hyperkalemia
- Increased osmotic fragility
- Decreased ATP and 2,3 DPG → left shift of ODC

FROZEN RBCS

- RBCs frozen to -79°C in glycerol
- Washed before transfusion
- Advantages –
 1. Rare bld gps can be stored for long
 2. Safer in pt susceptible to allergies
 3. Less risk of transfusion hepatitis
 4. Safe in pt receiving massive BT
 5. Normal levels of 2,3 DPG retained.

Leukoreduced

- Non-LR RBC contain $1-3 \times 10^9$ WBC
- LR contain $< 5 \times 10^6$ WBC and retains 85% of the original cells
- Reduces febrile reactions
- Reduces HLA immunization (e.g. transplant)
- Effective in reducing CMV transmission (CMVsafe)
- Cellular immune function preservation
- Does NOT prevent GVHD
- Prestorage vs. Bedside Filtration

Complications Of Bt

- **Immune complications**

1. Hemolytic
2. Non-hemolytic

- **Infectious complications**

1. Viral
2. Parasitic
3. Bacterial

Acute Hemolytic Reactions

- Intravascular hemolysis d/t ABO incompatibility
- MC cause misidentification of pt, blood specimen or transfusion unit
- As little as 10-15ml of blood can cause severe reactions
- 20-60% fatality rate
mainly renal and coagulation systems affected
- S/S in awake pt – chills, fever, chest pain, flank pain, unexplained tachycardia, nausea
- S/S under anesthesia – hemoglobinuria ,
hypotension , diffuse oozing in surgical field, DIC

Acute Hemolytic Reactions

- Lab tests – sr haptoglobin, plasma and urine hb, bilirubin, direct antiglobulin determination
- Management -
 1. stop transfusion
 2. Unit should be rechecked
 3. Maintain u/o @75-100ml/hr by giving iv fluids and mannitol, furesimide 20-40mg iv
 4. Alkalinize the urine – 40-70meq of soda bicarb / 70 kg body weight raises urine pH to 8.0
 5. assay urine and plasma hb conc.
 6. determine platelet count , APTT, Sr fibrinogen
 7. return unused blood with bt set to blood bank
 8. Send pts blood and urine sample to blood bank
 9. Prevent hypotension

Delayed Hemolytic Reaction

- Extravascular hemolysis
- Mild
- Occurs mainly in recipient sensitised to RBC antigen by previous bt or pregnancy – anamnestic antibody response
- More common in females
- Delayed 2 to 21 days after transfusion
- S/s malaise , jaundice, fever
- Diagnosed by direct Coombs tests
- T/t – supportive

Nonhemolytic Immune Reactions

Due to Sensitisation of recipient to donor WBC ,
platelets or plasma proteins

TYPE

1. FEBRILE REACTIONS
2. URTICARIAL
3. ANAPHYLACTIC
4. NONCARDIOGENIC PULMONARY EDEMA
5. GRAFT V/S HOST DS
6. POST TRANSFUSION PURPURA
7. IMMUNE SUPPRESSION

Nonhemolytic Immune Reaction

1. **Febrile reaction** – incidence 3%.
 - Rise in temp without e/o hemolysis
 - Chills , fever , headache, myalgia, nausea, non-productive cough
 - D/t wbc / platelet sensitisation
 - Patients with h/o repeated febrile reactions should be given leukocyte-poor red cell transfusion

Nonhemolytic Immune Reaction

2. Urticarial reaction

- Erythema, itching, facial swelling
- D/t sensitization of pt to transfused plasma proteins
- T/t with antihistaminic and steroids

Nonhemolytic Immune Reaction

3. Anaphylactic reaction

- Rare
- Dyspnea, hypotension, laryngeal edema, chest pain, shock
- Seen in IgA deficient patient who receive IgA containing BT
- Does not involve RBC destruction
- T/t with epinephrin, fluids , steroids and H1,H2 blockers

Nonhemolytic Immune Reaction

4. Non cardiogenic pulmonary edema

- Also known as TRALI
- Fatality rate 10-15%
- D/t transfusion of anti HLA antibodies that interact with and cause patients WBCs to aggregate in the pulmonary circulations
- S/s – (1 to 2 hrs after tx) – fever, dyspnea, fluid in ETT, severe hypoxia
- Dx – based on exclusion of other causes of respiratory distress and PE. CXR and testing the serum of both donor and recipient for WBC antibodies will support the dx
- No specific treatment resolves within 72 to 96 hrs

Nonhemolytic Immune Reaction

5. Graft v/s host ds

- Seen in immunocompromised pts
- D/t lymphocytes present in cellular blood products
- Generalised rash, leukopenia, thrombocytopenia, sepsis and death
- Prevented by (a) use of special leukocyte filters
(b) irradiation of red cells , granulocytes and platelet transfusion

Nonhemolytic Immune Reaction

6. Post transfusion purpura

- Profound thrombocytopenia d/t platelet alloantibodies
- Platelet count drops 1 week after transfusion
- Plasmapheresis recommended

Nonhemolytic Immune Reaction

7. Immune suppression

- Transfusion of WBC containing blood products
- Recurrence of malignant growths, increase in post op infection , virus activation may occur in pt who receive blood transfusion during surgery

Infective Complications

- One of the most imp complications of BT
- NAT testing has decreased window of activity

1. Hepatitis

Icteric/ non-icteric – 1:2-5

Icteric hepatitis – 50-180 days post transfusion , variable course

Non-icteric hepatitis – 14-180 days post transfusion, 2 consecutive increase $>2SD$ 14 days apart of recipients ALAT.

90% - hepatitis C, rest hepatitis B.

Incidence decreasing d/t - Improved donor screening, NAT testing for hepatitis

Infective Complications

2. AIDS

Severe depression of cellular immunity

NAT testing has decreased window period to 11 days

3. HTLV 1 –

Associated with adult T cell leukemia, progressive myelopathy

4. West Nile virus

Infective Complications

5. CMV

Asymptomatic chronic infection very common.

High risk groups – premature neonates, allograft recipients, post splenectomy pts.

Prevention – use of leukocyte depleted blood, use of frozen RBC, screening of donors for absence of antibodies to CMV.

Infective Complications

6. Other infections

- *Yersinia enterocolitica* – manifests in 4 weeks, storage of blood at 4°C enhances its growth
- Syphilis – cannot survive at 1-6°C, common with platelet concentrates
- Malaria
- Herpes virus , infectious mononucleosis, toxoplasmosis, trypanosomiasis, leishmaniasis, brucellosis, filariasis, measles, salmonellosis, CZD.

BLOOD COMPONENT THERAPY

Definition

The process of transfusing only that portion of the blood which is needed by the patient is called BCT

Component Therapy

- Can give individual component for specific illness
- Patient does not require all the components
- This policy can benefit more than one individual

One Unit Of Whole Blood

- One unit of RBC'S
- One unit of Platelets
- One unit of Cryoprecipitate
- One unit of Plasma (minus above 2)

1 unit of whole blood = 450 ml blood

63 ml anticoagulant preservative

Blood Components

Cellular components	Plasma components	Plasma derivatives
Red cell concentrate	Fresh frozen plasma	Albumin 5% and 25%
Leucocytes-reduced red cells	Single donor plasma	Plasma protein fractions
Platelet concentrate	Cryoprecipitate	Factor VIII concentrate
Leucocytes-reduced platelet concentrate	Cryo-poor plasma	Other coagulation factors
Platelet apheresis		Immunoglobulins
Granulocyte apheresis		

LIGHT SPIN at 2000 rpm for 3 minutes at 22°

RESULT - Packed RBC
- PRP

WHY LIGHT SPIN?

- To avoid damage to Platelets
- Process required to be done within 6 hrs of whole blood collection
- Packed RBC's are suspended in a hematocrit of 70% (CPDA-1) or 60 % (AS -1 or AS- 3,5)

HEAVY SPIN at 5000 rpm ,5 minutes & 4°C

RESULT- PPP

Heavy spin → Damage to platelets

Volume → 200 – 400 ml per whole blood
transfusion bag

Platelet Poor Plasma (PPP)

FRESH PLASMA

Prepared & infused within 6 hrs of preparation

FRESH FROZEN PLASMA

- Fresh plasma stored at -20°C in a freezer
- Is stable for 1 year

Both forms of PPP have all the Coagulation factors & proteins

High spin at 4 °C to PPP

RESULT

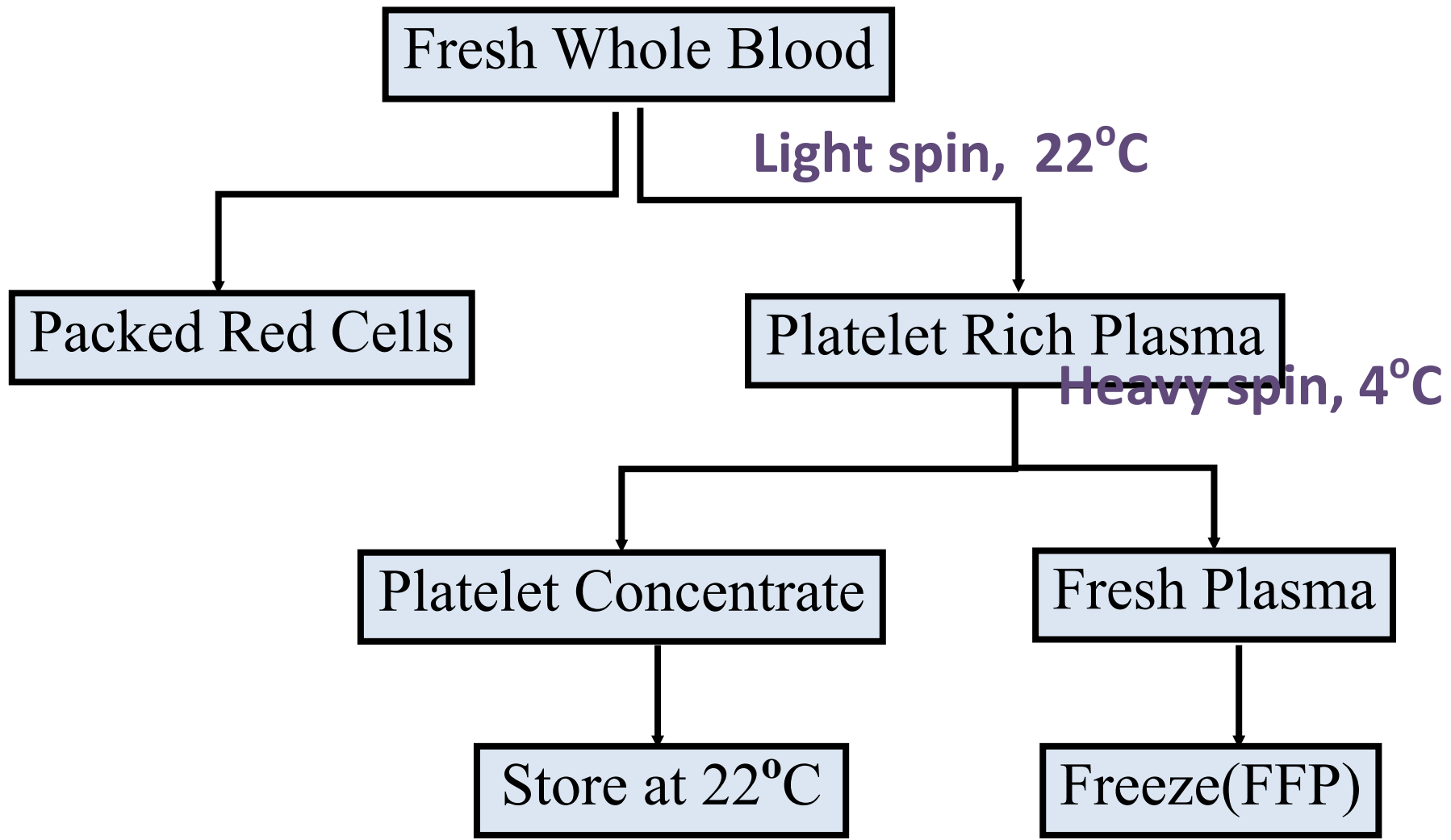
- Cryoprecipitate (20-30ml)
- Cryosupernant

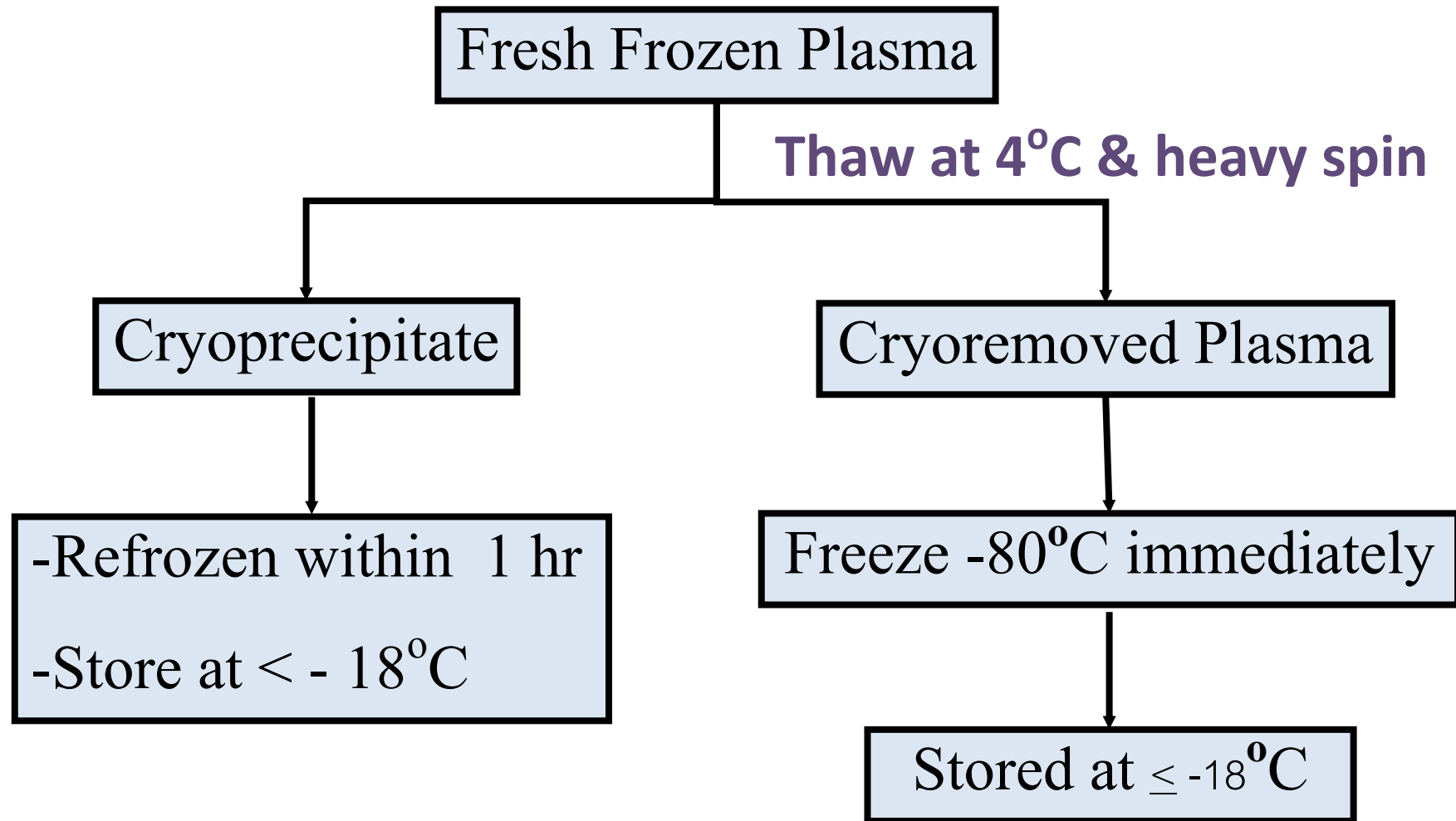
Cryoprecipitate

- Concentrated source of Von- Willebrand factor, fibrinogen, Factor VIII and fibronectin
- Stable for 1 year

Cryosupernant

- Remaining plasma after removal of cryoprecipitate
- Stable for 5 years at -20°C





Whole blood

1st patient - Pope Innocent VIII in 1492 (stroke)

Whole blood = Transfusing all the components in one go

6 ml / kg blood transfusion = ↑ in Hb by 0.5 gm – 0.75 gm /dl
in adults

8 ml / kg blood transfusion = ↑ in Hb by 1 gm / dl in children

INDICATIONS

1. Where blood loss is $> 25\%$
2. In exchange transfusion, as less than 5 days old blood is required

Packed RBC's

- Most frequently required and used
- Benefit – Will increase amount of O₂ delivery to tissues
- 1 unit PRBCs = 200 ml RBCs
100 ml additive solution
30 ml plasma
- Storage - 1°C to 6 °C
- Post transfusion viability - 75 %

Cont..

- Hematocrit value 70%.
- 1 unit of pRBC increases hematocrit by 3-5%.
- Ideal for pt needing red cells but not volume replacement
- Transfusion tubing should contain 170micron filter
- Warmed to 37* c if more than 2-3 units are to be given
- Solutions recommended for reconstituted RBCs are 5% dextrose in 0.4% saline, 5% Dx in 0.9% saline, 0.9% saline

Changes In RBC's During Storage

- Decrease in ATP
- Decrease in 2,3 DPG
- Hyperkalaemia , Acidosis in storage
- RBC lysis & decrease in Hb (6 weeks storage- RBC recovery 85%)
- Membrane damage making it difficult to penetrate microcirculation
- Decrease in viability (shelf life of stored RBC's is 35 – 42 days)

Anticoagulants

AIM – To increase the RBC life, safety & overall effectiveness

1. CPDA (35 Days)
2. SAGM- Saline ,Adenine , Glucose, Mannitol
3. AS-1, AS-3 ,AS -5 (Additive solution) (42 Days)
4. Extended storage preservative solution containing
 - Dextrose
 - NaCl
 - Citric acid
 - Sodium citrate
 - Adenine and Mannitol

Indications

Broadly

- Anaemia
- Haemorrhage

Other Indications

- Critically ill patients of sepsis and trauma
- Acutely bleeding patients
 - Rapid loss of $> 15\%$ if preexisting Hb is < 10 gm / dl

contd....

- Perioperative period
 - < 8 gm / dl without significant Heart, Lung, Vascular, Renal or Neural disease
 - < 10 gm / dl with significant underlying diseases
- Patients of chronic Anemia
 - Hb < 8 gm / dl with evidence of CHF, Angina or Hypovolemia
- Patients of marrow failure
 - Hb < 10 gm / dl with Leukemia, Lymphoma , Aplastic anemia

Current Recommendations Acc To ASA Task Force

- Transfusion is rarely indicated when the hemoglobin concentration is greater than 10 g/dL and is almost always indicated when it is less than 6 g/dL
- The determination of whether intermediate hemoglobin concentrations (6-10 g/dL) justify or require RBC transfusion should be based on the patient's risk for complications of inadequate oxygenation

- The use of a single hemoglobin "trigger" for all patients and other approaches that fail to consider all important physiologic and surgical factors affecting oxygenation are not recommended
- When appropriate, preoperative autologous blood donation, intraoperative and postoperative blood recovery, acute normovolemic hemodilution, and measures to decrease blood loss (deliberate hypotension and pharmacologic agents) may be beneficial
- The indications for transfusion of autologous RBCs may be more liberal than for allogeneic RBCs because of the lower risks associated with the former.

Leucocyte Reduced Blood Components

- Average unit of RBC'S contain 1 – 2 million WBC's
- Average unit of platelets contain 50 million WBC's
- Febrile and inflammatory reactions largely due to WBC's

METHODS FOR REDUCTION

- Washing of RBC's(50-90% WBC's are removed with a resultant loss of 15% RBC's also)
- Leucocytes reduction filters

2.PLATELET CONCENTRATE

- Prepared by differential centrifugation from freshly drawn units of blood.
- 1 unit of pc increases platelet count by 5000 to 10000 one hr after transfusion in 70 kg adult.
- Therapeutic dose 1 platelet conc / 10kg body wt.
- Stored at 20-24* c – increased risk of bacterial overgrowth
- Survival of transfused platelets – 1-7days

ABO compatible platelet conc desirable but not necessary

Platelet concentrate

Indications (WHO guidelines)

- Rx of bleeding d/t thrombocytopenia and platelet function defect
- Prevention of bleeding d/t thrombocytopenia

Platelet concentrate

Current recommendations acc to ASA task force

- ▶ Prophylactic platelet transfusion ineffective and rarely indicated when thrombocytopenia is d/t platelet destruction
- ▶ Prophylactic platelet transfusion rarely indicated in surgical pt with platelet count $>100,000$ and usually indicated when count $<50,000$ with intermediate platelet counts therapy given based on risk of bleeding.
- ▶ Surgical and obs patient with microvascular bleeding require transfusion if count $<50,000$ and rarely required if count $>100,000$.

Platelet concentrate

- Vaginal deliveries or minor operative procedures may be undertaken if platelet count $<50,000$.
- In pt with microvascular bleeding despite adequate count – platelet transfusion indicated.
- Use of fresh blood rather than platelet conc as a source of platelet better.
- Not indicated- ITP , TTP, untreated DIC

Fresh Frozen Plasma (FFP)

- Primary source of coagulation factors
- Most common blood component to be used irrationally in today's practice
- 1 unit of FFP = 200 – 250 ml plasma
- Expiry date 365 days
- Use – Thaw at 37 °C for about 20 – 30 mins
- Once thawed , can be again stored for upto 24 hrs at 1- 6 °C

SHOULD BE **ABO** COMPATIBLE OR IDENTICAL
CROSS MATCHING NOT

Cont..

Indications (ASA task force 2)

1. Urgent reversal of warfarin therapy
 2. Correction of known coagulation factor deficiencies
 3. Correction of microvascular bleeding in the presence of $pt > 1.5$ times
 4. Correction of microvascular bleeding secondary to coagulation factor deficiency in pt transfused with > 1 blood vol and when pt PTT can not be obtained timely
 - ▶ Dose 10-15ml/kg
 - ▶ Dose for warfarin reversal – 5-8ml/kg
- C/I* – for augmentation of plasma volume or albumin conc.

Cryoprecipitate

- 1 bag of cryoprecipitate = 250 mg of fibrinogen
15 – 20 ml plasma
Von Willebrand factor (IX)
80 – 130 units of factor VIII
Fibronectin
Factor XIII 20 -30 %
- Expiry date= 365 days
- Once thawed , use in 4 hrs
- Should be given as rapidly as possibly (200ml/hr)

Cont..

- Recommendation of ASA task force 2
 1. Prophylaxis in nonbleeding periop and peripartum pt with congenital fibrinogen deficiency , vWd , unresponsive to DDAV
 2. Bleeding pt with vWd
 3. Correction of microvascular bleeding in massively transfused pt when fibrinogen level cannot be measured timely

Prothrombin complex

- For treatment of Fac IX deficiency or Hemophilia b
- For t/t of acquired hypoprothrombonemic bleeding disorder eg. Sod warfarin overdose
- Risk of hepatitis

Granulocyte transfusion

- Prepared by leukopheresis
- Indicated in neutropenic patient with bacterial infection unresponsive to antibiotic
- Very short circulatory life span
- Irradiation decreases incidence of GVD , pulmonary endothelial damage but adversely affects granulocyte function
- Newer types filgrastin(g-csf), sargramostin(gm-csf)

MASSIVE BLOOD TRANSFUSION

- Defined as
 1. Replacement of patients blood volume with packed RBC in 24 hrs
 2. Administration of >half the pt blood volume within 3 hrs
 3. Transfusion of >4 red cell concentrates within 1 hr when ongoing need is foreseeable
 4. Transfusion @ > 150ml / 70kg/min

Massive Blood Transfusion

- Indication

1. Perioperative – cancer surgery, PPH, vascular surgery
2. ICU – acute variceal bleed
3. Accident and emergency – trauma

COMPLICATIONS OF MASSIVE BT

1. Dilutional thrombocytopenia

- When blood storage is >24hrs
- After 24 and 48 hrs of storage platelet activity is only 10% and 5 % of normal respectively.
- T/t – platelet conc given if signs of microvascular bleeding or plat count <20000

2. Coagulopathy

- After 6-10 units of blood given
- D/t dilution of coagulation factors and dilution thrombocytopenia
- s/s – oozing into the surgical field, hematuria, gingival bleeding, petechial bleeding from venipuncture sites , ecchymosis
- FFP and platelet given according to coagulation study and platelet counts

3. Hypothermia

- ▶ Decreases recipient temp → post op shivering → inc O₂ consumption → inc CO.
- ▶ D/t transfusion of multiple units of cold blood
- ▶ Increases affinity of Hb for O₂ and impairs clotting function
- ▶ Increases potential for hypocalcemia because of decreased hepatic metabolism of citrate
- ▶ Increases risk of end organ failure and coagulopathy
- ▶ Prevention - blood warmed to body temperature

4. Metabolic alkalosis

- Sodium citrate in liver gets converted to NaHCO_3
- Post transfusion pH between 7.48 to 7.50
- Widespread vasoconstriction → compromises tissue perfusion
- Decrease myocardial contractility → decrease CO
- Left shift of ODC.

5. Changes in 2,3 DPG

- 2,3 DPG greatly reduced in RBCs after 3 weeks of storage
- OxyHb affinity increases , compensatory capillary flow increases.
- Causes left shift of ODC
- Increased CO and work of the heart
- Regeneration of 2,3 DPG seen within 24hrs of transfusion

6. Citrate toxicity

- ▶ Capacity of liver to metabolise sodium citrate decreases when large volume of blood is transfused(>150ml/ 70kg/min)
- ▶ Rate of citrate metabolism decrease by 50% at body temp of 31* C.
- ▶ May induce hypocalcemia and hypomagnesemia
- ▶ S/s – hypotension, narrow pulse pressure, increased CVP, parasthesia, tetany, arrhythmia
- ▶ Predisposing factors – hypothermia, liver disease, liver transplantation, hypotension
- ▶ Improves after cessation of BT.

7. Hyperkalemia

- Extracellular conc of K^+ increases in stored blood
- Usually $<4\text{meq/unit}$
- Sr K^+ in 21 days stored blood – 20-30 meq / lit of blood.
- Clinical problem when transfusion rate $> 100\text{ml/ min}$
- Slowing of electrical conductance in heart.
- ECG changes at $K^+ 6\text{meq / lit}$
- Immediate t/t – 5mmols of Ca given iv over 5 min

Blood Sparing Strategies

Transfusion is either

Autologous

or

Homologous (Allogenic)

Sparing Strategies in Preoperative Period

- Diagnosing and effective treatment of preexisting ailments like Iron deficiency anemia, bleeding disorders.
- Review of Anticoagulant therapy
- Adoption of MSBOS
- Utilizing Cell salvage.

Sparing Strategies in Intraoperative Period

- Careful positing to reduce venous congestion
- To maintain Normothermia
- If possible controlled Hypotension
- Appropriate use of Diathermy , laser
- Utilizing cell salvage
- Following Transfusion Triggers

Sparing Strategies in Postoperative Period

- Utilizing cell salvage
- Following Transfusion Triggers

Autologous Blood Harvesting

A) Predeposit Autologous Blood Donation(PABD)

A) Acute Normovolemic Hemodilution (ANH)

PABD

- Patients visit 6 weeks in advance to donate blood
- Blood donation 1 per week
- Blood donation stops 3 weeks before surgery
- Iron therapy is integral to PABD
- No PABD 72 hrs before surgery
- Usually 2 units sufficient

Contraindications to PABD

- 1) If HB < 11 gm /dl
- 2) More than 6 units reqd
- 3) Comorbidity e.g cardiac disease
- 4) Patient having infectious disease markers

Since maximum allowed storage interval for RBC is 6 weeks , hence PABD is executed 6 weeks in advance.

ANH

- Removal of whole blood , replacement with acellular fluid shortly before anticipated blood loss
- Done after Induction of Anesthesia and before start of surgery

Advantages of ANH

- 1) Reduced Absolute RBC loss
- 2) Unit remains with patient ; no wrong transfusion
- 3) No microbiological testing reqd
- 4) No risk of hemolytic reaction

Caution: Should be restricted to patients with sufficiently high Hb, who can withstand 1 lt of whole blood to be taken out and in whom low target Hb is deemed appropriate

Disadvantages

- The staff is at risk as no microbial testing is done on blood
- There is Requirement of large volume crystalloids
- Dilution of coagulation factors may be a risk.

Cell Salvage

INTRAOPERATIVE / POSTOPERATIVE

- Shed surgical blood is suctioned under low pressure into a reservoir filled with saline
- Then washed & filtered & returned to patient
- Can be given upto 6 hrs at room temperature
- Cost effective if loss is > 1000 ml

CONTRAINDICATIONS

- Malignancy
- Leakage of bowel contents in surgical field

Pharmacological Blood Sparing Strategies

ERYTHROPOIETIN- 300 U /kg x14 days

or 600 U / kg thrice a week

APROTININ (Serine protease inhibitor)

It has following properties

- ▶ (a) Antifibrinolytic action
- ▶ (b) Inhibition of kallikrein
- ▶ (c) Inhibition of Plasma
- ▶ (d) Activation of Protein C

Dose : Loading 2 million units followed by 0.5 million units / hr during surgery

High risk of Anaphylaxis to reexposure

TRANEXAMIC ACID – 10 – 15 mg / kg prior to
release of tourniquet

DESMOPRESSIN – Mainly for Haemophilia, Von
Willebrand disease

FIBRINOGEN – (Combination of bovine thrombin &
human fibrinogen)

Factor VIIA – “universal hemostatic agent”

- Used when blood loss $>300\text{ml/hr}$ or surgical control of bleeding not possible
- Blood loss even after adequate replacement of coagulation factors with FFP, cryoprecipitate, platelets done and acidosis corrected

STRATEGIES TO DECREASE COMPLICATION OF TRANSFUSION THERAPY

Complication	Strategy
Impaired O ₂ release from Hb	Warm all blood, avoid alkalosis, maintain normothermia
Dilutional coagulopathy	FFP if PT > 1.5 and clinically seen bleeding

STRATEGIES TO DECREASE COMPLICATION OF TRANSFUSION THERAPY

Complication	Strategy
Hypothermia	Warm all blood. Humidify all inspired gases
Hypocalcemia	CaCl ₂ 20mg/kg in setting of massive transfusion and hypotension

STRATEGIES TO DECREASE COMPLICATION OF TRANSFUSION THERAPY

Complication	Strategy
Hyperkalemia	monitor ECG and t/t with cacl ₂ 20ml/kg. glucose-insulin
Hemolytic reactions	Stop transfusion, maintain systemic perfusion and renal flow, Send blood to blood bank

STRATEGIES TO DECREASE COMPLICATION OF TRANSFUSION THERAPY

Complication	Strategy
Infection	Lower transfusion trigger, red cell salvage, O ₂ carrying RBS substitutes
Immunosuppression	Lower transfusion trigger, red cell salvage, leukocyte filter

BLOOD ANALOGUE

- Substances that carry or facilitate the transfer of O₂.
- O₂ carriers are in phase III trials as blood substitute
- Types-
 1. Cell free purified Hb solution(recombinant or outdated human blood)
 2. Perfluorocarbon emulsions (Fluosol DA, Perfluoroacetyl bromide)

Cont..

- Advantages

1. Carry dissolved o₂ better than plasma
2. PFCs are not metabolised in biological systems, temporarily stored in RES and exhaled completely unchanged.
3. Does not transmit disease or become rapidly outdated
4. Does not require cross matching

Cont...

- **Indications**
 1. Blood is not easily available or accepted (Jehovah witness)
 2. When universal compatibility, prolonged shelf life and transportability into the field is required (eg in war)

Cont..

- Disadvantages
 1. Requires high p_{aO_2}
 2. Kidney toxicity
 3. Increased affinity for O_2 (left shift of ODC)
 4. Slight increase in MAP

CONCLUSION

- Transfusion of blood and blood products carries a high risk of adverse reactions and may be life threatening and benefits of blood transfusion must always be weighed against the risk
- Should not be a first choice
- Loss of ~ 1000 ml blood is sustainable in adults provided replacement is there with crystalloids.
- There is **no concept as single unit transfusion.**
- Concept of Autologous blood transfusion should be encouraged.

THANK YOU