

Handbook on Appropriate Use of Blood & Blood Components



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CHAPTER: I

BLOOD TRANSFUSION Yesterday, Today and Tomorrow

Blood transfusion is an undeniable component of the contemporary healthcare system. It is life-saving, if used correctly. The risk of potential adverse reactions and probable transfusion-transmitted infections has to be weighed against the risk of substituting with other available infusions. The appropriate use of blood and blood components means the transfusion of safe blood and/or components ONLY to treat a condition leading to significant morbidity or mortality, that cannot be prevented or managed effectively by other means.

The discovery of blood group antigens marked a revolutionary step in the history of blood transfusion. Karl Landsteiner discovered the ABO antigens way back in 1901. He, along with Weiner, in 1939, brought to light the concept of Rh antigen. Since then, a total of 29 human blood group systems, and over 600 different blood group antigens have been described. The past fifty years have seen a paradigm shift in the provision of allogenic blood components. Just half a century ago, most of the transfusions used to be whole blood. However, since 1960, various blood components subjected to different manufacturing processes have been promoted.

Blood substitutes are now the need of the hour, especially in view of increasing demand for blood coupled with the inadequate supply. Additionally, blood substitutes help avoid the risk of transfusion-transmitted diseases and transfusion reactions. The current focus is on developing stem cells, cord blood, dendrimers, and biodegradable micelles to overcome the deficit in demand and supply of blood.

Blood banking involves collection, processing, storage and issue of blood or blood components after compatibility testing. All these services survive solely on the goodwill of voluntary blood donors. Hence, motivational drives to give impetus to continuous and steadily increasing number of voluntary and regular blood donors is singularly the most sacred duty of all health care workers. Clinical transfusion medicine is an evolving speciality which is concerned with safe and appropriate use of blood and blood components. The ultimate goal of this handbook is to promote good transfusion practice, which is often hindered by a lack of awareness of the standard operative procedures amongst the end-users. Effective clinical practice is a constantly evolving parameter. Evidence for various aspects is available through a plethora of sources. Hence, readers are advised and encouraged to consult up-to-date sources of information for their queries.

CHAPTER: II

BLOOD COMPONENTS

Key Points: -

- Safe blood products, used correctly can be life-saving. However, even where quality standards are very high, transfusion carries some risks. If standards are poor or inconsistent, transfusion may be extremely risky.
- No blood or blood products should be administered unless all nationally required tests have been carried out.
- Each unit should be tested and labeled to show its ABO and RhD group.
- Whole blood can be transfused to replace red cells in acute bleeding when there is also a need to correct hypovolemia.
- The preparation of blood components allows a single blood donation to provide treatment for two or three patients and also avoids the transfusion of elements of the whole blood that the patient may not require. Blood components can also be collected by apheresis.
- Plasma can transmit most of the infections present in whole blood and there are very few indications for its transfusion.
- Plasma derivatives are made by a pharmaceutical manufacturing process from large volumes of plasma comprising many individual blood donations. Plasma used in this process should be individually tested prior to pooling to minimize the risks of transmitting infection.
- Factors VIII and IX and immunoglobulins are also made by recombinant DNA technology and are often favoured because there should be no risk of transmitting infectious agents to the patient. However, the costs are high and there have been some reported cases of complications.

Definition: -

Blood components are various parts of blood like Red Blood Cells, Platelets, Granulocytes and plasma separated from one another by conventional blood bank method by centrifugation because of their different specific gravities.

I Cellular Components: -

- Red Blood cell (RBC) or Packed Red cells (PCV)
- Leucocyte depleted Red cells
- Platelet concentrate
- Platelet Apheresis
- Leucocyte depleted Platelet concentrate

II Plasma Components: -

- Fresh Frozen Plasma
- Cryo-precipitate
- Cryo-poor Plasma



Whole Blood: -

Definition: - Whole blood contains 350 ml. of donor blood plus anticoagulants.

Volume: - 350 ml.

Storage: - Between 2⁰ C to 6⁰ C in approved Blood Bank refrigerator

Shelf Life: - 35 days

Indications: -

1. Red cell replacement in acute blood loss with hypovolemia
2. Exchange transfusion

Contraindications: -

1. Chronic anemia
2. Incipient cardiac failure

Dosage: - One unit of whole blood increases Hemoglobin by 0.75 to 1 gm/dl and hematocrit by 3–5 %.

Administrations: -

- Must be ABO and RhD compatible with the recipient
- Never add medications to the unit of blood
- Complete transfusion within 4 hours of commencement

I Cellular Components: -

1. Red Blood Cells: -

Synonyms: -

RCC (Red Cell Concentrate)

PCV (Packed Cell Volume)

Description: - Generally available in two types -

RCC without additive solution: 150 – 200 ml red cells (depending on the volume and hematocrit of blood collected) from which about 80% of the plasma has been removed. Hematocrit is about 65-75%

RCC with additive solution: 150 – 200 ml red cells (depending on the volume and hematocrit of blood collected) with minimal residual plasma to which 100 ml of additive solution has been added. Hematocrit is about 50-70%

Aimed For: - To increase the oxygen carrying capacity in anemic patients.

Indications: -

- Replacement of Red cells in normovolemic anemia, acute or chronic for restoration of oxygen

- carrying capacity,
- Use with crystalloid replacement fluid or colloid solution in acute blood loss

Preparation, Storage and Shelf life: - Following are the details of Red Blood Cells prepared in different conditions -

Volume of parent whole blood	Type of bag used	Volume of RBC prepared	Storage temperature	Shelf life
450 ml blood + 63 ml anticoagulant (CPD)	With Additive Solution	350 +/- 20 ml	2 ⁰ C to 6 ⁰ C in BBR* (Do not store in domestic fridge)	• 42 days if unopened • 01 day if opened
350 ml blood + 49 ml anticoagulant (CPD)	With Additive Solution	300 +/- 20 ml	2 ⁰ C to 6 ⁰ C in BBR* (Do not store in domestic fridge)	• 42 days if unopened • 01 day if opened
450 ml blood + 63 ml anticoagulant (CPDA1)	Without Additive Solution	280 +/- 40 ml	2 ⁰ C to 6 ⁰ C in BBR* (Do not store in domestic fridge)	• 35 days if unopened • 01 day if opened
350 ml blood + 49 ml anticoagulant (CPDA1)	Without Additive Solution	230 +/- 40 ml	2 ⁰ C to 6 ⁰ C in BBR* (Do not store in domestic fridge)	• 35 days if unopened • 01 day if opened

*Blood Bank Refrigerator (BBR) has facility of maintaining uniform temperature between 2⁰ C to 6⁰ C, digital thermometer with continuous displaying of temperature, continuous temperature recording and audible alarm system.

Unit of Issue: Normally one donation, but in pediatric patients, it can be divided in required quantity.

Administrations: -

- Must be ABO and RhD compatible with recipient
- Never add medication to the unit of blood
- Complete transfusion within 4 hours of commencement

Dosage effects: -

In **Adults**, if not bleeding actively, one unit of RBC increases -

- Hemoglobin by 0.75 to 1 gm%
- Hematocrit by 2.5 to 3%

In **Children** if not bleeding actively, 8 ml/Kg body weight of whole blood or RBC prepared from it, increases-

- Hemoglobin by 0.75 to 1 gm%
- Hematocrit by 2.5 to 3%



In **Infants** if not bleeding actively, 3 ml/Kg body weight of whole blood or RBC prepared from it, increases-

- Hemoglobin by 0.75 to 1 gm%
- Hematocrit by 2.5 to 3%

Advantage of Transfusing RBC over Whole Blood: -

- RBC without additive solution increases oxygen carrying capacity without increasing blood volume. This is useful in chronic anemia, CHF and in old, debilitated patients.
- Removal of plasma decreases plasma proteins thus decreases chances of allergic or anaphylactic reactions.
- Total electrolytes are decreased, which is helpful in some diseases.

Advantages of using RBC with additive solution: -

- Reduces the viscosity of blood, hence making the transfusion easy.
- Shelf life of RCC increases from 35 days to 42 days.
- Post-transfusion viability of Red cells increases.

Contra-Indications: -

- Pharmacologically treatable Deficiency Anemia,
- Coagulation factors deficiency,
- Platelet deficiency,
- For volume replacement only,
- To enhance wound healing,
- To improve general “well-being”,
- In place of a hematinic.

2. Saline Washed Red Blood Cell or Packed Red Cell: -

Definition: - Red cells are washed using sterile Normal Saline.

Volume: - 275 ml to 300 ml

Storage: - 2⁰ C to 6⁰ C

Shelf Life: - 24 hours

Indications: -

- IgA deficiency
- hypersensitivity to plasma proteins
- Paroxysmal nocturnal hemoglobinuria
- Prevention of febrile non hemolytic transfusion reactions in patient receiving multiple transfusion

Dosage and Administration are same as Red Cell concentrate



3. Random Donor Platelets (RDP) / Platelet Concentrate: -

Definition: -

Platelets are collected from one unit of blood and resuspended in an appropriate volume of original plasma

Volume: - Platelet concentrate – 50 ml to 760 ml

Storage: - Between 20⁰ C to 24⁰ C in Platelet Agitator with Incubator

Shelf Life: - 5 days

Indications: -

- Treatment of bleeding due to:
 - Thrombocytopenia
 - Platelet function defects
- Prevention of bleeding due to thrombocytopenia such as in Bone-Marrow failure

Contraindications: -

- For prophylaxis of bleeding surgical patients unless pre-operative platelet deficiency
- Idiopathic autoimmune Thrombocytopenic Purpura (ITP) except in life-saving emergencies
- Thrombotic Thrombocytopenic Purpura (TTP)
- Thrombocytopenia associated with septicemia until treatment has commenced or in cases of hypersplenism
- Heparin induced thrombocytopenia, unless life threatening hemorrhage exists

Dosage: - 1 unit of Platelet concentrate /10 kg of body weight

Administration: -

- ABO compatible (though preferred but not a must)
- Infused through standard blood transfusion set

4. Plateletpheresis or Single Donor Platelet (SDP): -

Definition: -

Platelet concentrate prepared from one donor being apheresed with the help of cell separator.

Volume: - 200 ml to 300 ml (may vary according to platelet content and application)

Storage: - 20⁰ C to 24⁰ C with agitation in platelet agitator with incubator

Shelf Life: - 5 days

Indications and contraindications are same as platelet concentrate prepared manually.



Dosage: - 1 unit SDP contains $> 3 \times 10^{11}$ platelets/bag
One unit of SDP increased the recipient platelet count by 30,000 to 50,000/cmm

Administration: - Same as platelet concentrate
When multiple transfusions are required SDP is better.

5. Leucocyte Reduced (Depleted) Red Cells / Platelets: -

Definition: -

Cellular blood components (Red Blood Cells and platelets) contain reduced number of leucocytes ($< 5 \times 10^6$) prepared by filtration through a leucocyte depleting filter.

Why?

Many of the reactions of blood component transfusion (especially in multi-transfused patients) are due to leucocytes, or **cytokines** produced by these leucocytes. If we remove these leucocytes, we can reduce the possibilities of these reactions.

Leucocyte depleted blood components imply more than 99.9% of leucocytes. These are the ideal blood components eliminating most of the post-transfusion reactions caused by leucocytes.

Types: -

Two types of leucocyte depleted components are available –

1. **Prestorage leucocyte reduction** – Leucocyte reduction is done in blood bank just after collection of blood. This is the ideal method for leucoreduction.
2. **Bedside leucocyte reduction** – Special Blood Transfusion Set (BT Set) is available that contains special leucocyte reduction filter. The blood is transfused through this BT Set resulting in transfusion of leucocyte reduced component.

Leucoreduced blood components are used to prevent: -

- Non–Hemolytic Febrile Transfusion Reaction (NHFT)
- Alloimmunization
- Platelet Refractoriness
- Transfusion Associated Acute Lung Injury (TRALI)
- Transmission of some viruses (CMV, HTLV – I & II, EB virus, Varicella Zoster virus etc.)
- Immunomodulation

Note: - **Storage, Shelf Life, Dosage and Administration** are almost same as of normal cellular components as described in this chapter.

6. Irradiated Red Blood cell or Packed Red Cells / Platelet Concentrate: -

Definition: -

Cellular blood components (Red Blood cells and platelets) are irradiated by Gamma rays or Cobalt 60 by the dose of 25 gy.

Shelf Life: -

RBC - 28 days from the day of irradiation or date of expiry whichever is earlier



Platelet - 5 days

Indications: -

To prevent Transfusion Associated Graft versus Host Disease (TA-GvHD) in following conditions -

- Immunocompromised patients
- Hereditary Immune T-cell deficiencies
- Fetuses and neonates
- Pediatric malignancies (Neuroblastomas)
- Hodgkin's disease
- Bone – Marrow transplants
- Transfusion from all blood relatives
- Intrauterine transfusion

Volume, dosage and administration are same as Red blood cell / platelet concentrate except that in small children red cells should be irradiated just before use due to risk of hyperkalemia. In high-risk adults (for hyperkalemia) the red cells should be irradiated just before use or red cells should be washed with 0.9% sterile normal saline before use.

II PLASMA COMPONENTS: -

1. Fresh Frozen Plasma (FFP)
2. Cryoprecipitate
3. Cryo-poor plasma

1. Fresh Frozen Plasma (FFP): -

Definition: -

FFP is plasma separated by normal whole blood donation by single donor and rapidly frozen within 6 hours of being collected. It contains all coagulation factors.

Volume: 200 ml – 220 ml (1 unit)

Storage: At -30⁰ C or colder

Shelf Life: 1 year

Note: - Before use, FFP should be thawed in blood bank in thawing bath between 30⁰ C to 37⁰ C. FFP should be administered as soon as possible after thawing and any event within 24 hours if kept at 2⁰ C to 6⁰ C.

Indications: -

- Used in patients with multiple coagulation factor deficiencies
 - Liver diseases
 - Warfarin (anticoagulant) overdose
 - Depletion of coagulation factors in patients receiving large volume transfusions



- Disseminated Intravascular Coagulation (DIC)
- Thrombotic Thrombocytopenic Purpura (TTP)

Contraindications: -

Should not be used as a volume expander

Dosage: - Initial dose of 10 to 15 ml/kg

Administration: -

- Must be ABO compatible
- No compatibility testing required
- Infuse using standard blood transfusion set as soon as possible after thawing

2. Cryoprecipitate: -

Definition: -

Cryoprecipitate are precipitated proteins of plasma rich in factor VIII and fibrinogen obtained from a single unit of fresh frozen plasma.

Volume: - 10 ml to 20 ml

Storage: - At -30° C or colder

Shelf Life: - 1 year

Note: - Before use, should be thawed in blood bank in thawing bath between 30° C to 37° C. Once thawed, cryoprecipitate should be transfused immediately but in any case not later than 6 hours.

Indications: -

- As an alternative to factor VIII concentrate in the treatment of inherited deficiencies of:
 - Von Willebrand factor (Von Willebrand disease)
 - Factor VIII (haemophilia A)
 - Factor XIII
- As a source of fibrinogen in acquired coagulopathies e.g. Disseminated Intravascular Coagulation (DIC)

Dosage: - 2 units/10 kg wt. One bag contains more than 80 units of factor VIII and more than 150 mg of fibrinogen.

Dose of factor VIII (Cryoprecipitate) depends upon the nature of bleeding episode and severity of factor VIII deficiency. Each unit of factor VIII per kg raises plasma factor VIII by 2%.



Administration: -

- No compatibility testing required
- After thawing, infuse as soon as possible through a standard blood transfusion set
- Must be transfused immediately or within 4 hours of thawing

3. Cryo poor Plasma: -

Definition: -

Plasma from which approximately half the fibrinogen and factor VIII has been removed as cryoprecipitate.

Volume: - 150 ml – to 200 ml

Storage: - - 30⁰ C or colder

Shelf Life: - 5 years

Indications: -

T.T.P. (Thrombotic Thrombocytopenic Purpura)

Dosage: - 10 ml to 15 ml / kg

Administration: -

- Use ABO compatible product
- No cross-matching is required
- After thawing, infuse as soon as possible through standard blood transfusion set

CHAPTER: III

CLINICAL TRANSFUSION PRACTICE

Key Points: -

- Every blood transfusion centre should have policy to administer right blood/blood component to the right patient at right time.
- Transfusion should be given in safe and hygienic conditions and care should be taken to avoid the errors.
- Established policies and documentation is very important in administration of blood/blood component.
- Communication is very important between clinical side and blood bank for better and safe transfusion practices.
- Correct and complete requisition process, good transportation and storage conditions are necessary for safe transfusion.
- Patient should be supervised closely by clinical staff throughout the transfusion.

1. **Decision for transfusion:** - Following steps of guidance should be followed by clinical side (including doctor and other related staff) whenever deciding for blood/blood component transfusion.

A. Before the Transfusion: -

- Decide need of blood/blood component transfusion to the patient
- Weigh the benefits of transfusion against risk involved
- Explore possibilities of alternatives for blood/blood component
- If no alternative is possible and it is necessary to give transfusion then counsel the patient and provide information about transfusion.
- Take Informed Consent of patient. **It is mandatory to take informed consent of patient.**

1. Informed Consent of patient:-

1. Clinician's responsibility to explain the benefits, risks, and alternative therapies of blood transfusion.
2. In the language understandable by the patient.
3. Patient and family education regarding blood donation
4. Patient should be given opportunity to ask questions.
5. Informed Consent should be taken.

Note: - Sample draft of Informed Consent is given as annexure.

- Ensure availability of blood/blood component with the blood bank.
- Decide for the category of requirement, means whether the requirement is planned, urgent or life-saving emergency. Coordinate with the blood bank regarding normally time taken in different categories of requirement (Planned/Urgent/Life-saving emergency).



Note: - Clinician should be aware of time taken for supply by blood bank for routine components, Pediatric units, Frozen components and specialized components like Saline washed red cells, Apheresis components, Irradiated components etc. Coordinate with blood bank for detailed information about these components.

2. Generating request for transfusion:

- Each demand of blood/blood component should be raised through Blood Requisition Form (BRF). Along with the BRF, prescribed blood sample(s) should be sent.
 - Blood Component can not be supplied without prescription of a registered medical practitioner. So **every request form should be signed by a registered medical practitioner with proper identification of his/her.**

- **Blood Requisition Form (BRF)-**

The BRF should be dully filled and signed by the duty doctor and should be sent to the blood bank along with the blood samples.

The BRF should contain minimum following details: -

- Complete Name of patient
- Age and sex of patient
- Diagnosis of patient.
- Hospital's Identification Number
- Ward/Bed number.
- Name of blood/blood component required
- Quantity (units/volume) of blood/blood component required
- Date and Time of requirement
- Category of requirement (Planned/Urgent/Life saving emergency).
- H/o previous transfusion if any
- Signature of the doctor

Note: -

1. For patients personal details, it is always better to use pre-printed labels.
2. For infants of less than 6 months of age, sample of mother is also required.
3. Blood component requisition should be sent to blood bank during daytime in planned cases.
4. After 48 hours of blood transfusion, a fresh blood sample should be sent for cross matching.
5. If blood/blood component is not required at the time of sending demand, an “Issue slip” (having details of patient and blood/blood component required) should be sent at the time of collecting blood/blood component from the blood bank.

3. Blood sample collection and transportation

A. Blood Sample Collection: -

- a. Collection of properly labeled blood sample from the intended recipient is critical for safe blood transfusion.
- b. Quantity and nature of blood samples required for different blood components can be determined by the blood bank (Only once that will be valid for ever otherwise changed).

- c. The person drawing the blood sample must identify the intended recipient, most effectively done by comparing the information on the patient's identification band.
- d. Always use at least two identifier parameters (for example complete name and ID number) to identify the patient.
- e. Samples should be transported in a secure manner which should include cold chain maintenance as well as safety issues.

a. Sample Labeling: -

- a. Sample tubes should be labeled at bedside just before collection of blood sample.
- b. Blood sample collection should be done one at a time for each patient to reduce the risk of error
- c. Phlebotomist must label the blood sample tubes with the following details: -
 - Name, age and sex of the patient
 - Hospital's Identification Number
 - Ward/Bed number.
 - Date of collection
 - Signature of the phlebotomist.

• **Alternate blood group for transfusion: -**

Although it is practiced to use blood/blood components of same blood group, but in case of nonavailability of blood component of specific group, other blood groups can also be used safely as given below: -

Patient Group	RBC	FFP / CPP	Cryo	Platelets
O Positive (OP)	OP / ON	Any Group	Any Group	<ul style="list-style-type: none"> ➤ Any group can be used if no red cell contamination ➤ For red cell contaminated units (more than 2 ml red cells), ABO identical and Rh compatible units should be used after crossmatch ➤ Preferably should be Rh compatible ➤ For large demands, should be ABO compatible ➤ In children ABO and Rh group specific Platelets should be used preferably. ➤ Small Children may require platelet to be volume reduced
O Negative (ON)	ON			
A Positive (AP)	AP / AN / OP / ON	A / AB		
A Negative (AN)	AN / ON	B / AB		
B Positive (BP)	BP / BN / OP / ON			
B Negative (BN)	BN / ON	AB		
AB Positive (ABP)	Any Group			
AB Negative (ABN)	Any Negative Group			

Note: -

- No Rh consideration for FFP / CPP / Cryo
- Single Donor Platelet (SDP) should be ABO and Rh compatible



4. Receiving and transportation of blood/ components from blood bank: -

- Designated person will collect blood/blood component from the blood bank and take it to the patient area in conditions suggested by blood bank.
- It is duty of blood bank to issue requested blood/blood component : -
 1. After satisfactorily identifying the intended recipient
 2. After visual inspection.
 3. After ensuring the right transportation conditions (including maintenance of cold chain).
Blood bank has to advise the collecting personnel about transporting blood/blood component in recommended manner designed for defined distance and time.

5. Pre-transfusion Check at the Time of Infusion: -

- Send person to collect blood/blood component from blood bank just before transfusion.
 - The person receiving blood/blood component should ensure the maintenance of cold chain during transportation.
 - The transfusionist who administers the blood must check all identifying information immediately before beginning the transfusion, and record on the transfusion form that this information has been checked and found to be correct.
 - The information that must be received and found to be correct is as follows: -
 1. The name and identification number on the patient's identification band must be identical with name and number on the form attached to the unit. It is desirable to ask the patient to state his or her name, if capable of doing so.
 2. The unit identification number on the blood container and on the form attached to the unit must agree.
 3. The ABO and Rh type on the primary label of the donor unit must be same as those recorded on the crossmatching certificate. The recipient's type and the type of the component may not be identical, but the information on the crossmatching certificate and that on the container label must be the same.
 4. The expiration date of the donor unit should be verified as acceptable, before infusion.
 5. The interpretation of crossmatching testing must be recorded on the form attached to the unit. If blood was issued before crossmatching tests were completed in emergencies, this must be conspicuously indicated.
 6. Result of all transfusion transmissible infection testing should be checked on blood bag label and all these should be nonreactive.
 7. The nature of the blood or component should be checked against the clinician's written order to verify that the correct component and amount are being given.
 8. All identification attached to the container must remain attached until the transfusion has been terminated.
 9. Visual inspection of blood components viz. hemolysis, change of colour, clots or aggregates etc.
- **Pre-transfusion Counseling: -**
 - Generally the patient becomes more comfortable and less anxious if they know that how the transfusion will be given, how long it will take, the expected outcome, and what symptoms to report.

- If pre-existing line is used, it should be checked for patency, for signs of infiltration or infection, and mainly for compatibility of fluid with blood or component.

6. Administration of blood/ components

• Starting Transfusion: -

- Ensure that red cell component is not exposed to temperature above 10⁰ C kept at room temperature before starting of transfusion. Generally in air-conditioned room it takes about 30 minutes to raise the temperature of red cell component (kept at room temperature) above 10⁰ C.
- Ensure taking Informed Consent from patient/guardian
- After checking all the identifying information, the transfusionist must sign the compatibility certificate to indicate that the identification was correct. He will also document; who has started the transfusion with date and time.
- In addition to informing the patient of the procedure and checking all identification steps, the transfusionist should record the patient's pretransfusion vital signs, i.e., temperature, blood pressure, pulse, respiration rate etc.

• Delay in Starting Transfusion: -

- Start transfusion immediately after receiving of blood/blood components.
- All blood components should be ordered at time when it is required. Blood/blood component should not be left at room temperature or stored in an unmonitored refrigerator in ward.
- Although the blood once issued should not be taken back by blood bank but if blood bank protocols permits, blood can be taken back by blood bank.
- If the transfusion cannot be initiated promptly, the blood should be returned (if protocols permits) to the blood bank for proper storage as per the guidelines given below -

Sr. No.	Name of the Component	Storage Conditions	Return back to Blood Bank within	Remark
1	Red Blood Cells or Whole Blood.	2 ⁰ C to 6 ⁰ C in blood bank refrigerator.	30 minutes, if it is kept in airconditioned room	Do not keep in freezer.
2	Platelet	22 ⁰ C with continuous agitation in Platelet Incubator with Agitator	20 minutes if it is stored at room temperature in A.C. Room.	Do not keep in refrigerator or freezer.
3	Fresh Frozen Plasma/ Cryoprecipitate/ Cryopoor Plasma	Below -30 ⁰ C in deep freezer	Will not be taken back.	Once thawed, can not be frozen again

7. Patient care during and after transfusion: -

- The transfusionist should remain with the patient for the first few minutes of the transfusion, which should be started slowly.
- Catastrophic reactions from acute hemolysis, anaphylaxis, or bacterial contamination can become apparent after a very small volume enters the patient's circulation.



- After first 15 minutes, the patient should be observed and the vital signs recorded; if the patient's condition is satisfactory, the rate of infusion can be increased as desired.
- Clinical personnel should continue to observe the patient periodically throughout the transfusion and up to an hour after completion.

- **Rate of Infusion: -**

- The desirable rate of infusion depends upon the patient's blood volume, cardiac status, and hemodynamic condition.
- However, the references gives 4 hours as the maximum duration for an infusion, but maximum time should not be confused with recommended time, as most transfusions are completed within 2 hours.
- If rapid transfusion is needed, blood can be infused as rapidly as the patient's circulatory system will tolerate, within a few minutes, if the rate does not cause the red cells to hemolyze.
- Except during urgent restoration of blood volume, the first 25-50 ml should be given slowly and patient should be closely monitored.
- If blood flows more slowly than desired, the cause may be obstruction of the filter or needle or excessive viscosity of the component.
- Steps to investigate and correct the problem include the following:
 1. Elevate the blood container to increase hydrostatic pressure.
 2. Check the patency of needle.
 3. Examine the filter of the administration set for excessive debris.
 4. Consider the addition of 50-100 ml of sterile 0.9% normal saline to a preparation of red cells, if there is an order permitting such addition.

- **8. Action for Suspected Reactions: -**

- Severity of symptoms can vary significantly and symptoms are not specific, all transfusions must be observed carefully and stopped as soon as a reaction is suspected.
- Inform treating doctor as well as blood bank immediately. Send the "Transfusion Adverse Reaction Form" dully filled to blood bank.

- **After transfusion: -**

- **Transfusion Follow-up: -**

- The time, the volume and type of blood component given, the patient's condition, and the identity of the person who stopped the transfusion and made the observations should be recorded after each unit of blood/blood component has been infused.
- Never peel off labels from the blood bags and fix it on the clinical documentation (like case sheet). Instead, write the details by hand/other method.
- It is advisable to send "Transfusion Reaction form" to blood bank after every transfusion. This form can be an integral part of compatibility certificate or other documentation.
- Whether adverse transfusion reaction has occurred or not, this form should be sent back to blood bank properly filled up.
- If a severe complication occurs, blood bags, tubing, and attached solutions should be returned to the transfusion service with written documentation.



- **Disposal of blood bag and BT Set: -**

- Discard the used blood bag along with attached (if any) BT set as per the policy of hospital (generally it is discarded in red biohazard polythene). Ensure proper disposal of discarded material either by hospital or by outside waste management agency.
- If blood/blood component is not used in ward by any means, these units should be sent to blood bank for proper disposal. Never discard blood/blood component in ward.

Facilities used for transfusion: -

9. Venous Access: -

- It depends on integrity of the patient's veins, volume to be transfused and expected duration of intravenous therapy
- Steel needles or plastic catheters are commonly used for short-term transfusion therapy.
- For medium and long-term therapy or for administration of solutions potentially toxic to the vein lining, central vein catheters are used.
- The administration of fluids incompatible with blood is never encouraged in transfusion setting.
- An 18-gauge needle is commonly used, but patients with small veins require much smaller needles.
- Thin walled, 23-gauge needles may be used for transfusions for pediatric patients

- **Infusion Sets: -**

Blood and components must be administered through a filter designed to retain blood clots and particles those are harmful to the recipient.

- **Standard Blood Transfusion Sets: -**

1. Have inline filters with pore size of 170-260 μ , drip chambers and tubing in a variety of configurations.
2. Filter should be fully wetted and drip chambers filled no more than half full.
3. In order to reduce the risk of bacterial contamination, a reasonable time limit for an infusion set is 4 hours.
4. Filter can be used for two to four units of blood provided maximum time not exceeds 4 hours and if the manufacturer permits.

- **Leukocyte-depletion Filters: -**

1. Special blood filters (third and fourth generation) can reduce number of leukocytes in red cell or platelet components to less than 5×10^6 , a level that reduces the risk of -
 - a. HLA alloimmunization
 - b. Transmission of Cytomegalovirus (CMV)
 - c. Incidence of febrile reactions.
2. Filters for red cells and filters for platelets use the different technology; therefore they must be used only with their desired component and according to manufacturer's directions.
3. These filters are mainly useful for multi-transfused patients.



- **Blood Warmers: -**
 - Routine use of blood warmer is not recommended.
 - Blood warmer can be used by the hospital for the following indications –
 1. Rapid transfusion at flow rate of >50 ml/kg/hour in adults and > 15 ml/kg/hour in children
 2. For Exchange Transfusion
 3. Transfusing patients with clinically significant cold agglutinins.
 - Conventional microwave ovens and microwave devices for thawing plasma should not be used for warming blood and can damage red cells.

- **Electromechanical Infusion Devices: -**
 - For pediatric, neonatal, and selected adult patients, mechanical pumps those deliver infusion at a controlled rate are especially useful.

- **Compatible IV Solutions: -**
 - It is advisable not to add medications to blood or components.
 - If red cells require dilution to reduce their viscosity or if a component needs to be rinsed from the blood bag or tubing, 0.9% normal saline is the product of choice. ABO-compatible plasma, 5 % albumin, or plasma protein fraction can also be used with approval of the concerned clinician.
 - Lactated Ringer's solution, 5% dextrose in water, and hypotonic sodium chloride solutions should not be used for addition to blood components or for simultaneous administration via the same intravenous line.

- **Suggested Infusion Rate for Adults: -**
 - Concentrate of Human Red Blood Corpuscles (Packed Cells): - 100 – 200 ml/hour.
 - Fresh Frozen Plasma/Platelets: - 200 – 300 ml/hour

- **Suggested Infusion Rate for Pediatric Patients: -**
 - Concentrate of Human Red Blood Corpuscles (RBC): - 2 – 5 ml/kg/hour.
 - Fresh Frozen Plasma: - 1 – 2 ml per minute
 - Platelet: - As tolerated.

CHAPTER IV

ISSUE OF BLOOD/BLOOD COMPONENTS FROM BLOOD BANK

Key Points: -

1. After completion of all required tests including crossmatching, technician of blood bank will issue the blood component after visual inspection.
2. Blood/component unit will be released along with Compatibility (crossmatching) Certificate.
3. Communication between clinical side and blood bank is very important in issuing blood/blood components in urgent and life-saving emergencies.

Labeling: -

- The compatibility certificate indicates patients name, age, sex, Hospital's identification number, ABO and RhD type of recipient and donor, type of blood component issued etc.
- The labeling on Blood bag should contain following details -
 - Name of blood/blood component,
 - Name and address of blood bank
 - License number of blood bank
 - Blood Unit No,
 - Blood Group (ABO and Rh) of blood/blood component supplied,
 - Date of Collection
 - Date of Expiry
 - Nonreactive status of following Transfusion Transmissible Infection (TTI) -
 - a. Antibody of Human Immunodeficiency Virus (HIV) 1 and 2,
 - b. Antibody of Hepatitis C Virus (HCV)
 - c. Surface antigen of Hepatitis B Virus (HBsAg)
 - d. Syphilis
 - e. Malaria parasite
- Volume of blood/blood component with nature and percentage of anticoagulant
- Instructions for use
- Status of donor (voluntary or replacement)

General: -

- Blood sample of patient and donor will be preserved in blood bank at 2⁰C - 6⁰C at least for 7 days after issue.
- The blood component should be transfused immediately after receiving at patient site. In any condition it should not be stored in domestic/unmonitored refrigerator.
- If blood/blood component is not required at the time of sending demand, an “Issue slip” (having details of patient and blood/blood component required) should be sent at the time of collecting blood/blood component from the blood bank. While issuing details of patient and donor should be crosschecked with this issue slip.

Category of issue: -

Blood component can be asked in following categories of requirement: -

- Planned
- Urgent
- Life-saving emergency

Time taken for issue of component: -

- Normally the time taken for different components in different categories differs from blood bank to blood bank due to various reasons but by generally adopted techniques, following is the time taken for different components for different categories -

Sr. No	Name of Component	Approximate time taken		
		Planned	Urgent	Life-saving emergency
1	Red Cells (RBC)*	2 – 3 hours	1 hour	15-20 minutes or less
2	RBC: Saline washed	4 - 6 hours		
3	Fresh Frozen Plasma (FFP)	45 - 60 minutes		
4	Cryoprecipitate	30 - 40 minutes		
5	Cryopoor plasma	45 - 60 minutes		
6	Random Platelets	30 – 40 minutes		
7	Single Donor Platelet	3 – 4 hours		

*Depends on the technique, workload and any discrepancy

Emergency issue of blood components: -

- Uncrossmatched Blood / Rapid (immediate) cross-matched blood is indicated if transfusion is required in less than 1 hour from the time the specimen arrives in the Blood Bank; that is, patient's clinical status indicates there is insufficient time to perform a complete blood group, and /or cross match.
- The attending physician is responsible for requesting uncross matched / Rapid cross matched blood components and must sign the blood requisition form clearly mentioning of **“UNCROSSMATCHED / RAPID CROSSMATCHED BLOOD COMPONENTS.”**
- All uncross matched blood should be ABO compatible with the patient; that is, either group O or patient specific ABO group is issued.
- In such emergency cases, blood grouping will be performed by rapid slide method and depending on that result, blood component will be issued. But in any case, complete blood grouping will be performed afterwards and if any discrepancy is found, then the relevant physician will be intimated.
- Until the full **cross matching test** is completed, there is the potential that unexpected RBC antibodies may be present that could destroy transfused RBCs Therefore **emergency cross match should be asked only when absolutely essential.**
- Blood Bank will continue to cross match blood even after emergency issue-
 - Cross match is negative; all uncross matched blood issued or already transfused are then known to be compatible with the patient.
 - Cross match is positive; the blood bank will immediately notify the requesting physician or surgeon as well as the Blood Bank incharge, to discuss the options for transfusion



- If there is no time of blood sample collection or collection is not possible by any reason and the condition of the patient is critical, then the doctor in emergency can ask O Negative (preferred) or O Positive blood (if O Negative is not available). In any case, the patient having Anti D and women of child bearing age should not be transfused with Rh Positive blood unless there is no option available and there is danger of life. As soon as the sampling becomes possible, sample should be sent to blood bank.
- In emergency requirement of blood, in addition to giving category (Planned, Urgent or Life-saving emergency) always mention maximum time of requirement and this time should be communicated to blood bank.

Procedure for Requesting Uncrossmatched Blood

- In life-saving emergency requirement of blood components, it is always preferable to communicate blood bank Incharge/ technician on duty, on phone before sending demand.
- Notify the Blood bank by phone that uncrossmatched blood is required. In the meantime send requisition form with all the required information. If the patient is unknown, then communicate that to blood bank.
- Send properly labeled blood samples.
- As soon as the emergency is over, complete all documentary formalities

CHAPTER: V

ADVERSE TRANSFUSION REACTION

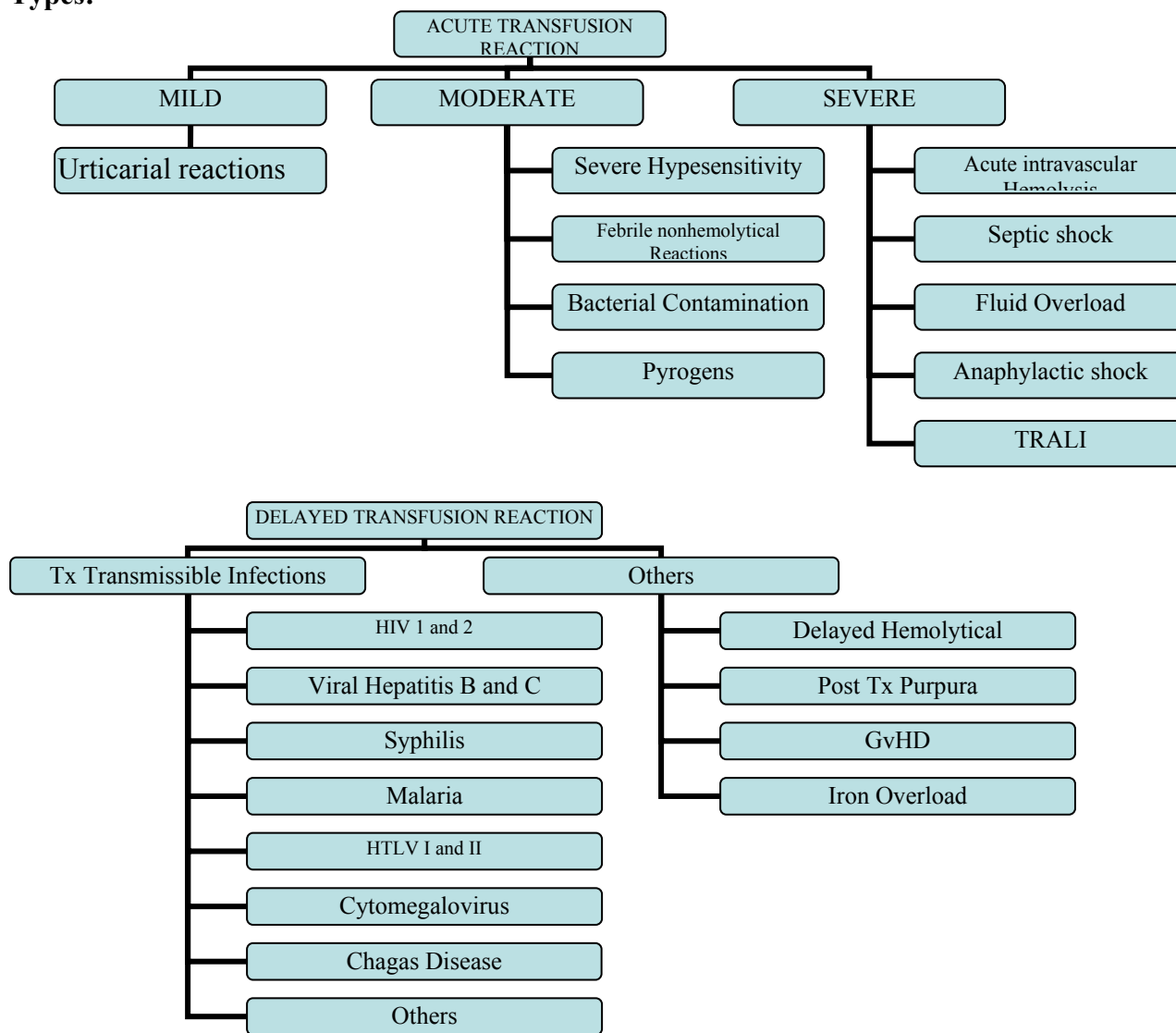
Key Points: -

- All suspected acute transfusion reactions should be reported immediately to the blood bank and to the clinician.
- Rapid recognition and early management of the reaction may save the patient's life. The time between the suspicion of a transfusion reaction and the investigation and the initiation of a appropriate treatment should be as short as possible
- Once immediate action has been taken, careful and repeated clinical assessment is essential to identify and treat the patient's main problems.
- Errors and failure to adhere to correct procedures are the commonest cause of life-threatening acute hemolytic transfusion reactions.
- Patients who receive regular transfusions are particularly at risk of acute febrile reactions. In such cases, special care of the patient is required to prevent repeated transfusion reactions.
- Transfusion-transmitted infections are the most serious delayed complications of transfusion. A delayed transfusion reaction may occur days, weeks or months after the transfusion.
- The transfusion of large volumes of blood and intravenous fluids may cause haemostatic defects or metabolic disturbances.

Introduction: -

- Blood transfusion can be associated with various adverse effects.
- Acute – rapid onset
- Delayed – days to weeks to months
- Consequently, the decision to transfuse must be based on a careful assessment of the risks and benefits to the patient, and with the knowledge and skills to recognize and treat any adverse reactions or complications that may arise.

Types:



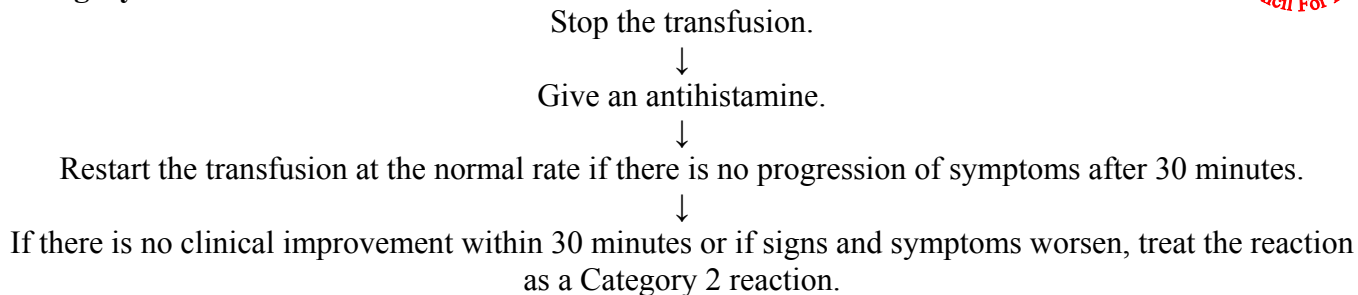
Signs and Symptoms: -

- When an acute reaction first occurs, it may be difficult to decide on its type and severity as the signs and symptoms may not initially be specific or diagnostic.
- It is essential to monitor the transfused patient closely in order to detect the earliest clinical evidence of an acute transfusion reaction.
- In an unconscious or anaesthetized patient, hypotension and uncontrolled bleeding may be the only signs of an incompatible transfusion.
- In a conscious patient undergoing a severe hemolytic transfusion reaction, signs and symptoms may appear within minutes of infusing only 5–10 ml of blood. Close observation at the start of the infusion of each unit is essential.

CATEGORY	SIGNS	SYMPTOMS	POSSIBLE CAUSE
CATEGORY 1: MILD	Localized cutaneous reactions: <ul style="list-style-type: none"> • Urticaria • Rash 	<ul style="list-style-type: none"> • Pruritus (itching) 	<ul style="list-style-type: none"> • Hypersensitivity (mild)
CATEGORY 2: MODERATE	<ul style="list-style-type: none"> • Flushing • Urticaria • Rigors • Fever • Restlessness • Tachycardia 	<ul style="list-style-type: none"> • Anxiety • Pruritus (itching) • Palpitations • Mild dyspnoea • Headache 	<ul style="list-style-type: none"> • Hypersensitivity (moderate to severe) • Febrile non-haemolytic transfusion reactions: <ul style="list-style-type: none"> • Antibodies to white blood cells, platelets • Antibodies to proteins, including IgA • Possible contamination with pyrogens and/or bacteria
CATEGORY 3: SEVERE	<ul style="list-style-type: none"> • Rigors • Fever • Restlessness • Hypotension (fall of 20% in systolic BP) • Tachycardia (rise of 20% in heart rate) • Hemoglobinuria • Unexplained bleeding (DIC) 	<ul style="list-style-type: none"> • Anxiety • Chest pain • Pain near infusion site • Respiratory distress/shortness of breath • Loin/back pain • Headache • Dyspnoea 	<ul style="list-style-type: none"> • Acute intravascular hemolysis • Bacterial contamination and septic shock • Fluid overload • Anaphylaxis • Transfusion-associated lung injury

Management:

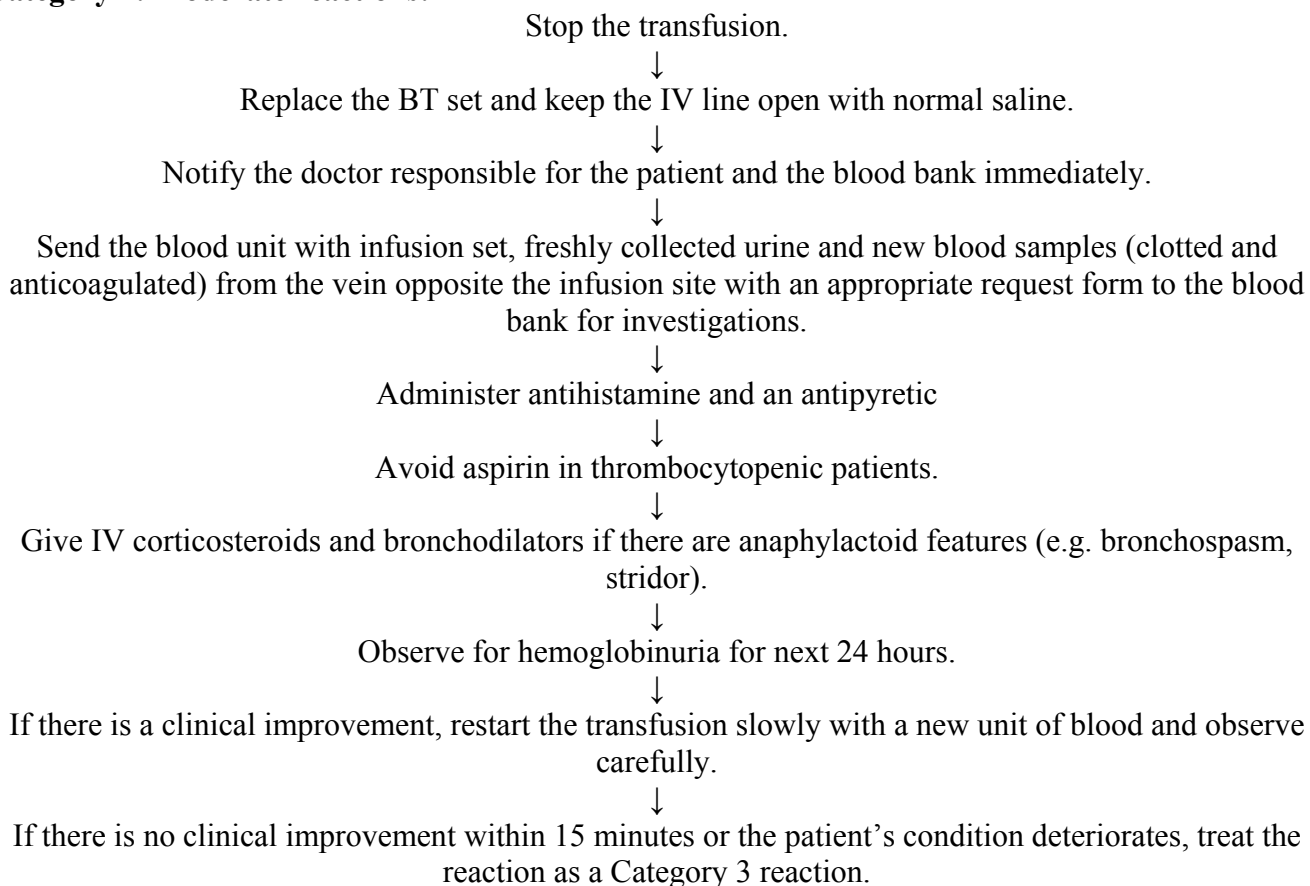
Category 1: Mild reactions: -



Prevention: -

If a patient has previously experienced repeated urticarial reactions, give an antihistamine before commencing the transfusion, where possible.

Category 2: Moderate reactions: -



Note: Febrile reactions are quite common, but fever is associated with other adverse reactions to transfusion and it is important to eliminate these other causes, particularly acute hemolysis and bacterial contamination, before arriving at a diagnosis of a febrile reaction. Fever may also be caused by the patient's underlying condition: e.g. malaria.

Prevention: -

If the patient is a regular transfusion recipient or has had two or more febrile non-haemolytic reactions in the past:

- Give an antipyretic 1 hour before starting the transfusion
- Do not use aspirin in a patient with thrombocytopenia.
- Repeat the antipyretic 3 hours after the start of transfusion.
- Transfuse slowly, where possible:
 - Red Blood Cells: 3–4 hours per unit
- If this fails to control the febrile reaction and further transfusion is needed, use buffy coat removed or filtered red cells or platelet concentrates to remove the leucocytes.

Category 3: Severe reactions: -

Stop the transfusion. Replace the BT set and keep IV line open with normal saline.

↓

Infuse normal saline (ensure cardiac and renal sufficiency) to maintain systolic BP (initial 20–30 ml/kg).

↓

If hypotensive, give over 5 minutes and elevate foot end of bed.

↓

Maintain airway and give high flow oxygen by mask.

↓

Give 1:1000 adrenaline 0.01 mg/kg body weight by intramuscular injection.

↓

Give IV corticosteroids and bronchodilators if there are anaphylactoid features (e.g. bronchospasm, stridor).

↓

Give diuretic

↓

Notify the clinician of the patient and the blood bank immediately.

↓

Send blood unit with BT set, fresh urine sample and new blood samples (clotted and anticoagulated) from vein opposite infusion site with appropriate request form to blood bank and laboratory for investigations.

↓

Check a fresh urine specimen visually for signs of Hemoglobinuria (red or pink urine).

↓

Start a 24-hour urine collection and fluid balance chart and record all intake and output. Maintain fluid balance.

↓

Assess for bleeding from puncture sites or wounds.

↓

If there is clinical or laboratory evidence of DIC, give:
 Platelet concentrates (adult: 5–6 units Or 1 unit/10 kg) and
 Either cryoprecipitate (adult: 12 units) or fresh frozen plasma (adult: 3 units or 10-15 ml/kg).

↓

Use virally-inactivated plasma coagulation products, wherever possible.

↓

Reassess.

If hypotensive: Give further saline 20–30 ml/kg over 5 minutes
Give inotrope.



If urine output falling or laboratory evidence of acute renal failure:
Maintain fluid balance accurately
Give further frusemide
Consider dopamine infusion
Seek expert help: the patient may need renal dialysis.



If bacteremia is suspected (rigors, fever, collapse, no evidence of a hemolytic reaction), start broad-spectrum antibiotics IV, to cover pseudomonas and gram positives.

Investigating Acute Transfusion Reactions: -

- Immediately report all acute transfusion reactions to the clinician and to the blood bank that supplied the blood.
- Record the following information on the patient's notes:
 - Type of transfusion reaction
 - Length of time after the start of transfusion that the reaction occurred
 - Volume, type and blood unit numbers of the blood components transfused.
- Take the following samples and send them to the blood bank for laboratory investigations:
- Immediate post-transfusion blood samples (clotted and anticoagulated) from the vein opposite the infusion site for:
 - Full blood count
 - Coagulation screen
 - Direct antiglobulin test
 - Urea
 - Creatinine
 - Electrolytes
 - Blood culture in a special blood culture bottle
 - Blood unit and BT set containing red cell and plasma residues from the transfused donor blood
 - First specimen of the patient's urine following the reaction.
- Complete a transfusion reaction report form and send it to blood bank.
- Record the results of the investigations in the patient's records for future follow-up, if required.

Acute Intravascular Hemolysis

- Acute intravascular hemolytic reactions are caused by infusing incompatible red cells.
- Antibodies in the patient's plasma hemolyse the incompatible transfused red cells. Even a small volume (5–10 ml) of incompatible blood can cause a severe reaction and larger volumes increase the risk.
- For this reason, it is essential to monitor the patient at the start of the transfusion of each unit of blood.
- The most common cause of an acute intravascular hemolytic reaction is an ABO incompatible transfusion. The antibodies concerned are either IgM or IgG directed against the A or B antigens on the transfused red cells, causing acute intravascular hemolysis.
- The infusion of ABO-incompatible blood almost always arises from:
 - Errors in the blood request form
 - Taking blood from the wrong patient into a pre-labeled sample tube
 - Incorrect labeling of the sample tube sent to the blood bank
 - Inadequate checks of the blood against the identity of the patient before starting a transfusion.
 - Antibodies in the patient's plasma against other blood group antigens of the transfused blood, such as Kidd, Kell or Duffy systems, can also cause acute intravascular hemolysis.

Signs: -

- Fever
- Rigors
- Tachycardia, hypotension
- Breathlessness
- Hemoglobinuria, oliguria
- Signs of an increased bleeding tendency due to disseminated intravascular coagulation (DIC)

In the conscious patient undergoing a severe hemolytic reaction, signs and symptoms usually appear within minutes of commencing the transfusion, sometimes when less than 10 ml have been given.

In an unconscious or anaesthetized patient, hypotension and uncontrollable bleeding due to DIC may be the only signs of an incompatible transfusion.

Symptoms: -

- Pain or heat in limb where infusion canula is sited
- Apprehension
- Loin or back pain.

Management: -

Stop the transfusion, replace the transfusion set and keep the IV line open with normal saline



Maintain the airway and give high concentrations of oxygen



Support the circulation:

Give intravenous replacement fluids to maintain blood volume and blood pressure

Inotropic support of the circulation may be required: e.g. dopamine, dobutamine or adrenaline 1:1000 by intramuscular injection, 0.01 ml/kg body weight.



Prevent renal failure by inducing a diuresis:

Maintain blood volume and blood pressure

Give a diuretic, such as frusemide 1–2 mg/kg

Give a dopamine infusion



If DIC occurs:

Give blood components, as guided by clinical state and coagulation tests

Regularly monitor the coagulation status of the patient

Investigations: -

- Recheck the labeling of the blood unit against the patient
- Send patient blood sample for:
 - Full blood count
 - Coagulation screen
 - Direct antiglobulin test
 - Urea
 - Creatinine
 - Electrolytes
- The direct antiglobulin test will be positive and serum bilirubin raised, examine the patient's urine sample and send to the laboratory for testing for Hemoglobinuria
- Return the blood unit and infusion set for checking of group and compatibility testing
- Repeat electrolytes and coagulation screening 12-hourly until the patient is stable.
- Preserve first 24 hours urine sample for hemoglobinuria.

Prevention: -

Ensure that:

- 1 Blood samples and request forms are labeled correctly.
- 2 The patient's blood sample is placed in the correct sample tube.
- 3 The blood is checked against the identity of the patient before transfusion.

Bacterial Contamination and Septic Shock: -

- It is estimated that bacterial contamination affects up to 0.4% of red cells and 1–2% of platelet concentrates.
- Blood may become contaminated by:



- Bacteria from the donor's skin during blood collection (usually skin staphylococci)
- Bacteraemia present in the blood of a donor at the time the blood is collected
- Errors or poor handling in blood processing
- Manufacturing defects or damage to the plastic blood pack
- Thawing frozen plasma or cryoprecipitate in a water bath (often contaminated).

Signs: -

- Signs usually appear rapidly after starting infusion, but may be delayed for a few hours.
- A severe reaction may be characterized by sudden onset of high fever, rigors and hypotension. Urgent supportive care and high-dose intravenous antibiotics are required.

Investigations and Management: -

- Broad Spectrum antibiotics
- Culture for blood unit and patient

Fluid Overload: -

- When too much fluid is infused, the transfusion is too rapid or renal function is impaired, fluid overload can occur resulting in heart failure and pulmonary edema.
- This is particularly likely to happen in patients with chronic severe anemia, and also in patients with underlying cardiovascular disease, for example ischemic heart disease.

Anaphylactic Reactions: -

- Anaphylactic-type reactions are a rare complication of transfusion of blood components or plasma derivatives.
- The risk of anaphylaxis is increased by rapid infusion, typically when fresh frozen plasma is used as an exchange fluid in therapeutic plasma exchange.
- Cytokines in the plasma may be one cause of bronchoconstriction and vasoconstriction in occasional recipients.
- A rare cause of very severe anaphylaxis is IgA deficiency in the recipient. This can be caused by any blood product since most contain traces of IgA.
- Anaphylaxis occurs within minutes of starting the transfusion and is characterized by cardiovascular collapse and respiratory distress, without fever. It is likely to be fatal if it is not managed rapidly and aggressively.

Transfusion-Associated Acute Lung Injury: -

- Transfusion-associated acute lung injury (TRALI) is usually caused by donor plasma that contains antibodies against the patient's leucocytes.
- In a clear-cut case of TRALI, which usually presents within 1 to 4 hours of starting transfusion, there is rapid failure of pulmonary function with diffuse opacity on the chest X-ray.
- There is no specific therapy.
- Intensive respiratory and general support in an intensive care unit is required.

CHAPTER: VI

TRANSFUSION PRACTICES IN GENERAL MEDICINE

Key Points:

- The decision to transfuse should be guided by the clinical situation, and not only by laboratory reports.
- Do not add any medication to the unit of blood.
- Do not transfuse more than required to tide over a crisis. Restoring hemoglobin to normal value is not necessary.
- Rate of transfusion should not exceed 2-4 ml/kg/hr (except in emergency or massive transfusion.)
- Transfusion cannot correct cause or non hematologic effects of the underlying pathology.
- Avoid volume overload in patients with incipient cardiac failure.
- Avoid transfusion from first degree relatives to prevent TA-GvHD.
- Single unit transfusions are not recommended. However, it is important to identify situations where more than one unit may harm the patients. (e.g. Low cardiac output)

Following clinical situations may warrant transfusion of blood components:-

- I. Anemia
- II. Malaria
- III. Bleeding disorders
- IV. Bone marrow suppression /failure
- V. HIV – AIDS
- VI. G.I. bleed

I. Anemias:-

Definition: WHO defines anemia as Hb < 13 gm/dl in men
Hb < 12 gm/dl in women

Patients with underlying serious respiratory or cardiac disorders need to have Hb \geq 10 gm/dl.

Patients without associated medical illness tolerate Hb upto 8 gm/dl.

- The rate at which anemia develops determines the symptoms, irrespective of the cause.
- In acute anemia, blood transfusion is a priority if associated with symptoms of hypovolaemia.
- In chronic anemia, diagnosis and correction of cause is a priority. Blood transfusion may not be required at all in majority of the cases.

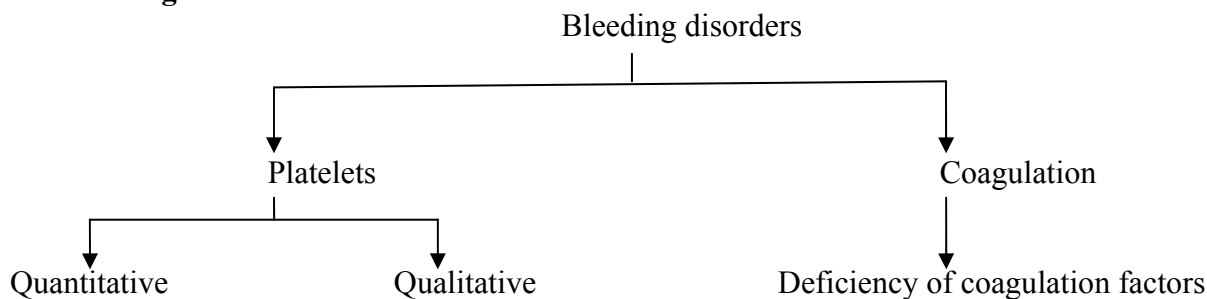


Type		Remark	Required Blood Component with doses
Hypo proliferative	1. Iron deficiency Anemia	*Replace iron first. *Transfusion required in elderly, symptomatic severe anemia, associated medical diseases.	RBC 1 Unit expected to raise Hb% by 1 gm %
	2. Multi vitamin deficiency	Replenishing of deficiency usually suffices	”
	3. Endocrine deficiency	Diagnose and treat cause- transfusion usually not required.	”
	4. Anemia of chronic disease	Use only if tissue Hypoxia evident.	”
Megaloblastic		*Usually inadvisable and unnecessary. *Use only to alleviate hypoxic symptoms.	RBC-given slowly.
Hemolytic	G6PD Deficiency	*Rapidly developing severe anemia is an emergency. *Hemolysis is self limiting when all G6PD deficient cells are destroyed. *Avoid drugs causing hemolysis.	RBC
	Paroxysmal Nocturnal Hemoglobinuria	Commonly associated with pancytopenia and risk of venous thrombosis	Saline washed RBC
	Toxin/ Chemical induced e.g. snake bite	*Transfusion required only if platelets grossly decreased or coagulation factors depleted *Adequate anti venom administration is a must.	Platelet concentrate Cryoprecipitate FFP
Aplastic		*Use as adjunct with specific therapy for the cause. *If multiple transfusion required use apheresis. *Patients are immunocompromised, hence are at increased risk of CMV infection.	*RBC(leucodepleted) *PC(leucodepleted)
Sickle Cell disease (Detailed in multiple transfusions)		*Aim at avoiding development of crisis. *Transfusion required only in Sequestration and aplastic crisis.	RBC Maintain hematocrit >30%
Thalassemia (Discussed in detail in chapter of Tx practice in pediatrics)			
Leukemias		*Usually required in patients of acute myeloid leukemia. *Use LR and IR to prevent TAGvHD *Specific treatment is a must.	RBC Platelet conc. Elevate Hb% & Platelets enough to relieve symptoms of hypoxia or control bleeding.

II. Malaria:-

- Transfusion of RBC may be required when:
 - Acute severe hemolysis i.e. hematocrit falls to <20%.
 - Hb <7 gm/dl
 - Hb: 7-9 gm/dl but peripheral smear shows severe parasitemia indicating impending hemolysis (red cell exchange may be used for severe parasitemia)
- Pregnant female and children should be given special consideration.

III. Bleeding Disorders:-



- Recognition of underlying cause and its prompt treatment is absolutely essential.
- Optimal platelet dose is poorly defined and debatable.
 - For therapeutic platelet transfusion give enough platelets to control bleeding.
 - For prophylactic platelet transfusion, threshold is as follows:
 - 5000 / μ L – in asymptomatic patients(if adequate lab. support)
 - 10,000 / μ L – in patients with fever, infection, DIC, splenomegaly, etc.
 - 50,000 / μ L – for invasive procedures.
- The clinical response to platelet transfusion is evaluated as follows:

$$CCI = \frac{\text{Post Tx. Count} - \text{Pre Tx. Count} \times \text{BSA}}{\text{No. of platelet transfused} \times 10^{11}}$$

Where CCI= Corrected count increment

BSA = Body surface area in sq. mtrs

Acceptable CCI	$\geq 5 \times 10^9 / \text{Lt}$ in 1 hr. $\geq 7 \times 10^9 / \text{Lt}$ in 24 hr	}	Post transfusion
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Platelet disorders		
Disease	Indication/ Remarks	Recommended Component with dose
ITP	Transfuse if <ul style="list-style-type: none"> • Significant bleeding symptoms • Severe thrombocytopenia i.e. Platelet <5000 / μL • Signs of impending hemorrhage 	PC- till active bleeding stops
TTP	Plasma exchange is mainstay in treatment	FFP - till active bleeding stops
Infection induced e.g. Viral infection, DIC, AIDS	Treatment of cause mandatory	PC- till active bleeding stops
Drug induced e.g. heparin (HIT), warfarin etc.	Transfusion usually not required: discontinuation of heparin suffices.	
Congenital Platelet function disorders	Platelet transfusion frequently required if bleeding present.	Prestorage leucodepleted platelet

Coagulation Disorders				
Clotting Factor deficiency	Laboratory Abnormality			Treatment
	APTT	PT	TT	
Fibrinogen	+	+	+	Cryoprecipitate
Prothrombin	+	+	-	FFP / Prothrombin Complex Concentrate (PCC)
Factor V	+/-	+/-	-	FFP
Factor VII	-	+	-	FFP / PCCs
Factor VIII	+	-	-	F VIII Concentrate
Factor IX	+	-	-	F IX Concentrate
Factor X	+/-	+/-	-	FFP / PCCs
Factor XI	+	-	-	FFP
Factor XII	+	-	-	
HK	+	-	-	
Prekallikrein	+	-	-	
Factor XIII	-	-	+/-	Cryoprecipitate

IV. Bone Marrow Suppression / Failure:

- Generally manifests as pancytopenia.
- Identify and remove cause if possible.
- If repeated transfusions required, use Leucocyte Depleted RBC or platelets.
- If multiple platelet transfusion required, use apheresis platelets.

V. HIV – AIDS:

- This fast spreading epidemic causes anemia in patients because of multiple reasons e.g. Malnutrition, drug induced, etc.
- Approximately 80% of AIDS patients have Hb <10 gm/dl.
- Criteria for transfusion are same as for non AIDS patients.

VI. Gastro Intestinal Bleeding:

It is important to resuscitate the patient first, find the source of bleeding, and stop further bleed. Transfuse as per requirement for individual patient.

Type	Indication	Dose
Mild	Rarely Indicated- Keep blood crossmatched and ready.	
Moderate	If signs of hypovolaemia and/or hypoxia.	Till Hb >9 gm/dl
Severe	All patients	Till Hb >9 gm/dl Systolic BP > 100 mm Hg.

Monitor the patients closely for ongoing internal bleeding and be prepared for impending large haemorrhage in all patients with even mild G.I. bleed.

CHAPTER: VII

TRANSFUSION PRACTICES IN SURGERY

Key Points:-

- Blood transfusion is generally not required in most elective surgery as it does not result in blood loss that patient can not tolerate.
- There is rarely justification for the use of preoperative blood transfusion simply to facilitate elective surgery.
- A significant degree of surgical blood loss can often safely be incurred before blood transfusion becomes necessary, provided that the loss is replaced with intravenous replacement fluids to maintain normovolemia.
- Autologous transfusion is an effective technique in both elective and emergency surgery to reduce or eliminate the need for homologous blood. However, it should only be considered where it is anticipated that the surgery will result in sufficient blood loss to require homologous transfusion.
- Blood loss and hypovolemia can still develop in the postoperative period. Vigilant monitoring of vital signs and the surgical site is an essential part of patient management.

Introduction:-

- Need of blood transfusion in surgical patient varies between hospitals. It mainly dependent on variations in the medical condition of patients presenting for surgery, differences in surgical or anesthetic techniques, differing attitudes and concerns of both clinicians and patients towards blood transfusion and differences in the cost and availability of blood.
- The decision to transfuse a surgical patient can often be a difficult judgment.
- There is no one sign or measurement, including a single hemoglobin estimation, which accurately predicts that the oxygen supply to the tissues is becoming inadequate.
- It is necessary to rely on the careful assessment of a variety of factors and clinical signs, which themselves may be masked or attenuated by the effects of general anesthesia.
- Most elective or planned surgery does not result in sufficient blood loss to require a blood transfusion.

Anemia and Surgery:-

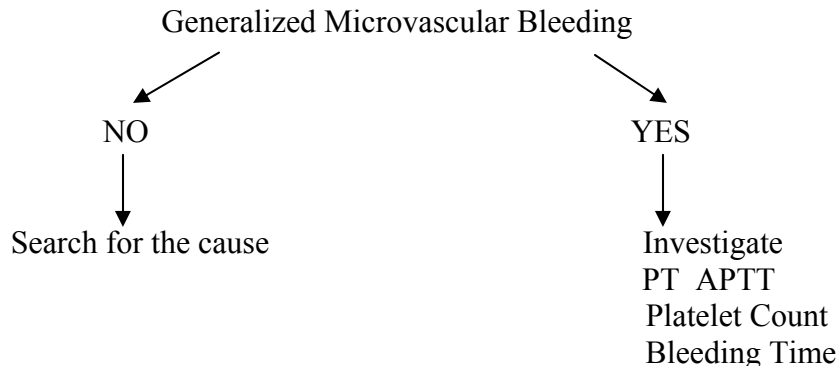
- It is common to detect anemia in patients presenting for elective surgery.
- Although the compensatory mechanisms often enable patients to tolerate relatively low hemoglobin levels.
- Ensuring adequate hemoglobin preoperatively will reduce the likelihood of a blood transfusion becoming necessary if expected or unexpected blood loss occurs during surgery.

- The screening and treatment of anemia should therefore be a key component of the preoperative management of elective surgical patients.
- The judgment on what is an adequate preoperative hemoglobin level for patients undergoing elective surgery must be made for each individual patient.
- It should be based on the clinical condition of the patient and the nature of the procedure being planned.
- Usually it is accepted a threshold hemoglobin level of approximately 7–8 g/dl in a well-compensated and otherwise healthy patient presenting for minor surgery. However, a higher preoperative hemoglobin level will be needed in the following circumstances.
 - Where the patient has symptoms or signs indicating that there is inadequate compensation for the anemia and the oxygen supply to the organs and tissues is insufficient, such as:
 - Evidence of angina
 - Increasing dyspnea
 - Dependent edema
 - Frank cardiac failure as a result of the reduced oxygen-carrying capacity of blood.
 - When major surgery is planned and it is anticipated that operative blood loss may be more than 10 ml/kg
 - Where the patient may have coexisting cardio-respiratory disease which may limit his or her ability to further compensate for a reduction in oxygen supply due to operative blood loss or the effects of anesthetic agents. For example:
 - Significant ischemic heart disease
 - Obstructive airways disease.

Coagulation disorders:-

- Undiagnosed and untreated disorders of coagulation in surgical patients may result in excessive operative blood loss, uncontrolled hemorrhage and death of the patient.
- Coagulation and platelet disorders can be classified as follows:
 - Acquired coagulation disorders, arising as a result of disease or drug therapy: for example, liver disease, aspirin-induced platelet dysfunction or disseminated intravascular coagulation
 - Congenital coagulation disorders, for example, hemophilia A or B, and von Willebrand disease.
- Although a specific diagnosis may require detailed investigation, the history alone is nearly always sufficient to alert the physician to a potential problem.
- It is therefore essential that a careful preoperative enquiry is made into any unusual bleeding tendency of the patient and his or her family, together with a drug history.
- If possible, obtain expert hematological advice before surgery in all patients with an established coagulation disorder.

Evaluation of bleeding in surgical patients:



Surgery and thrombocytopenia:-

- A variety of disorders may give rise to a reduced platelet count.
- Prophylactic measures and the availability of platelets for transfusion are invariably required for surgery in this group of patients; for example, splenectomy in a patient with idiopathic thrombocytopenic purpura (ITP).
- Platelet transfusions should be given if there is clinical evidence of severe microvascular bleeding and the platelet count is below $50-100 \times 10^9/L$.

Surgery and the anticoagulated patient:-

- In patients who are being treated with anticoagulants (oral or parenteral), the type of surgery and the thrombotic risk should be taken into account when planning anticoagulant control perioperatively.
- For most surgical procedures, the INR and/or APTT ratio should be less than 2.0 before surgery commences.

Patients fully anticoagulated with warfarin

Elective surgery

- Stop warfarin three days preoperatively and monitor INR daily.
- Give heparin by infusion or subcutaneously, if required.
- Stop heparin 6 hours preoperatively.
- Check INR and APTT ratio immediately prior to surgery.
- Commence surgery if INR and APTT ratio are <2.0 .
- Restart warfarin as soon as possible postoperatively.
- Restart heparin at the same time and continue until INR is in the therapeutic range.

Emergency surgery

- Give vitamin K, 0.5–2.0 mg by slow IV infusion.
- Give fresh frozen plasma, 15 ml/kg. This dose may need to be repeated to bring coagulation factors to an acceptable range.
- Check INR immediately prior to surgery.
- Commence surgery if INR and APTT ratio are <2.0 .

Patients fully anticoagulated with heparin

Elective surgery

- Stop heparin 6 hours preoperatively.
- Check APTT ratio immediately prior to surgery.
- Commence surgery if APTT ratio is <2.0 .
- Restart heparin as soon as appropriate postoperatively.

Emergency surgery

- Consider reversal with IV protamine sulphate. 1 mg of protamine neutralizes 100 IU heparin.

Patients receiving low-dose heparin

- It is rarely necessary to stop low-dose heparin injections, used in the prevention of deep vein thrombosis and pulmonary embolism prior to surgery.

Techniques to reduce operative blood loss:-

Operative blood loss can be significantly reduced by the following techniques during surgery:

- Meticulous surgical technique - The training, experience and care of the surgeon performing the procedure is the most crucial factor.
- Use of posture - Positioning the patient to encourage free unobstructed venous drainage at the operative site can reduce venous blood loss.
- Use of vasoconstrictors - Infiltration of the skin at the site of surgery with a vasoconstrictor can help to minimize skin bleeding. Vasoconstrictors should not be used in areas where there are end arteries.
- Use of tourniquets - When operating on extremities, blood loss can be reduced considerably by the application of a limb tourniquet. Towards the end of the procedure, it is good practice to deflate the tourniquet temporarily to identify missed bleeding points and ensure complete hemostasis before finally closing the wound.
- Anesthetic techniques - Episodes of hypertension and tachycardia due to sympathetic overactivity should be prevented by ensuring adequate levels of anesthesia and analgesia.
- Use of antifibrinolytic drugs - Several drugs, including aprotinin and tranexamic acid, which inhibit the fibrinolytic system of blood and encourage clot stability, have been used in an attempt to reduce operative blood loss.

Estimating blood loss

- In order to maintain blood volume accurately, it is essential to continually assess surgical blood loss throughout the procedure.

Blood volume

Neonates	85–90 ml/kg body weight
Children	80 ml/kg body weight
Adults	70 ml/kg body weight

- Accurate measurement of blood loss is especially important in neonatal and infant surgery where only a very small amount lost can represent a significant proportion of blood volume.

Signs of hypovolemia

- Color of mucous membranes
- Heart rate
- Respiratory rate



- Capillary refill time
- Level of consciousness
- Blood pressure
- Urine output
- Peripheral temperature
- ECG
- Saturation of hemoglobin
- CVP, if available and appropriate

Two methods are commonly used to estimate the volume of surgical blood loss that can be expected (or allowed) to occur in a patient before a blood transfusion becomes necessary:

- Percentage method
- Hemodilution method.

Percentage method of estimating allowable blood loss

This method simply involves estimating the allowable blood loss as a percentage of the patient's blood volume.

- Calculate the patient's blood volume.
- Decide on the percentage of blood volume that could be lost but safely tolerated, provided that normovolemia is maintained.
- During the procedure, replace blood loss up to the allowable volume with crystalloids or colloid fluids to maintain normovolemia.
- If the allowable blood loss volume is exceeded, further replacement should be with transfused blood.

Hemodilution method of estimating allowable blood loss

This method involves estimating the allowable blood loss by judging the lowest hemoglobin (or hematocrit) that could be safely tolerated by the patient as hemodilution with fluid replacement takes place:

- Calculate the patient's blood volume and perform a preoperative hemoglobin (or hematocrit) level.
- Decide on the lowest acceptable Hemoglobin (or Hematocrit) that could be safely tolerated by the patient.
- Apply the following formula to calculate the allowable volume of blood loss that can occur before a blood transfusion becomes necessary.

Allowable blood loss = Blood volume x $\frac{(\text{Preoperative Hb} - \text{Lowest Acceptable Hb})}{(\text{Average of Preoperative \& Lowest Acceptable Hb})}$

- During the procedure, replace blood loss up to the allowable volume with crystalloid or colloid fluids to maintain normovolemia.
- If the allowable blood loss volume is exceeded, further replacement should be with transfused blood.

Method	Healthy	Average clinical condition	Poor clinical condition
Percentage method Acceptable loss of blood volume	30%	20%	10%
Hemodilution method Lowest acceptable Hemoglobin (or Hct)	9 g/dl (Hct 27)	10 g/dl (Hct 30)	11 g/dl (Hct 33)

(Details of replacement fluids are given in chapter on Replacement fluids.)

Blood transfusion strategies

Blood ordering schedules

- Blood ordering schedules which aid the clinician to decide on the quantity of blood to crossmatch for a patient about to undergo surgery are widely used.
- Although they provide a useful guide to potential transfusion requirements they are often based solely on the surgical procedure.
- Blood ordering schedules should always be developed locally and should be used simply as a guide to expected normal blood usage.

CHAPTER: VIII

TRANSFUSION PRACTICES IN OBSTETRICS AND GYNECOLOGY

Key Points: -

- Anemia in pregnancy is defined as Hb level of < 11.0 gm% in first trimester, third trimester and puerperium and < 10.5 gm% in second trimester due to physiological hemodilution.
- The diagnosis and effective treatment of chronic anemia in pregnancy is an important way of reducing the need for future transfusions and decreasing maternal morbidity and mortality.
- Obstetric bleeding may be unpredictable and massive.
- If disseminated intravascular coagulation is suspected, do not delay treatment while waiting for the results of coagulation tests.
- Intrauterine transfusion for severely affected Rh positive fetus can be effectively done now under USG control.

Following situations in Obstetrics and Gynecology require blood or blood products: -

1. Anemia in Obstetrics and Gynecology.
2. Massive obstetric hemorrhage.
3. Obstetric and Gynecology surgery.
4. Disseminated intravascular coagulation.
5. Rh isoimmunization.

1. Anemia: -

Obstetrics : -

- **Definition** : As per WHO anemia in pregnancy is defined as Hb level of < 11.0 g/dl in first trimester, third trimester and puerperium and < 10.5 g/dl in second trimester due to physiological hemodilution.
- Anemia is very common in Indian patients (30-80%) due to nutritional deficiencies, deficit iron reserve and repeated pregnancies at short intervals.
- Severe anemia is defined as Hb < 7.0 g/dl, it is found in 5-10 % of patients.
- **Indication** : RBC is required at any gestational age when there is severe anemia. As per WHO, transfusion is required when Hb is 5.0 g/dl or less before 36 weeks of pregnancy and when Hb is 6.0 g/dl or less when pregnancy is 36 weeks or more.
- When Hb is between 5.0 to 7.0 g/dl before 36 weeks and between 6.0 to 8.0 g/dl after 36 weeks transfusion is required if there is an incipient cardiac failure, clinical evidence of hypoxia or any serious bacterial infection.
- In puerperium due to fluid shift from extravascular compartment to intravascular compartment anemia can worsen and transfusion may be required if Hb falls below 7.0 g/dl.
- Pregnant patients with hemoglobinopathies (e.g. sickle cell) might require repeated transfusions.



Gynecology: -

- Young girls with puberty menorrhagia if not treated in time become severely anemic and require transfusion.
- Adult females with excessive menstruation due to D U B, fibroids, adenomyosis etc. when develop severe anemia require transfusions.

2. Obstetric hemorrhage: -

Early pregnancy: -

- Excessive hemorrhage in early pregnancy can be due to abortions, ruptured ectopic pregnancy or hydatidiform mole.
- However such situations are decreasing nowadays as these conditions are diagnosed early by USG and laboratory investigations and adequately treated.
- Two or more transfusions are required as per the need.

Late pregnancy: -

- It is called antepartum hemorrhage – APH. It can be mainly due to placenta previa or abruptio placenta.
- Placenta previa: - In placenta previa during expectant line of treatment depending upon the blood loss transfusions are required. During caesarean section for placenta previa bleeding can be torrential and if it is accreta multiple units are required.
- Abruptio placenta (Accidental hemorrhage): - During spontaneous or induced labour patient loses considerable amount of blood in concealed hemorrhage (retroplacental clot) and accordingly transfusion is required checking the hematocrit. At delivery or caesarean section uterus may not contract leading to atonic PPH. DIC is common in abruptio placenta requiring FFP and other component therapy.

Labour: -

Post partum hemorrhage (PPH): -

- Atonic: - Atonic is more common (80%)
- Severe atonic PPH occurs in 5 % of deliveries.
- Multiple transfusions are required till medical and/or surgical measures are effective.
- At term >700 ml of blood circulates through placenta every minute, so blood loss in severely atonic uterus can be massive.
- Due to physiological changes of pregnancy, all signs of hypovolemia may not be present despite considerable blood loss.
- Signs of hypovolemia include tachycardia, tachypnea, hypotension, thirst, reduced urine output, decreased conscious level and increased capillary refill time.
- Traumatic: - Episiotomy, perineal and vaginal lacerations and lacerations of cervix can lead to severe blood loss at times.
- Adequate surgical repair is must along with pressure hemostasis

Obstetric complications: -

- Retained placenta: - It causes excessive third stage hemorrhage till manual removal of placenta or some definite measures are done. Placenta accreta can lead to excessive hemorrhage if removal is tried.
- One or more units of RBCs are required.
- Rupture uterus: - In modern times these commonly occur in vaginal delivery of previous caesarean cases, misuse of oxytocics and obstructed labour cases.
- Blood loss can be massive if major vessels are involved.
- Two or more units are usually required.
- Inversion of uterus: - Rare but dangerous condition with high mortality
- Inverted uterus cannot contract and retract properly so massive hemorrhage results.
- Two or more units are usually required.

Major obstetric hemorrhage is defined as any blood loss occurring in the peripartum period, revealed or concealed, that is likely to endanger life.

Guidelines for management of massive obstetric hemorrhage: -

- Administer high concentration of oxygen
- Foot end raised.
- Establish IV access with 2 large bore cannulae
- Inform blood bank that this is an emergency. Ask for compatible blood.
- Transfuse crystalloid or colloid till blood is available.
- Use pressure infusion device and warming device if possible.
- Call for help.
- Stop the bleeding by appropriate means.

3. Obstetric and Gynecology surgery: -

Cesarean section: -

- One unit of RBC is usually kept X matched and ready for every caesarean section elective or emergency.
- Excessive blood loss can be from placental site, edges of incision or extension of angle involving vessels.
- Chances of transfusion are more in emergency cases.

Major Gynecology surgery: -

- One unit of RBC is kept X matched and ready at every planned major Gynecology surgery.
- Four units are required in radical surgery in cancer Gynecology.
- Preoperatively transfusions may be required to raise the Hb of patient if she is having severe anemia.

4. Disseminated Intravascular coagulation (DIC) :-

- DIC is a cause of major obstetric hemorrhage. It may be triggered by :
 - Intrauterine fetal death

- Amniotic fluid embolism
 - Abruptio placenta
 - Sepsis
 - Missed abortion
 - Preeclampsia, Eclampsia
 - Massive blood loss
- Laboratory tests in the form of BT, CT, PT, platelet count, APTT, Thrombin time, Serum fibrinogen, FDP and D-dimer are carried out.
 - Blood products in the form of FFPs, Cryoprecipitate and platelet concentrates are used along with PCVs. One FFP or cryoprecipitate raises fibrinogen by 10 mg %, while one unit of platelets raises platelet count by 10,000/cmm.
 - Treatment of the cause of DIC i.e. evacuation of uterus, control of blood pressure, control of sepsis should be done simultaneously.
 - Raised FDP inhibits uterine contractions so ecbolics are given to prevent further blood loss.
 - Once the crisis is over and general condition improves, patient's liver regenerates essential clotting factors in 24 hours.
 - For more details regarding DIC refer chapter on Tx practice in Massive Transfusion.

5. Rh isoimmunization: -

- Prevention is done by giving Anti D 300 ug I/M to the Rh negative mother within 72 hours of delivery if newborn is Rh positive. Anti D 50 ug I/M should be given to Rh negative woman after abortion, ectopic pregnancy or incomplete vesicular mole if husband is Rh positive.
- Severely affected baby is diagnosed antenatally by USG, Doppler studies and amniotic fluid studies.
- Intrauterine transfusions is given by O–ve packed cells or Rh negative cells of the same ABO group of fetus if maturity is less than 34 weeks. Repeat transfusion may be required after 10-14 days. Direct intravascular transfusion is better than intraperitoneal transfusion. All cellular components for intrauterine tx should be irradiated.
- If gestational age is 34 weeks or more it is better to deliver the fetus and give exchanged transfusion after birth. It is done by Rh negative same ABO group of newborn or O–ve RBCs.
- Little amount is required in these situations.



CHAPTER: IX

TRANSFUSION PRACTICES IN PEDIATRICS

Key Points: -

- As with adults, transfusion should not be administered to pediatric patients without consideration of risk-to-benefit ratio.
- As with all patients, indications for transfusion must be individualized.

Pediatric Anemia: -

Definition: Pediatric anemia is defined as a reduction of hemoglobin concentration or red cell blood volume below the normal values for healthy children.

Hb levels in neonates and children: -

Age	Hb concentration (g/dl)
Cord Blood	\pm 16.5 g/dl
Neonate: Day 1	\pm 18.0 g/dl
1 month	\pm 14.0 g/dl
3 months	\pm 11.0 g/dl
6 months – 6 years	\pm 12.0 g/dl
7 – 13 years	\pm 13.0 g/dl
> 14 years	Same as adults, by sex

- The decision to transfuse should not be based on the hemoglobin level alone, but also on a careful assessment of the child's clinical condition.
- If the child is stable, is monitored closely and is treated effectively for other conditions, such as acute infection, oxygenation may improve without the need for transfusion.

Indication for Transfusion (Decompensated Anemia): -

- Hemoglobin concentration of 4 g/dl or less (or hematocrit 12%) whatever the clinical condition of the patient.
- Hemoglobin concentration of 4-6 g/dl (or hematocrit 13-18%) if any of the following clinical features are present :
 - Clinical features of hypoxia: Acidosis(usually causes dyspnea), Impaired consciousness
 - Hyperparasitemia (>20%)

Transfusion Procedure: -

- 10 ml/kg of red cells or 20 ml/kg whole blood are usually sufficient to relieve acute shortage of oxygen carrying capacity. This will increase the hemoglobin concentration by approximately 2-3 g/dl unless there is continued bleeding or hemolysis.
- The first 5 ml/kg of red cells are given rapidly to relieve the acute signs of tissue hypoxia. Subsequent transfusion should be given slowly. (5 ml/kg of red cells over 1 hour)
- Re evaluate patient's hemoglobin or hematocrit and clinical condition after transfusion.

- If patient is still anemic with clinical signs of hypoxia or a critically low hemoglobin level, give a second transfusion.
- Infants and children require small transfusions, so appropriate dosage should be transfused and demanded from the blood bank to avoid wasting of the blood unit.

Sickle Cell Disease: -

- Children with sickle cell disease do not develop symptoms till they are six months old.
- The main aim of management is to prevent sickle crises.
- Exchange transfusion is indicated for treatment of vaso-occlusive crisis and painful priapism that does not respond to fluid therapy alone.
- Chronic transfusion therapy to maintain the HbS below 30% of the total hemoglobin prevents first stroke in high-risk children.

Thalassemia Major: -

- Children with thalassemia cannot maintain oxygenation of tissues and the hemoglobin has to be corrected by regular transfusions.
- When to start transfusion?
 - Confirm diagnosis.
 - If Hb < 6gm/dl.
 - If < 7gm/dl, initiate transfusion after complete evaluation.
 - If between 7 – 8 gm/dl, growth and development closely monitored.
 - If > 8gm/dl, postpone until Hb falls significantly.
 - Presence of major facial deformities or any other complications.
 - Risk of alloantibodies reduced if started below 3 years of age

Bleeding and Clotting Disorders: -

Platelet therapy for bleeding due to thrombocytopenia

- Platelet concentrate from 1 donor unit (450 ml) of whole blood contains about 5.5×10^{10}

Dosage	Volume	Platelet Count
Upto 15 kg	1 platelet concentrate	50-70 ml
15-30 kg	2 platelet concentrate	5.5 x 10 ¹⁰ .
> 30 kg	4 platelet concentrate	100-140 ml
		11 x 10 ¹⁰ .
		200-280 ml
		22 x 10 ¹⁰ .

Transfusion in Neonates and Critically Ill Children: -

- Infants may require simple or exchange transfusions for hemolytic disease of the newborn (HDN) or symptomatic anemia in the first months of life.
- Apart from HDN, neonatal anemia occurs in many preterm infants because of iatrogenic blood loss for laboratory tests, concurrent infection or illness and inadequate hematopoiesis in the first weeks of life.
- General guidelines for transfusion should take cardiorespiratory status of infant into consideration but transfusion decisions must be tailored to the individual patient.



General Guidelines for Small-volume (10-15 mL/kg) Transfusion to Infants: -

Maintain Hct between:	40-45%	Severe cardiopulmonary disease
	30-35%	Moderate cardiopulmonary disease (e.g. less intensive assisted ventilation such as nasal CPAP or supplemental oxygen)
	30-35%	Major surgery
	20-30%	Stable anemia, especially if unexplained breathing disorder or unexplained poor growth

Guidelines for transfusion of RBC in Neonates: -

- Hct < 40% or Hb < 11 gm/dl and requiring significant mechanical ventilation.
- Hct < 35% or Hb < 10 gm/dl and requiring minimal mechanical ventilation.
- Hct < 25 % or Hb < 8 gm/dl with clinical manifestations of anemia like Tachycardia (Heart rate >180) or Tachypnea (R.R >80).
- Hct < 20% or Hb <7 gm/dl without any symptoms.
- Blood loss of 10% or more in 72 hrs. (Acute loss or loss due to sampling).

Guidelines for Transfusion of Platelet Concentrate: -

A normal neonate's platelet count is $80-450 \times 10^9 /L$. After one week of age, it reaches adult level of $150-450 \times 10^9 /L$. Platelet count below this level is considered to be thrombocytopenia. The patient with thrombocytopenia due to bleeding typically has petechiae, retinal hemorrhage, bleeding gums and bleeding from venipuncture sites.

Guidelines for Platelet Transfusion in children: -

- Platelet count < $10 \times 10^9/L$ with failure of platelet production.
- Platelet count < $30 \times 10^9/L$ in neonate with failure of platelet production.
- Platelet count < $50 \times 10^9/L$ in stable premature infant:
 - With active bleeding.
 - Invasive procedure with failure of platelet production.
- Platelet count < $100 \times 10^9/L$ in sick premature infant:
 - With active bleeding.
 - Invasive procedure in patient with DIC.
- Active bleeding in association with a qualitative platelet defect.
- Unexplained excessive bleeding in a patient undergoing cardiopulmonary bypass.
- Patient undergoing Extracorporeal membrane oxygenation (ECMO):
 - With a platelet count < $100 \times 10^9/L$.
 - With higher platelet count and bleeding.

The sick premature infant is at a greater risk for intracranial hemorrhage due to poor platelet function and decreased level of plasma coagulation protein. Platelet transfusion is generally recommended in a sick premature infant when the platelet count is $<100 \times 10^9/L$ and in a stable premature infant when the platelet count is $< 50 \times 10^9/L$ provided there is active bleeding or an invasive procedure is planned.

Guidelines for Transfusion of FFP: -

Recommendations for transfusion of FFP: -

- Vitamin K dependant coagulopathy in HDN with significant haemorrhage.
- Replacement of isolated factor deficiencies when specific component therapy is not available (Factors VIII, IX, X, V, II, fibrinogen etc).
- Replacement therapy in antithrombins III, protein C or protein S deficiency.
- Disseminated intravascular coagulation (DIC).
- Reversal of hemostatic disorders following massive transfusion.
- Therapeutic plasma exchange in Thrombotic Thrombocytopenic Purpura (TTP).

Maternal clotting factors do not cross placenta, hereditary deficiency of clotting factors may become apparent at birth. FFP should only be used if a specific factor is not available or in the case of liver failure where multiple factors are simultaneously decreased. The doses can be repeated every 12 or 24 hrs depending on the clinical situation. FFP is also used in the treatment of DIC along with the treatment of underlying cause. FFP is not indicated for volume expansion.

Blood Components commonly used in the management of neonatal disorders: -

Component	Indication	Special Requirements for neonates
Whole Blood	Exchange transfusion for HDN	Blood less than 5 days of collection
Red cells	“Top –up” transfusion to raise Hb in symptomatic chronic anemia	Small dose unit to minimize exposure to different donors

Exchange Transfusion: -

- The need for exchange transfusion has decreased in recent years because of the following developments:
 - Prevention of HDN by administration of anti Rh D immunoglobulin to the mother.
 - Prevention of kernicterus in less severe jaundice by phototherapy of the infant.
- The main indication for exchange transfusion of a neonate is to prevent neurological complications (Kernicterus) caused by a rapidly rising unconjugated bilirubin concentration.

The underlying cause is usually hemolysis (red cell destruction) due to antibodies to the baby's red blood cells.

Other indications are -

- 1) Sickle cell anemia.
- 2) RDS in newborn.
- 3) Small volume in pregnant women.

For HDN due to anti D, use ABO specific Rh D negative unit which is also negative for sickle cell disease. All products should be irradiated.

HDN due to ABO incompatibility: -

- Treatment should be initiated promptly as these infants develop jaundice severe enough to lead to kernicterus.
- Neonate should receive phototherapy and supportive treatment.
- Blood units for exchange transfusion should be group O, with low titre anti-A

and anti-B with no IgG lysins. (group AB plasma added to group O cells)

Volume of exchange transfusion: –

An exchange of about two times the neonate’s blood volume (about 170ml/Kg) is most effective to reduce bilirubin and restore the Hb level. This can usually be carried out with one unit of whole blood.

Age	Total blood volume
Premature infants	100 ml/Kg
Term newborns	85-90 ml/Kg
> 1 month	80 ml/Kg
>1 year	70 ml/Kg

Management of Neonates with indirect hyperbilirubinaemia: -

- Treat underlying causes of hyperbilirubinaemia and factors that increase risk of kernicterus (Sepsis, Hypoxia,etc.).
- Hydration.
- Initiate phototherapy at bilirubin levels well below those indicated for exchange transfusion. Phototherapy may require 6-12 hrs before having a measurable effect.
- Monitor bilirubin levels - Suggested maximum indirect serum bilirubin concentration:

Birthweight (gm)	Uncomplicated	Complicated
<1000	12-13	10-12
1000-1250	12-14	10-12
1251-1499	14-16	12-14
1500-1999	16-20	15-17
>2000/term	20-22	18-20

1. Give exchange transfusion when indirect serum bilirubin levels reach maximum levels.

Calculations for neonatal exchange transfusion: -

Partial exchange transfusion for treatment of symptomatic polycythemia: -

Replace removed blood volume with normal saline or 5 % albumin

Volume to be replaced (ml): -

$$\text{Estimated blood volume} \times \frac{(\text{Patient's Hct} - \text{desired Hct})}{\text{Patient's Hct}}$$

Two volume red cell exchange transfusion for treatment of sickle cell crisis and neonatal hyperbilirubinaemia: -

Replace calculated blood volume with whole blood or red cells suspended in 5 % human albumin.

Volume to be exchanged (ml): -

$$\text{Estimated blood volume} \times \frac{\text{Patient's Hct}(\%) \times 2}{\text{Hct of transfused unit}(\%)*}$$

*Hematocrit of whole blood	-	35 - 45 %
Red Blood Cells without additive solution	-	55 - 75 %
Red Blood Cells with additive solution	-	50 - 70 %

2. Continue to monitor bilirubin levels until a fall in bilirubin is observed in the absence of phototherapy.

Transfusion procedure: -

- Give nothing by mouth to the infant during and at least 4 hours after exchange transfusion.
- Closely monitor vital signs, blood sugar and temperature.
- For a newborn, umbilical and venous catheters inserted by sterile technique may be used. Blood is drawn out of the arterial catheter and infused through the venous catheter. Alternatively, two peripheral lines may be used.
- Exchange 15 ml increments in a full term infant and smaller volumes for smaller, less stable infants. Do not allow cells in the donor unit to form sediment.
- Withdraw and infuse blood 2-3 ml/ Kg/min to avoid mechanical trauma to the patient and donor cells.
- Give 1-2 ml of 10% Calcium Gluconate solution I.V slowly for ECG evidence of hypocalcemia (prolonged QT interval). Flush tubing with normal saline before and after calcium infusion. Observe for bradycardia during infusion.
- To complete two volume exchange, transfuse 170 ml/Kg for a full term infant and 170-200ml/Kg for a pre-term infant.
- Send the last aliquot drawn to the laboratory for determination of Hb or Hct, blood smear, glucose, bilirubin, K⁺, Ca⁺⁺ and group and match.
- Prevent hypoglycemia after exchange transfusion by continuing infusion of a glucose containing crystalloid.

CHAPTER: X

MULTIPLE RED CELLS TRANSFUSION

Key Points: -

- Multiple Transfusion is the repeated transfusion of red blood cells over a long period of time.
- If multiple transfusions are likely to be needed, use Leuco depleted red cells, wherever possible, to reduce the risk of reactions.
- Patients who receive multiple transfusions are particularly at risk of acute febrile reactions, with experience these can be recognized, so that transfusions are not delayed or stopped unnecessarily.

Definition: - It is the repeated transfusion of red blood cells over a long period of time.

Indications: -

- **Anemia due to bone marrow suppression: -**
 - Hypo plastic or aplastic anemias
 - Drugs or chemicals induced hypo or aplastic anemias
 - Radiation - induced marrow depression.
- **Hemolytic anemias**
 - Thalassemia major
 - Sickle cell anemia
 - Autoimmune haemolytic anemia(AIHA)
 - Paroxysmal nocturnal Hemoglobinuria
- **Anemias associated with chronic diseases like**
 - Renal insufficiency
 - Hepatic failure
 - Leukaemia and other malignancy
 - Pt. on chemotherapy
 - Endocrine failure
- **Anemia due to chronic blood loss**
 - Chr. GI Blood loss
 - Chr. uterine blood loss
- Myelo dysplastic syndrome (MDS) especially in RA (Refractory Anemia) and RARS (Refractory Anemia with ringed sideroblasts).

Guidelines for Multiple Transfusions: -

- Red Cell Concentrate is preferred to whole blood transfusion.
- Leucocyte depleted red cells should be used preferably.
- Red cells should be of same ABO and RhD group as that of the patient and should be cross matched by anti human globulin test.
- Patient receiving regular multiple transfusion should be given iron chelating agents to prevent hemosiderosis.
- Saline washed red cell should be used if repeated allergic reaction occurs.

Sickle cell Disease (SCD): -

Accepted Indications for Transfusion in Sickle Cell Disease: -

Episodic or acute complications of SCD	Chronic complications SCD
<ul style="list-style-type: none"> • Severe anemia Severe vaso occlusive or painful crises refractory to medical management. 	<ul style="list-style-type: none"> • Prevention of stroke in children with abnormal transcranial Doppler studies*
<ul style="list-style-type: none"> • Acute splenic sequestration 	<ul style="list-style-type: none"> • Prevention of stroke recurrence*
<ul style="list-style-type: none"> • Transient red cell aplasia 	<ul style="list-style-type: none"> • Chronic debilitating pain
<ul style="list-style-type: none"> • Preparation for general anesthesia 	<ul style="list-style-type: none"> • Pulmonary hypertension
<ul style="list-style-type: none"> • Sudden severe illness* 	<ul style="list-style-type: none"> • Anemia associated with chronic renal failure
<ul style="list-style-type: none"> • Acute chest syndrome* 	<ul style="list-style-type: none"> • Chronic leg ulcer
<ul style="list-style-type: none"> • Stroke* 	
<ul style="list-style-type: none"> • Acute multiorgan failure* 	

* Managed with exchange transfusion or erythrocytapheresis.

Management: -

- Transfusion of RBC less than 7 days old from non sickle cells donors (10-15 ml/kg body weight is given every 12 hourly until the hemoglobin levels increase to 12-13 gm/dl) in patient with SCD with Aplastic crises, splenic sequestration crises and before surgery.
- Partial exchange transfusion which is more rapid and efficient method to decrease the level of HbS (especially in painful crises, heart disease and cerebrovascular accidents)
- Exchange transfusion in sickle cell disease with fatal pneumococcol infections, impending stroke and acute chest syndrome.
- Whole blood transfusion to correct the hypovolemia and reverse the shock in splenic sequestration crises.

Thalassemia Major: -

- Children with thalassemia cannot maintain oxygenation of tissues and the hemoglobin has to be corrected by regular transfusions.
- **Rate of transfusion** : 5-7 ml/kg/hr over 2-4 hours (if no cardiac problem)
- **Transfusion Regimen – Hypertransfusion Regimen: -**
 - Maintain minimum Hb ~10 g/ dl
 - It depresses endogenous erythropoiesis
 - Prevent marrow hyperplasia
 - Children live normal active life with excellent physical development, normal facies, freedom from repeated infections and hepatosplenomegaly.
 - Effective iron chelation therapy should be there.
- **How to assess hypertransfusion is achieved?**
 - Hb level
 - RBC morphology-should be Normal
 - Nucleated cells in PBS - Absent
 - Reticulocyte count - < 1%
 - HbF - < 1%
 - Urine colour (for dipyrrole excretion)- Near normal

All of the above should be done monthly.

- **Blood Components used in Thalassemia: -**
 - **Red Cell Concentrate** – should be less than 5 days old.
 - **Leucocyte depleted red cells** are preferred.
 - **Dosage:** - 10-20ml/kg body wt. every 3-4 weeks.

Laboratory aspects: -

- Red cell should be ABO and RhD compatible and should be cross matched using antihuman globulin technique.
- In case a patient develops alloantibody(ies) against red cells antigen, antibody(ies) should be indentified and compatible blood should be provided. For future transfusions, pool of corresponding antigen negative blood donors should be identified and reserved.
- In children, red cells less than 5 days old should be used.

Long term effects of multiple transfusion: -

Besides the risk of acute haemolytic reactions, transfusion of infected blood and circulatory over load, the long term effects of multiple transfusion are –

- Iron over load
- Sensitization to leucocytes or plasma antigens
- Red cell allo immunization.
- Risk of transfusion transmitted diseases.

CHAPTER: XI

MASSIVE TRANSFUSION

Key Points: -

- Massive transfusion is usually defined as the replacement of one or more blood volume(s) within 24 hours or replacement of more than 50% of the blood volume in 3 hours in an adult.
- Blood must be warmed by specific blood warmer device.
- Blood should never be warmed in a bowl of hot water, microwave or in incubator as this could lead to hemolysis of the red cells which could be life threatening
- It is not necessary to warm blood before transfusion when rate of infusion is slow.

Definition: - massive transfusion is usually defined as the replacement of one or more blood volume(s) within 24 hours or replacement of more than 50% of the blood volume in 3 hours in an adult.

Normal blood volume: -

- In adult about 70 ml/kg.
- In children about 80 ml/kg.
- In neonates 85-90 ml/kg.

Indications: - Massive Transfusion is required due to acute hemorrhage in

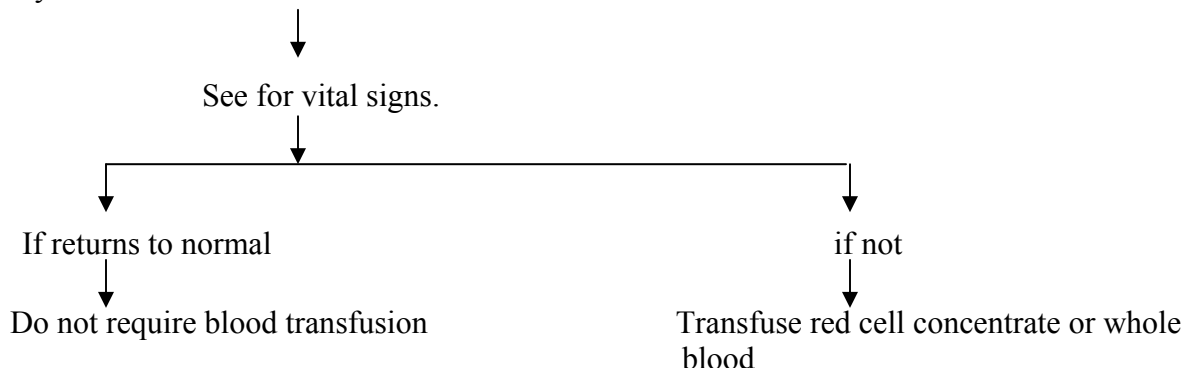
- Surgical or medical emergencies (e.g.- bleeding from varices)
- Cardiac and vascular surgery
- Exchange transfusion in infants
- Obstetric cases
- In multiple trauma
- Liver transplant

Objective: - Transfusion should be done to maintain following parameter -

- Hb: 10gm%
- Hct: 30%
- Platelet count: $>50,000/\text{mm}^3$
- PT: $<1.5\times\text{control}$
- APTT: $<1.5\times\text{control}$
- Fibrinogen: $>0.8 \text{ g/l}$

Management strategy for massive transfusion: -

Restore Blood volume to maintain tissue perfusion and blood pressure by rapid infusion of crystalloid or colloid fluids.



Note: - Specify on blood requisition form about urgency of blood like urgent/life-saving emergency.

Blood Component to be used: -

- Platelet concentrates to maintain platelet counts $>50,000/\text{mm}^3$
- FFP is given to correct coagulation abnormalities.
- Cryoprecipitate to replace fibrinogen and factor VIII

Complications: -

- Acidosis
- Hyperkalemia –to prevent it use blood preferably which is less than 7days old.
- Citrate toxicity and hypocalcemia
 - If calcium level becomes critically low, calcium gluconate or calcium chloride can be given.
- Depletion of coagulation factors and platelets due to dilution effect (corrected with Platelets, FFP and cryoprecipitate)
- Hypothermia: Increased risk of DIC, Ventricular arrhythmia or Cardiac Arrest (blood warmer should be used to prevent these).

Disseminated Intravascular Coagulation: -

Disseminated intravascular coagulation (DIC) is an acquired coagulopathy. DIC is caused by the abnormal and uncontrolled activation and consumption of coagulation proteins, fibrinogen and platelets, causing small thrombi with in the vascular system through out the body. Free thrombi in the vascular systems are the cause of DIC. There is over production of fibrinolytic enzymes which break down the clots formed, leading to an increase in fibrin degradation products. All the coagulation factors platelets, and fibrinogen are consumed faster than they are replaced, resulting in widespread bleeding.

Causes of DIC:

- Septicemia
- Malignancy: - Disseminated solid cancers and Acute promyelocytic leukaemia.

- Obstetric complications.
 - Eclampsia
 - Premature separation of placenta
 - Retained dead fetus
 - Amniotic fluid embolism.
 - Septic abortion
- Trauma- especially of brain or crush injury
- Hemolytic transfusion reaction
- Neonatal DIC secondary to sepsis and necrotizing enterocolitis
- Prolonged hypoxia or hypovolemia including shock.
- Thermal injury- heat stroke, extensive burns
- Snake bite e.g.- Russell's viper
- Severe liver disease

Symptoms:

- Severe bleeding from many sites in the body.
- Sudden onset of blood from bruising
- Oozing from venipuncture site.
- Microvascular thrombi may cause organs dysfunction:
- Respiratory distress.
- Renal failure
- Jaundice
- Coma

Laboratory investigation: -

DIC is characterized by -

- Reduced platelet count (thrombocytopenia)
- Prolonged PT, APTT and TT (Thrombin time)
- Decreased fibrinogen concentration - < 1.0 g/l suggestive of DIC (normal 2-4 g/l)
- Elevated fibrin degradation products (FDP) (normal < 10 mg/l) and D-dimer.
- Low plasma level of coagulation inhibitors: Antithrombin III (AT III) or Protein C.

Management: -

Immediate and appropriate treatment for removal of the underlying condition is essential to prevent tissue ischemia.

- Identify and treat or remove the cause of DIC.
- Maintain blood volume.
- If the patient is anemic give red cell concentrate/whole blood of less than 7 days old.
- Maintain hemostatic functions.
- If PT and APTT are prolonged and patient is bleeding, give FFP.



- Repeat FFP according to the clinical response.
- If fibrinogen is low (<80mg/dl), give cryoprecipitate.
- Platelets are although contraindicated but can be used in life-saving emergencies.
- Exchange transfusion may be effective therapy for infants suffering from severe symptomatic DIC following birth. It removes FDP and provides plasma clotting factors and platelets.
- Intravenous heparin: Heparin inhibits fibrin formation and may result in increase plasma fibrinogen concentration but it does not inhibit split products. Heparin is not effective in gram negative septicemia and in some other cases. Heparin is indicated in the cases of persistent thrombosis. The role of heparin is doubtful.

In some cases heparin may be useful preceding the transfusion of FFP. The recommended dose of heparin for an adult is a loading dose of 5000 units intravenously followed by a continuous infusion of 1500 units/hour. This may be continued for 6-12 hours. Heparin is contraindicated in surgery or already actively bleeding cases.

Monitoring is done by estimating: -

- Prothrombin time (PT)
- Activated partial thromboplastin time (APTT)
- Fibrinogen level
- Hb and Hct.

CHAPTER: XII

AUTOLOGOUS TRANSFUSION

Key Points:

- Autologous transfusion refers to removal and storage of blood from donor-patient for intended transfusion to the same person when required later.
- It requires consent of patient and request from treating physicians.
- The unit should be properly labeled with green colour 'FOR AUTOLOGOUS USE ONLY' with patient's signature, name of blood bank, license number, Patient's hospital identification number. ABO and RhD type, date of collection, date of expiry and TTI Status.
- Eligibility criteria for donor selection should be maintained.
- Last blood for autologous transfusion should be drawn 72 hours prior to surgery.
- Testing for TTI, IRREGULAR ANTIBODIES and ABO and RhD grouping should be done.
- Intra operative autologous transfusion should be avoided unless emergency and should be carried out aseptically using sterile pyrogen free equipment and filter.
- Records of all autologous transfusion should be maintained.

Definitions: - Collection and subsequent reinfusion of patients' own blood or blood components.

Advantages: -

- Prevents transmission of transfusion transmitted diseases.
- Avoid immunological complications of homologous transfusion reaction.
- Preserved blood of rare blood group.
- Useful in elective or planned surgery mostly

Disadvantages: -

- Requires planning
- Strict patient eligibility
- Risk of bacterial contamination, bowel contamination, malignant cells etc.
- Risk of procedural error

Types: -

- Preoperative
- Acute normovolemic
- Intraoperative

Types: -

1. Preoperative Autologous Collection: -

Definition: -Blood collected prior to surgery and given at time of operation.

Eligibility: -

- HB > 11 g/ dl, PCV > 33



- No age restriction.
- If weight > 45 kg – 8 ml/kg should be collected.
- Patient with bacteremia, cardiac disease and sickle cell disease are excluded.

Indications: -

Elective surgeries like:

- Urological surgery
- Orthopedic surgery.
- Cardiovascular surgery.
- Major abdominal surgery.

Procedure: -

- Informed Consent of patient
- Donations recommended being 7 days apart.
- May be scheduled as frequently as every 3 days.
- Minimum interval prior to surgery should be 72 hours.
- Oral iron supplementation is necessary.
- 5 Units of blood can be collected.

Testing: -

- ABO Grouping
- Transfusion Transmissible Infection Testing
- Irregular antibodies

Note:

- Clearly labeled with patient's name and an indication with green label 'FOR AUTOLOGOUS USE ONLY'
- On admission fresh venous blood sample is taken to ensure ABO compatibility and adequate Hb level.
- Unused units of blood should be transferred to allogenic pool unless tested for transfusion transmitted infection.
- **INFORMED CONSENT FOR PREDEPOSIT OF AUTOLOGOUS BLOOD COLLECTION SHOULD BE TAKEN.**

2. Acute Normovolemic Hemodilution: -

Definition: Removal of predetermined volume of patient's own blood prior to commencement of surgery and simultaneous replacement with sufficient crystalloid or colloid fluid.

- Advantage is fresh units maintain patient's Hb concentration and replenish coagulation factors and platelets.
- Clinicians should be consulted in cases of coronary heart disease, arrhythmias, hypertension etc.

Procedure: -

- Hb or Hematocrit determined
- Phlebotomy prior to surgery.
- Blood collected aseptically.
- Blood collection from one venous line
- Replacement in form of crystalloid (3 ml for every 1 ml of blood) and colloid (1 ml for every 1 ml of blood).
- Hematocrit determined by clinician.
- Total volume of blood collected should not exceed 40 % of patient's estimated blood volume. (Body wt in kg x 70)
- Blood collected in Standard blood collecting bags and mixed and volume monitored
- Procedure is to be completed within 10 to 30 mins.
- Blood bags clearly labeled with patient's name, time and date.
- Blood bag should remain with patient till transfusion. If interval is more than 6 hours, store at 4°C.
- In case of excessive bleeding, reinfusion to be started.
- Monitor for surgical blood loss.
- Standard haemodynamic measurement like Pulse, BP must be made during blood collection and during surgery.
- Records of collection and reinfusion entered in anesthesia record and fluid balance charts.

3. Intra Operative Blood Salvage: -

Definition: Collection of shed blood from a wound, body cavity during surgery and subsequent reinfusion into same patient.

- Clearly labeled with specific patient identification and date and time of blood collection.
- Re infused within 6 hours.
- Should be considered when anticipated blood loss is 20 % or more of patient's estimated blood volume or when transfusion requirement exceeds 4 units.
- Standards of sterility to be maintained.
- Useful in Cardiovascular surgery, transplant surgery, ruptured ectopic pregnancy etc.
- Blood contaminated with bowel contents, bacteria, malignant cells, amniotic fluid – contraindicated.
- Common methods are
 - Disposable suction collection device
 - Semi continuous flow centrifugation cell washing system.
- Blood should be filtered before reinfusion.

CONSENT FOR PREDEPOSIT AUTOLOGOUS BLOOD DONATION



1. I, Mr. / Mrs. / Miss son/ daughter / wife of have been explained fully the purpose and the procedure of the autologous transfusion, and the possibility and the nature of its complications.
2. I consent for withdrawal of my blood by an authorized member of the blood bank for autologous transfusion. If I do not require transfusion of the blood withdrawn for autologous transfusion, it may disposed off as per the hospital policy.

Date:

Patient – Donor signature

Witness signature

Patient / Guardian's signature
(if patient's minor)

CHAPTER: XIII

ALTERNATIVES OF TRANSFUSION / REPLACEMENT FLUIDS

Key Points: -

- Replacement fluids are used to replace abnormal losses of blood.
- Plasma or other extra cellular fluids by increasing volume of vascular compartment.
- IV replacement fluids are first line treatment for hypovolemia.
- Crystalloid solutions with similar concentration of sodium to plasma are effective. Dextrose solutions do not contain sodium.
- Crystalloid solutions should be infused in volume at least three times the volume lost. .
- Colloid solution should be infused equal to blood volume deficit.
- Plain water should never be infused intravenously as it causes hemolysis and will be fatal.
- IV Replacement fluids restore circulating blood volume, maintaining tissue perfusion and oxygenation.
- This may be life saving providing time to control bleeding and order blood for transfusion.

Crystalloids: -

- Contain similar concentration of sodium to plasma.
- Are excluded from intracellular compartment as cell membrane is impermeable to sodium.
- Cross capillary membrane from vascular compartment to interstitial compartment.
- Are distributed through whole extra cellular compartment.
- Only a quarter of volume infused remains in vascular compartment and should be infused in a volume at least three times the volume lost.

Advantages: -

- Few side effects
- Low cost
- Wide availability

Disadvantages: -

- Short duration of action
- Causes edema
- Weighty and bulky

Examples: -

- Normal saline- should not be used in renal failure.
- Balanced salt solutions like RINGER'S LACTATE, HARTMANN'S SOLUTION - should not be used in renal failure.
- Dextrose and electrolyte solution can be used only if it contains higher sodium concentration.

Colloids: -

- Initially remain in vascular compartment.
- Mimic plasma proteins, raising or maintaining colloid osmotic pressure of blood.



- Provide longer duration of plasma volume expansion than crystalloids.
- Requires smaller infusion volumes.
- GIVEN IN VOLUME EQUAL TO BLOOD VOLUME LOST.

Advantages: -

- Longer duration of action.
- Less fluid is required.
- Less Weighty and bulky

Disadvantages: -

- Higher cost
- Causes volume overload
- May interfere with clotting.
- Risk of anaphylactic reaction

Examples:

1) Plasma derived include

- Plasma
- FFP
- Albumin
- Freeze dried plasma

2) Synthetic:

(A) Gelatins-

- May precipitate Heart or Renal failure.

(B) Dextran 60 and Dextran 70-

- Coagulation defect occur.
- Platelet aggregation inhibited.
- Interferes with compatibility testing.

(C) Hydroxyethyl Starch:

- Not to be used with preexisting coagulation disorders or renal failure.