BLOOD TRANSFUSION

GENERAL CONCEPTS

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450 ml

TOPICS

1. Introduction
2. The recipient
3. The blood donor
4. Blood components
5. Procedure
6. Complications

Introduction

- Blood Transfusion is not without hazards
- Weigh the risk against benefits.
- Use of right products from the right person to the right patient at the right time .

Steps of blood transfusion

Before blood transfusion

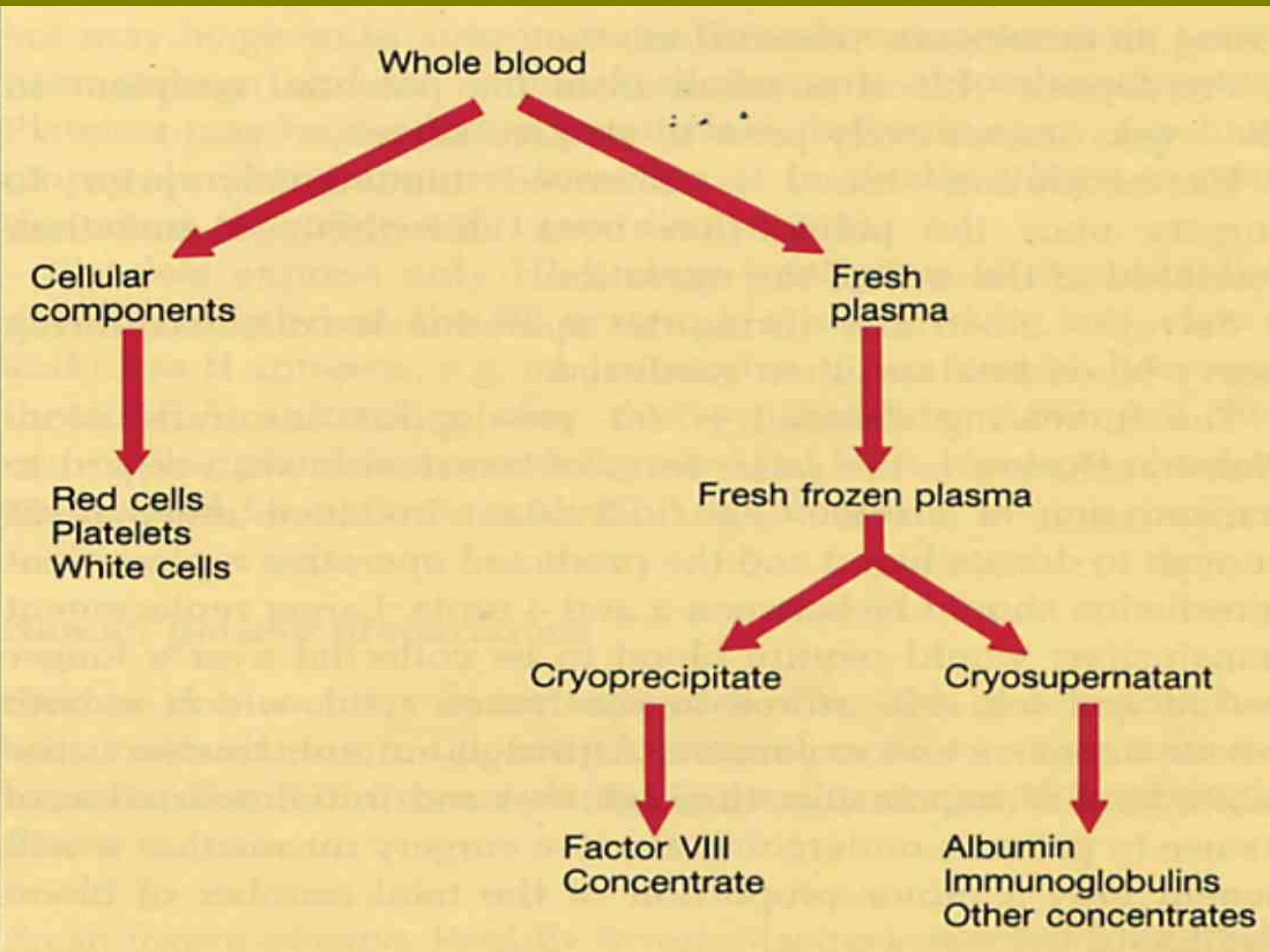
1. The recipient : indication and assessment
2. The donor : selection and assessment
3. The blood : type, storage and assessment

Steps of blood transfusion

During and after blood transfusion

1. **Procedure.**
2. **Complications of blood transfusion:**
   - A. **Infectious**
   - B. **Non- infectious:**
     1. Immunological complications
     2. Non-immunological complications

The recipient


Whole blood
Cellular components
Fresh plasma
Red cells
Platelets
White cells
Fresh frozen plasma
Cryoprecipitate
Cryosupernatant
Factor VIII Concentrate
Albumin
Immunoglobulins
Other concentrates

Red blood cells

- Goals :

To increase the oxygen-carrying capacity of the blood and, in turn, to maintain satisfactory tissue oxygenation.

- RBC are also indicated for exchange transfusion:
  - Sickle cell disease
  - Severe parasitic infection (malaria, babesiosis)
  - Severe methemoglobinemia
  - Severe hyperbilirubinemia of newborn

Factors to be considered in the decision to transfuse RBCs

1. Hemoglobin concentration
2. The patient's symptoms, signs, and compensatory capacities.
3. The presence of cardiorespiratory, vascular, and central nervous system disease.
4. The cause and anticipated course of the anemia.
5. The availability of alternative therapies, such as recombinant human erythropoietin (EPO) therapy (chronic renal insufficiency).

GUIDELINES FOR PEDIATRIC RED BLOOD CELL TRANSFUSIONS

- CHILDREN AND ADOLESCENTS

  Acute loss of > 25% of circulating blood volume

  Hemoglobin < 13.0 g/dL and *severe* cardiopulmonary disease

  Hemoglobin < 8.0 g/dL in the perioperative period

  Hemoglobin < 8.0 g/dL and *symptomatic* chronic anemia

  Hemoglobin < 8.0 g/dL and *marrow failure*

- INFANTS ≤ 4 MO OLD

  Hemoglobin < 13.0 g/dL and *severe* pulmonary disease

  Hemoglobin < 10.0 g/dL and *moderate* pulmonary disease

  Hemoglobin < 13.0 g/dL and *severe* cardiac disease

  Hemoglobin < 10.0 g/dL and *major* surgery

  Hemoglobin < 8.0 g/dL and *symptomatic* anemia

Anemia of term neonate

- The first 7- 10 days : loss of 7- 10 % of blood volume … no need for intervention .
- In healthy term infants : the nadir hemoglobin in physiological anemia is 9 g/dL at an age of 8 -12 wk .
- The cause is thought to be the unresponsiveness of bone marrow to hypoxia until a given threshold .
- This “physiologic” drop in RBCs does not require transfusions.

Anemia of preterm neonate

- in sick premature infants: the decline is due to phlebotomy.
- In premature infants : the mean hemoglobin concentration falls to approximately 7 g/dL , between 6 and 12 w of age , as physiological anemia.
- Most infants with birthweight <1.0 kg experience significant “anemia of prematurity” and need RBC transfusions.
- The nadir hemoglobin values of premature infants are lower than those of term infants due to :

1. In response to anemia; liver is less responsive than the kidneys to anemia and tissue hypoxia.
2. A sluggish EPO response to falling hematocrit values.
3. Diminished plasma EPO level
4. The EPO disappears more rapidly from the plasma in infants than in adults (i.e., rapid clearance or metabolism).

Precautions

- With chronic anemia, children compensate well and may be asymptomatic despite low hemoglobin levels.

- Patients with iron deficiency anemia are often treated successfully with oral iron alone, even at hemoglobin levels < 5 g/dL, except in case of symptomatic anemia (HF, disturbed consciousness).

Hemolytic anemia

- **Acute hemolytic anemia** : (e.g. G6PD def)
  - Give blood if Hb < 7 or
  - persistent hematuria with Hb of 9 g/dl .
- **Chronic hemolytic anemia :**
  1. **SCA** : target Hb 7- 11 g/dl , so give blood if Hb < 7 or with major crisis despite Hb level ; ± partial exchange .
  2. **Thalassemia** : target Hb 9.5 – 10.5 g /dl :
     - If Hb 9.5 – 10.5 g /dl : give 15cc/kg PRBC every 3 w.
     - If >10.5 don't transfuse , repeat next w .
     - If < 9.5 transfuse the same blood and look for causes.

Dosage and administration

- One unit of RBC will raise the hemoglobin by ~1g/dL (or raise HCT ~3%)
- ABO /Rh compatibility .
- 250 ml red cells /unit, reserved in 1-6 ^{o}C for 42 days.
- Rate : **60-180 minutes per unit , 2-3 ml /kg/ h**

GUIDELINES FOR PEDIATRIC PLATELET TRANSFUSION

- CHILDREN AND ADOLESCENTS

  PLT count < 50 x 10^9/L and bleeding.

  PLT count < 50 x 10^9/L and an *invasive* procedure .

  PLT count < 20 x 10^9/L and *marrow failure* with hemorrhagic risk factors.

  PLT count < 10 x 10^9/L and *marrow failure* without hemorrhagic risk factors.

  PLT count at any level, but with PLT dysfunction plus bleeding or an invasive procedure.

- INFANTS ≤ 4 MO OLD

  PLT count < 100 x 10^9/L and bleeding or during extracorporeal membrane oxygenation.

  PLT count < 50 x 10^9/L and an invasive procedure.

  PLT count < 20 x 10^9/L and *clinically stable.*

  PLT count < 50 x 10^9/L and *clinically unstable.*

  PLT count at any level, but with PLT dysfunction plus bleeding or an invasive procedure.

platelet transfusion

- **Goal** :

1. Raise the PLT count above $50x10^9/L$
2. Raise PLT for neonates to $\geq 100 \times 10^9/L$.

- **Dose** : 5 to 10 mL/kg up to 30 kg of standard (unmodified) PLT concentrates.
- **Time** : rapidly as tolerated , usually within 30 to **60 minutes.**

- Patients requiring repeated PLT transfusions should receive leukocyte-reduced blood products, including PLT concentrates, to diminish alloimmunization and PLT refractoriness and to reduce the risk of transfusion-transmitted cytomegalovirus infection.
- It is important to select PLT units for transfusion with the ABO group identical to that of the recipient ,and Rh for pregnant.
- Avoid repeated transfusion of group O PLTs to group A or B recipients, because passive anti-A or anti-B in group O plasma can lead to hemolysis.

GUIDELINES FOR PEDIATRIC GRANULOCYTE TRANSFUSIONS

- **CHILDREN AND ADOLESCENTS**

1. Severe neutropenia (blood neutrophil count <0.5 x 10^9/L) and infection (bacterial, yeast, or fungal) *unresponsive or progressive* despite appropriate antimicrobial therapy.
2. Qualitative neutrophil defect and infection (bacterial or fungal) *unresponsive* to appropriate antimicrobial therapy

- **INFANTS ≤4 MO OLD**

✓ Blood neutrophil count <3.0 x 10^9/L in 1st wk of life or <1.0 x 10^9/L thereafter and *fulminant* bacterial infection

- **Dose** :
  1. Neonates and infants weighing < 10 kg : 1-2 x 10^9/kg neutrophils .
  2. Larger infants and children: 1 x 10^{10} neutrophils.
  3. Adolescents :5-8 x 10^{10} .
- Granulocyte should be given daily until either the infection resolves or the blood neutrophil count is sustained above 1.0 x 10^9/L for a few days.
- Recombinant granulocyte colony-stimulating factor (G-CSF) plus dexamethasone has led to good results.

GUIDELINES FOR PEDIATRIC PLASMA TRANSFUSIONS

1. *Severe* clotting factor deficiency AND bleeding
2. *Severe* clotting factor deficiency and an invasive procedure.
3. *Emergency reversal* of warfarin effects.
4. Dilutional coagulopathy and bleeding (e.g., massive transfusion).
5. Anticoagulant protein (antithrombin III, proteins C and S) replacement.
6. Plasma exchange replacement fluid for thrombotic thrombocytopenic purpura or for disorders in which there is risk of bleeding due to clotting protein abnormalities (e.g., liver failure).

- Transfusion of plasma is efficacious for the treatment of deficiencies of clotting factors II, V, X, and XI.

- Deficiencies of factor XIII and fibrinogen are treated with cryoprecipitate.

- Transfusion of plasma is not recommended for the treatment of patients with severe hemophilia A or B, von Willebrand disease, or factor VII deficiency, because safer factor VII, VIII, and IX concentrates are available.

PLASMA TRANSFUSION

- 100 - 150 ml/unit ; contain all coagulation factors
  at - 20^{o}C x 12 months
- **Dose:** 15 mL/kg .
- 1 unit FFP will increase most coagulation factors by 3-5%.
- **Rate:** 30 minutes per unit
  (i.e. 10-20mL/kg/hr).

Measures to protect the recipient

- Donor selection
- Donor deferral/exclusion
- Microbiological testing of donations
- Immunohaematological testing of donations
- Stringent arm cleansing
- Diversion of the first 20–30 mL of blood collected
- Leucodepletion of cellular products

Important steps in blood administration

1. Ensure proper recipient identification*, ABO compatibility and Rhesus suitability of the product.*
2. Inspection of the blood bag for product appearance and any leaks.
3. Ensure that the administration set has an in-line filter.
4. Do not add to or infuse blood with any fluid or medication.
5. Vital signs should be taken before the transfusion.
6. The duration of a red cell transfusion is optimally 1½ hours, but should not exceed 4 hours.

Important steps in blood administration 2

7. The initial rate :1-2 ml/minute for 15 minutes to detect and respond to sudden severe unexpected events, i.e., acute hemolysis, bacterial sepsis, or anaphylaxis.
8. Vital signs should be taken after the transfusion or at any time if a reaction occurs.
9. If a reaction occurs, stop the transfusion, maintain an open IV line with saline and evaluate .
10. Avoid sampling from or above the IV site during, or immediately after, the transfusion.
11. If the transfusion is uneventful, discard the empty bag in a manner consistent with the disposal of biologic waste.

Infusion rates and precautions

- The infusion rate for blood products depends on the clinical context, age and cardiac status of the patient. In stable, non-bleeding adult patients typical administration durations are:
- For patients at risk of circulatory overload e.g. cardiac failure, it is usually necessary to transfuse more slowly with frequent monitoring. Concomitant use of diuretics should also be considered.
- Patients with acute bleeding or who are in hypovolemic shock require blood components to be transfused rapidly. The use of a blood warmer is recommended in critical bleeding / massive transfusion situations.

The donor

- Criteria of selection/ exclusion .
- Deferral
- Interval

Donor criteria

Category **Criteria**

1 **Age** ≥17 years –70 years

2 **Blood volume** ≤ **of 10.5 mL /kg**

3 **Donation interval** 8 weeks after whole blood donation

16 weeks after two-unit red cell collection

4 weeks after infrequent apheresis and 2 days after plasma-, platelet-,or leukapheresis

(Three donations per year maximum)

Donor criteria

	Category	Criteria
4	**Blood pressure**	less than 180 mm Hg systolic less than 100 mm Hg diastolic
5	**Pulse**	50–100 beats per minute, without pathologic irregularities <50 acceptable if an otherwise healthy athlete
6	**Weight**	>50 kg

Donor criteria

Category **Criteria**

7 **Temperature** ≤ 37.5°C (99.5°F)

(if measured orally, or equivalent if measured by another method)

8 Hemoglobin ≥12.5g/dL for men, 12 g/dL for women

hematocrit ≥38%

(blood obtained by earlobe puncture shall not be used for this determination)

9 Drug therapy Medication evaluation:

Finasteride (Proscar, Propecia), isotretinoin (Accutane)—Defer 1 month after—last dose

Dutasteride (Avodart)—Defer 6 months after last dose—

Acitretin (Soriatane)—Defer 3 years after last dose—

Etretinate (Tegison)—Defer indefinitely—

Ingestion of medications that irreversibly inhibit plated function (e.g.,—aspirin) within 36 hours of donation precludes use of donor as sole source of platelets

Donor deferral/ exclusion

1) All potential donors at risk of HIV (sexual practices, piercing, tattooing)
2) Donors with history of hepatitis deferred until 12 months after recovery
3) Exclusion of all potential donors who have themselves received a blood transfusion
4) Exclusion of those who have received pituitary-derived hormones or cadaveric dura mater or corneal grafts, and those with family history of CJD
5) Exclusion of those whose travel history places them at risk of malaria, Chagas' disease (unless antibody test available) and SARS

6- Exclusion of those with:

- Known cardiovascular disease, including hypertension
- Significant respiratory disorders
- Epilepsy and other CNS disorders
- Gastrointestinal disorders with impaired absorption
- Insulin-dependent diabetes
- Chronic renal disease
- Ongoing medical investigation or clinical trials
- Pregnant and lactating women because of high iron requirements
- Any donor returning to occupations such as driving bus, plane or train, heavy machine or crane operator, mining, scaffolding, etc.(delayed faint).

Permanent exclusion of any donor who has had filariasis, bilharzias, yaws or Q fever.

Exclusion for varying time periods following vaccinations

Exclusion after known exposure to infectious illnesses such as varicella.

Exclusion of anyone with a malignant condition except fully excised BCC of skin

Exclusion of those with diseases of unknown origin, e.g. Crohn's disease

Donor deferral for most drugs based on the underlying illness, e.g. cardiovascular, diabetes, malignancy, anaemia

Exclusion of those taking teratogenic drugs or those that accumulate in the tissues.

Those with severe allergic disorders should not give blood because recipients may develop temporary hypersensitivity reactions due to passively transfused antibodies.

Minor red cell abnormalities

Donors with minor red cell abnormalities, such as thalassaemia trait, sickle cell trait and hereditary spherocytosis, are perfectly acceptable, providing that the haemoglobin (Hb) screening test excludes anaemia.

Red cells containing HbS have a limited survival under conditions of reduced oxygen tension and so should not be transfused to newborn infants and patients with hypoxia or sickle cell disease.

Blood from donors with G6PD deficiency survives normally, unless the recipient is given oxidant drugs.

Volume of blood taken

Modem blood collection packs are designed to hold 450 ± 45 mL of blood, mixed with 63 mL of citrate–phosphate–dextrose– adenine (CPD-A) anticoagulant. The ratio of anticoagulant to blood must be maintained at the optimal level, and donations of less than 405 mL or more than 495 mL of blood should not be issued for clinical use. Healthy donors can generally withstand the loss of 450 mL of blood without any ill effect, but vasovagal reactions become more common in those who weigh less than 47.5–50.0 kg (105–110 lb), as the standard donation represents a greater proportion of their total blood volume.

Donation intervals

- A donation of 450 mL of blood contains approximately 200 mg of iron, which is lost to the body. Studies have shown depletion of iron stores in those who give three or four blood donations per year, but overt iron deficiency anaemia is uncommon except in female donors of childbearing age. In general, donors are bled two or three times per year in the UK (minimum interval 16 weeks), but some donors are able to donate more frequently without any significant iron depletion.
- When it is standard practice to take donations at shorter intervals, appropriate monitoring and/or iron supplements are recommended.

AUTOLOGOUS DONATION

Patients may give blood for themselves before elective surgery (preoperative) or have their blood returned during the operative procedure (intraoperative).

Preoperative autologous donation requires a donor who is healthy enough to give blood, but who is undergoing an operative procedure in the next 6 weeks that usually requires blood.

Autologous donors can be drawn with lower hemoglobin standards (≥11 g/dL) and drawn weekly, but blood should not be drawn for a few days immediately before surgery to allow blood volume to be restored.

Intraoperative salvage may be useful for procedures with large anticipated blood losses retrievable from a body cavity, such as for cardiovascular surgery.

DIRECTED DONATION

Directed donation is the donation of blood that is then specified for the use of a particular patient.

LIMITED DONOR EXPOSURE

It is at least theoretically desirable to limit the
number of donor exposures to a given recipient.

Donor selection and screening

A focused health history, and a limited physical examination, on the day of donation.

This process is designed to ensure, to the extent possible, that the donor is healthy enough to donate, and that the resulting blood will be as safe and effective for transfusion as possible.

Donor information

Donors are given written information that explains the donation process, complications of donation, signs and symptoms of human immunodeficiency virus (HIV) infection, what constitutes high-risk behavior, confidentiality, and the fact that they will be notified of positive test results.

Hazards of blood donation

The most common hazard of blood donation is **fainting**, reported in between 2% and 5% of all donors, but being especially common in young people and in those donating for the first time, particularly if they are nervous or apprehensive.

A sympathetic approach by blood collection staff, enforcement of an adequate rest period, and constant vigilance to detect warning signs of an impending vasovagal attack can help to avert this problem.

Once a faint occurs, the standard treatment of rest in a horizontal position and elevation of the legs is usually sufficient. Delayed faints occurring after a donor has left the clinic are potentially hazardous and a contraindication to further donation.

For this reason, those donors who are drivers, machine operators, scaffolders and so on should not return to work on the day of donation. Infection of the venepuncture site should be avoided by meticulous attention to skin cleansing and aseptic techniques.

Hazards of blood donation

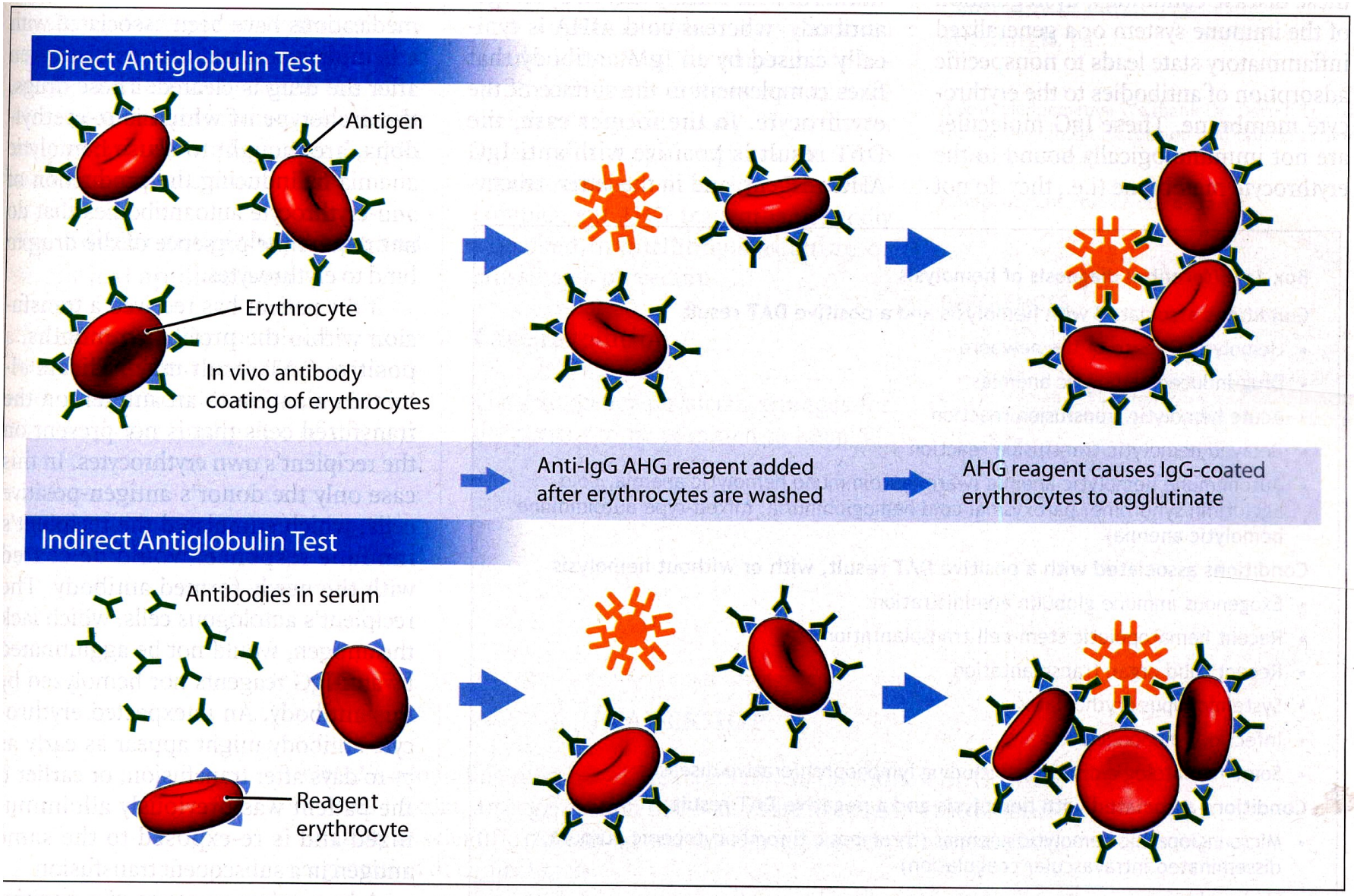
All blood collection packs are manufactured as integral sets, each needle is sterile, to be used only once. No pack should be reused (even on the same donor) if the initial venepuncture attempt fails.

Bruising of the arm may occur, particularly when venous access has been difficult; firm pressure over the site for 2–3 min and an explanation to the donor are usually sufficient.

In the very rare event of arterial puncture, elevation of the limb and firm pressure over the site for 10–15 min should be combined with prolonged rest if a whole donation has been taken, as the rate of blood donation under such circumstances is usually very rapid. Very occasionally, attempted venepuncture may result in trauma to the nerves in the arm, resulting in **pain, paraesthesiae and numbness**. Such symptoms generally resolve in a few days, but very rarely may take several months of recovery.

Hazards of transfusion

Immune	*Non-immune*	
Febrile non-haemolytic transfusion reactions Acute haemolytic transfusion reactions: intravascular (IgM), extravascular (IgG) Allergic reactions (urticarial) Anaphylactic reactions (anti-IgA) TRALI (transfusion-related acute lung injury)	*Bacterial: acute sepsis or endotoxic shock* Hypothermia Hypocalcaemia Air embolism rare	*Acute*
Delayed haemolytic transfusion reactions (due to anamnestic immune responses with red cell alloantibodies) Post-transfusion purpura (PTP) Transfusion-associated graft-versus-host disease (TA-GvHD) Immune modulation	*HIV* Hepatitis C Hepatitis B CMV Others: parvovirus B19; hepatitis A; malaria; Chagas' disease; brucellosis; syphilis.	*Delayed (days to years* after transfusion)


Direct Antiglobulin Test
Antigen
Erythrocyte
In vivo antibody coating of erythrocytes
Anti-IgG AHG reagent added after erythrocytes are washed
AHG reagent causes IgG-coated erythrocytes to agglutinate
Indirect Antiglobulin Test
Antibodies in serum
Reagent erythrocyte

USE OF THE DAT:

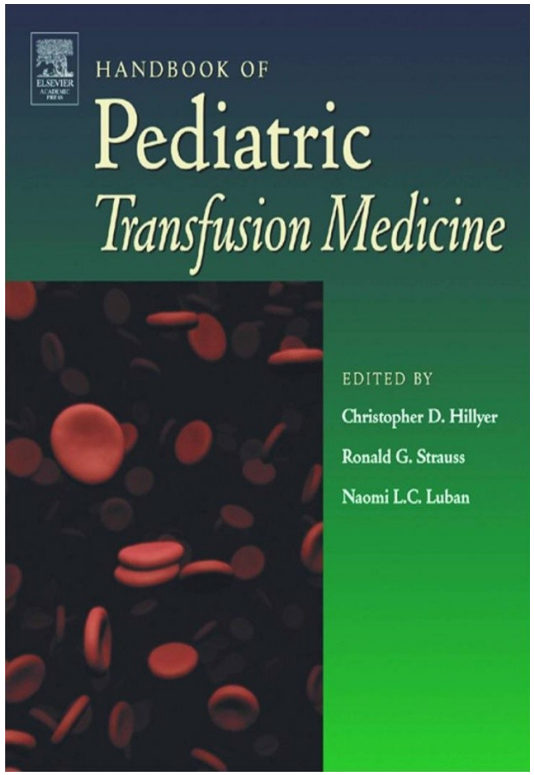
Diagnosis of:

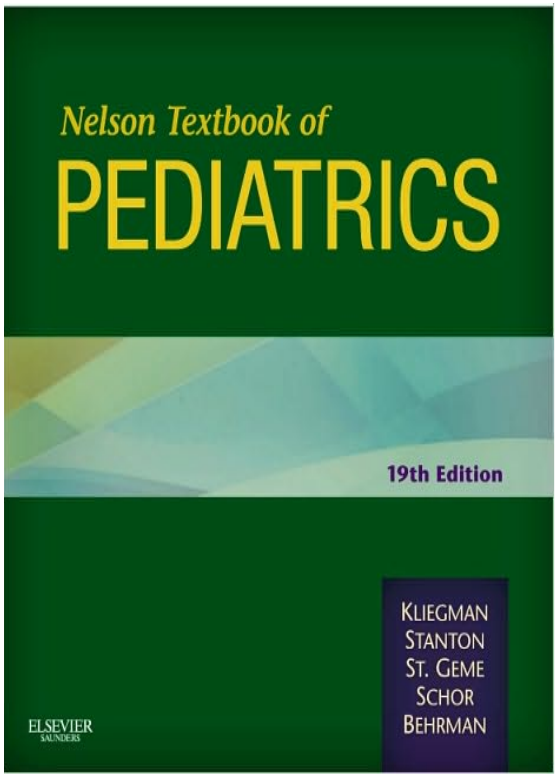
- Haemolytic Disease of the Newborn (HDN)
- Autoimmune Haemolytic Anaemia (AIHA)
- Drug related Haemolysis
- Haemolytic Transfusion Reaction

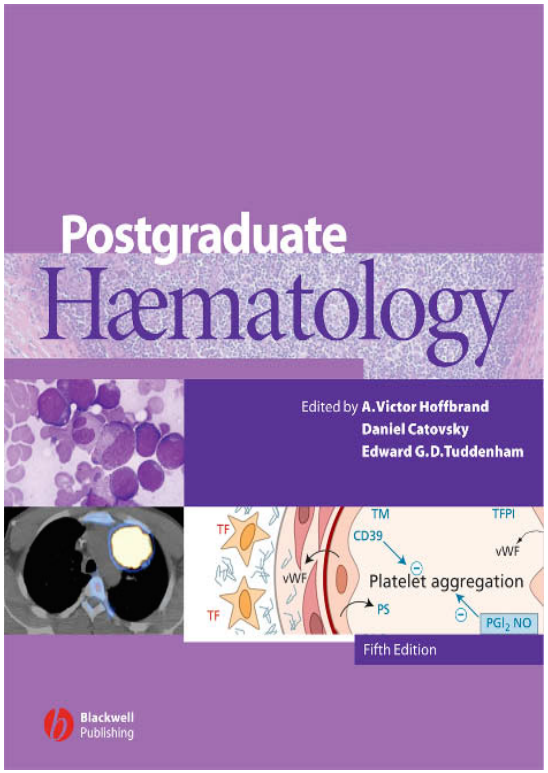
USE OF THE IAT:

- Detection of unexpected antibodies
- Phenotyping or detection of red cell antigens
- Crossmatching

REFERANCES







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THANK YOU