Blood Products and Transfusion

Surgery Team

MED 433

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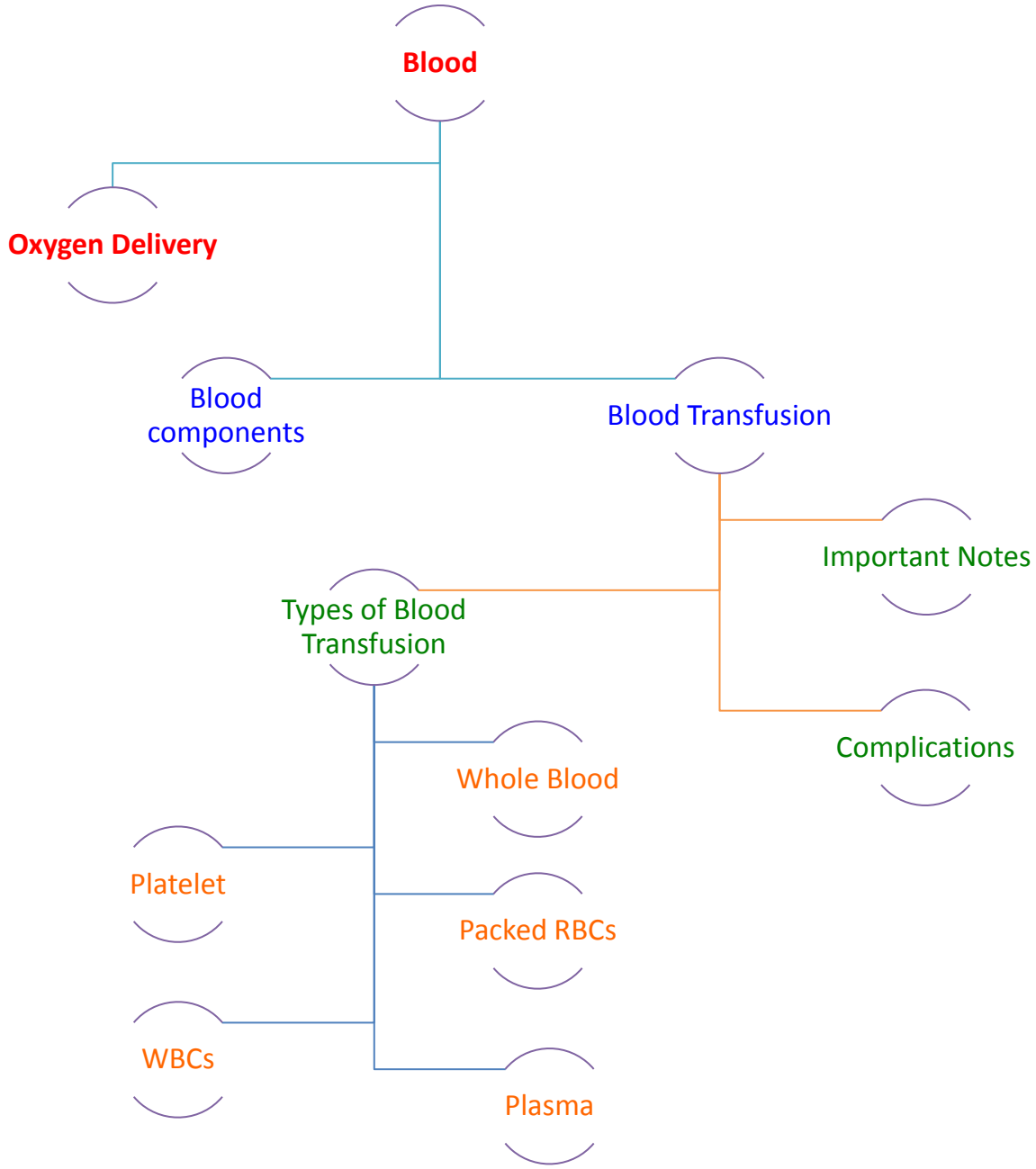
Objectives :

1. **Blood Donation**
2. **Blood Components** (Fresh Blood Components, Plasma Fractions)
3. **Red Cell Serology**
4. **Indications For Transfusion** (ABO Antigens, Rhesus Antigens, Other Red Cell Antigens)
5. **Pre-transfusion Testing**
6. **Blood Administration**
7. **Adverse Effects Of Transfusion**
8. **Autologous Transfusion** (Pre-operative Donation, Isovolaemic Haemodilution, Cell Salvage)
9. **Transfusion Requirements In Special Surgical Settings** (Massive Transfusion, Cardiopulmonary Bypass)
10. **Methods To Reduce The Need For Blood Transfusion** (Acute Volume Replacement, Mechanism For Reducing Blood Use In Surgery)
11. **Better Blood Transfusion**
12. **Future Trends**

Sources : Slides, Raslan's Notebook, Principles & Practice of Surgery by: O. James Garden

Color Index : Slides & Raslan's | Textbook | Doctor's Notes | Extra Explanation

Mind Map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Whole Blood
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Plasma

Oxygen Delivery

- Oxygen Delivery (DO_2) is the oxygen that delivered to the tissues

  DO_2= COP x CaO_2

- Cardiac Output (CO) = HR x SV
- Oxygen Content (CaO_2):
  - (**Hgb** x 1.39)O_2 saturation + PaO_2(0.003)

  Hgb is the main determinant of oxygen content in the blood

- Therefore: **DO_2 = HR x SV x CaO_2**
- If HR or SV are unable to compensate, Hgb is the major deterimant factor in O_2 delivery
- Healthy patients have excellent compensatory mechanisms and can tolerate Hgb levels of 7 gm/dL.
- Compromised patients may require Hgb levels above 10 gm/dL.

(Patients with any cardiac problem "Beta Blocker , Ischemic , heart failure …etc").

"*Transfusion Trigger*": Hgb level at which transfusion should be given.

Varies with patients and procedures

- Tolerance of acute anemia depends on:
  - Maintenance of intravascular volume
  - Ability to increase cardiac output
  - Increases in 2,3-DPG to deliver more of the carried oxygen to tissues

Blood Component

- Blood contains :
  - Red Blood Cells RBCs.
  - White Blood Cells WBCs.
  - Platelets.
  - Plasma:
    - Cryoprecipitate
    - Others (include Plasma protiens IV Ig, Coagulation Factors, albumin, Anti-D, Growth Factors, Colloid Volume Expanders).

- whole blood is donated by healthy adult volunteers over the age of 17 years with normal haemoglobin levels. The standard 480 ml donation contains approximately 200 mg of iron.
- Donated whole blood is collected into an **anticoagulant** (citrate) and **nutrient** (phosphate and dextrose) **solution** (CPD).

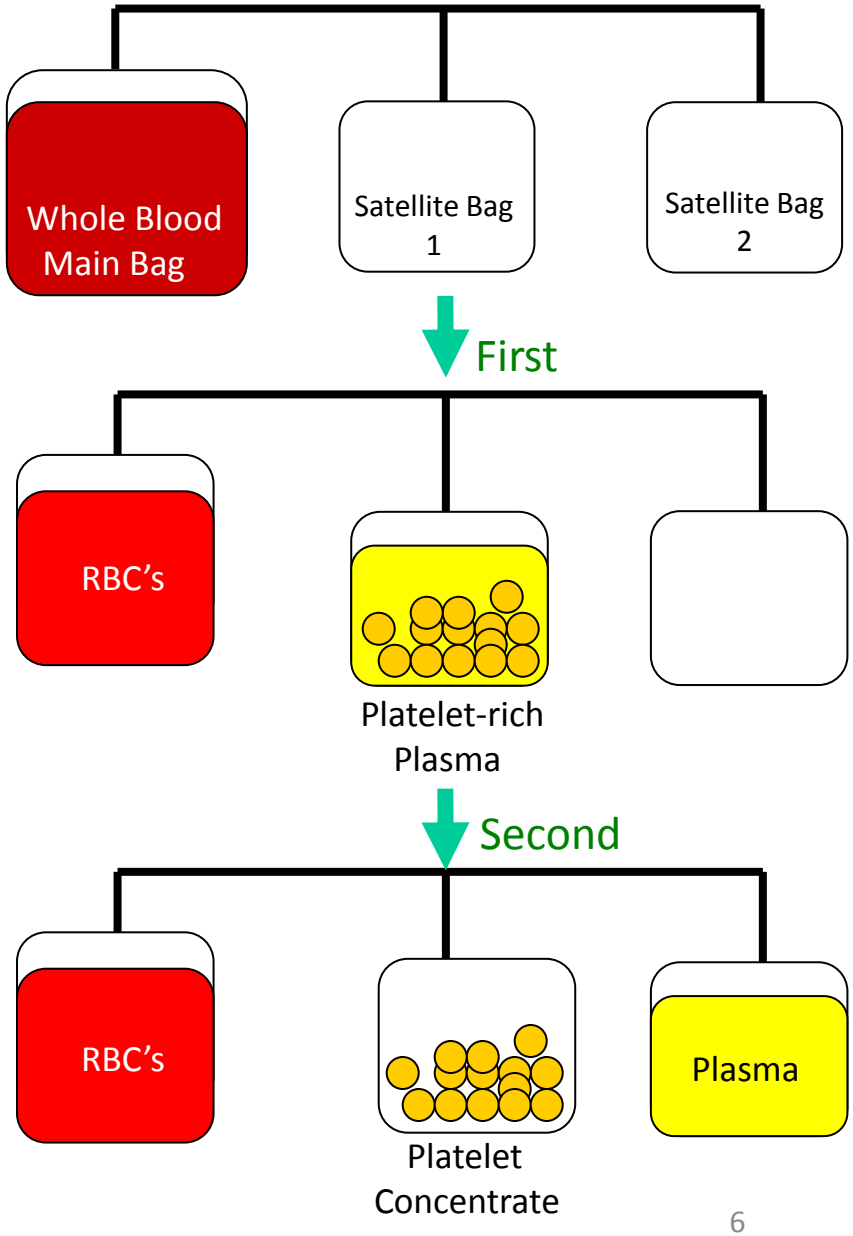
- Blood components can be separated from the donated blood or obtained from the donor as separate products by the use of a cell separator, in a process called apheresis.

Blood Transfusion important notes

- Centrifugation removes virtually all of the associated plasma, and a solution of saline, adenine, glucose and mannitol is then added to provide optimal red cell preservation.
- Differential Centrifugation:
  - 1st centrifugation: separates RBCs from platelet rich plasma.
  - 2nd centrifugation: separates Platelet from plasma

- Because of the high risk of infections, blood should not be transfused in unnecessary cases, instead we give colloids or crystalloids to compensate the volume loss. **Up to 30% of blood volume loss can be treated with crystalloids**

- Before going through with the blood transfusion, we take a blood sample from the donor to:
  - Avoid transmitted infections by doing a screening test
  - Blood group ABO testing (no need to do it in plasma or platelets donation)
  - Cross match test **Rh test** (+ve = Rh group antigen)



Blood Transfusion important notes

- **60% of transfusions occur perioperatively.**
- Indications of Blood transfusion:
  1. **Increase Oxygen carrying capacity**
  2. Restoration of red cell mass
  3. Correction of bleeding induced by: a. platelet dysfunction or thrombocytopenia
     b. Coagulation factors deficiency
- Considering Filter in blood transfusion is for Whole blood, RBCs, Fresh Frozen Plasma FFP to avoid any clot or debris and transmission of virus. Platelets don't have to undergo filtering otherwise they will be damaged.

  Filter Size :
  - 170 micro
  - 20-40 micro " in case of immunocompromised patients"
- **Leukocyte Reduction Filters :** used for prevention of transfusion reactions

Used with RBCs, Platelets, FFP, and Cryoprecipitate. Other plasma components (albumin, colloid, factors…etc) do not need filters

Never use filter with stem cell/ bone marrow infusions

- Blood Testing :

Type & Screen

Donated blood that has been tested for ABO/Rh antigens and screened for common antibodies (not mixed with recipient blood).

- Used when usage of blood is unlikely, but needs to be available (hysterectomy).
- Allows blood to available for other patients.
- The incidence of a serious hemolytic reaction after transfusion of an ABO-Rh compatible transfusion with a negative screen is less than 1%.

Cross match

Major: (NOT part of a type and screen) **Donor's erythrocytes incubated with recipients plasma** reduces the risk of a serious hemolytic reaction to essentially zero.

Minor:- Donor's plasma incubated with recipients erythrocytes for FFP & Platelets

Agglutination occurs if either is incompatible

Types of Blood Transfusion

	WHOLE BLOOD	PLATELETS	PLASMA	CRYPRECIPITATE
Storage	○ 4° for up to 35 days, with (Mannitol, Adisol, Nutrisol) it lives up to 42 days. ○ Transported in 1-10° . ○ Storage of whole blood can have a risk of coagulopathy cause it affects coagulation factors especially factor V & VIII	○ 20-24° up to 7 days	○ Frozen : 18° up to 12 months ○ Fresh : must be given within 2 hours	○ Is low purity concentrate of 3 hemostatic proteins prepared from donated whole blood
Indications	○ Massive Blood Loss (Trauma) ○ Exchange Transfusion (Thalassemia sickle cell anemia) "it increases volume expansion"	○ Thrombocytopenia < 15.000 ○ Bleeding ○ Invasive Procedure } < 50.000 "it increases volume expansion"	○ Massive or exchange transfusion. ○ Coagulation factor deficiency ○ Fibrinogen replacement ○ Liver disease ○ Disseminated intravascular coagulation (DIC)	○ hypo-fibrinogenemia <100mg/dl & Hemophilia
Considerations	○ Use filter. ○ <u>Donor & Recipient must be ABO identical.</u> ○ Need to warm up to avoid hypothermia.	○ Don't need Filter, or warming. ○ <u>Donor & Recipient must be ABO identical</u> ○ Contains : Leukocytes & Cytokines. ○ 1unit/ 10kg of body weight can increase platelets count by 5000-10.000	○ <u>Donor & Recipient must be ABO identical.</u> ○ In children, should also be Rh compatible. ○ Contains : Coagulation factors ○ Usual dose is 20cc/ kg can rise coagulation factors by 20%	○ No compatibilty test required ○ A single bag Cryo contains: 100units factor VIII and VWF+150-250mg fibrinogen with XIII and fibronectin

Types of Blood Transfusion

Packed RBCs

Storage	Indications	Considerations
○ 4° for up to 42 days, can be frozen too. ○ Life span of RBCs depend on the preservative used.	Anemia Hypoxia Mild bleeding ..etc	○ Should never be given directly, must be diluted with saline "Not LR (lactate ringer) has Calcium which may cause clotting" ○ Donor & Recipient must be ABO identical. ○ Transfuse over 2-4hours but slower for chronic anemia. ❑1 unit = 250 ml. Hct. = 70-80%. ❑1 unit pRBC's raises Hgb 1 gm/dL.

Preparation

Type & screen RBCs for :
ABO and Rh for both donor & recipient , screen for atypical antibodies, viral screening
Crossmatching : Donor cells & recipient serum are mixed & evaluated for agglutination to prevent hemolysis reaction. Duration: 30-45 minutes.
** in case of ER, we don't have time to do crossmatching, so we only give patients O-ve "universal donor".

Administration

Dose: Usual dose of 10 cc/kg infused over 2-4 hours. Maximum dose 15-20 cc/kg can be given to hemodynamically stable patient
Procedure: May need Premedication (Tylenol)
Filter use—routinely leukodepleted
Monitoring—VS q 15 minutes, clinical status
Do NOT mix with medications
Complications: Rapid infusion may result in Pulmonary edema

Check Raslan's booklet p50 for extra information.

Blood Transfusion Complications

Physical	Immunological	Biochemical	Infection
- Circulatory overload - Embolism (air, micro aggregate) - Hypothermia	- Pyrogenic - Type 1 hypersensitivity - Graft versus host reactions	- Acid base disturbances - Hyperkalaemia - Citrate toxicity - Impaired oxygen release	- Acute Hemolytic transfusion reaction - Disseminated intravascular coagulation

Or in another classification:

A. Acute Transfusion Reaction.

A. Acute hemolytic transfusion reaction **(MOST important complication)**
B. (non-hemolytic) : a. febrile reaction b. Allergic reaction
C. Transfusion related ACUTE LUNG INJURY
D. Coagulopathy with massive Transfusion
E. Bacteremia

B. Chronic Transfusion Reaction.

Delayed, might take 2-20 days for the reaction to start:

-Alloimmunization
-Transfusion Associated Graft Versus Host Disease (GVHD) o Iron Overload.
-Transfusion Transmitted Infection.

D. Transfusion Associated Infections.

-Hepatitis C and Hepatitis B
-HIV
-CMV: CMV can be diminished by leukoreduction, which is indicated for immunocompromised patients

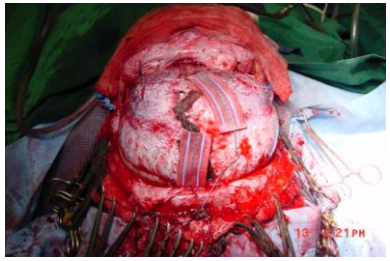
Autologous transfusion

Pre-operative donation: **"Pre-deposit transfusion"**

-blood collection begins 3-5 weeks preoperatively
-2-4 units stored
-Eliminates risk of viral transmission
-Reduces risk of immunological reactions
-Collection is expensive and time consuming
-Only suitable for elective surgery
-Clerical error (the patient may get another blood from the blood bank)

Isovolaemic haemodilution: **"Intra-operative acute normovolemic hemodilution"**

-This technique is restricted to patients in whom significant blood loss (> 1000 ml) is anticipated
-Whole blood removed at start of surgery
-1-1.5L can be collected and stored in OR
-Re-infused during or after surgery
-Cheaper than pre-deposit
-Little risk of clerical error (because it stored in OR)
-Suitable for elective surgery
-Example craniosynostosis surgery see picture



Intra-operative cell salvage:

-Shed blood is collected from surgical field
-heparin added
-cells washed with saline and concentrated by centrifugation.
-concentrate transfused
-large volume could be used
-platelets and clotting factors are consumed
-Used in cardiac surgery, trauma surgery and liver transplantation
-Contraindicated in contaminated surgical field, also in patients with malignancy and sepsis

Transfusion requirements in special surgical settings

✸ Massive transfusion:

Transfusion of at least one blood volume or 10 units of blood in a 24 hr period

Complication: Disseminated Intravascular Coagulopathy

✸ Cardiopulmonary bypass:

✓Platelets and coagulation factors may be activated or lost in the extracorporeal circulation* during cardiopulmonary bypass at open heart surgery

*the circulation of blood outside of the body through a machine that temporarily assumes an organ's functions, for example, through a heart-lung machine

✓FFP and platelet transfusion may be needed to deal with postoperative bleeding.

✓Platelet transfusion is indicated if there is microvascular bleeding, or if the bleeding cannot be corrected surgically after the patient is off bypass and once heparin has been reversed with an appropriate dose of protamine sulphate.

Methods to reduce the need for blood transfusion

✸ Acute volume replacement:

✓In the initial resuscitation of patients with hemorrhagic shock, the adequacy of volume replacement is usually of much greater importance than the choice of fluid. A reasonable guide in adults is 1000 ml of crystalloid (0.9% saline or Ringer's lactate solution), followed by 1000 ml of colloid, and then replacement with red cells.

✓In the elderly and those with cardiac impairment, red cell replacement should be started earlier to maintain oxygen-carrying capacity without causing fluid overload.

✸ Mechanism for reducing blood use in Surgery:

✸ Preoperative:

✓When surgery is elective, significant reductions in blood use can be made by ensuring that the patient has a normal hemoglobin and by correcting any pre-existing anemia

✓Drugs that interfere with haemostasis, e.g. non-steroidal anti-inflammatory drugs, aspirin and warfarin, should be stopped where appropriate

✓An abnormal clotting screen or platelet count should be investigated and corrected prior to surgery.

Methods to reduce the need for blood transfusion

✸ Intraoperative:

✓The training and experience of the surgeon performing the procedure are the most crucial factors in reducing operative blood loss. The importance of particular surgical technique, with attention to bleeding points

✓Other techniques, such as posture, the use of vasoconstrictors and tourniquets, and avoidance of hypothermia, as these can have a significant impact on perioperative blood loss.

✓Certain pharmacological agents, e.g. antifibrinolytics such astranexamic acid, may significantly reduce the requirements for blood and are indicated in certain operative procedures.

✓Fibrin sealant mimics the final stage in the coagulation cascade, in which fibrinogen is converted to fibrin in the presence of thrombin, factor XIII, fibronectin and ionized calcium.

✓ Fibrin sealant has been used in vascular, cardiac and liver surgery and in situations where even small amounts of bleeding can be problematic (e.g. middle ear surgery).

✓Acute normovolaemic haemodilution and intraoperative blood salvage are two of the autologous methods of blood conservation that can be employed during surgery to reduce exposure to transfusion.

✸ Postoperative:

✓Postoperative cell salvage can reduce the need for allogeneic transfusion.

✓The decision to transfuse postoperatively should depend on several factors.

✓Blood transfusion should be limited to the amount of blood required to raise the haemoglobin above the transfusion threshold and/or achieve clinical stability, even if this is only 1 unit.

✓Appropriate use of antifibrinolytic drugs such as tranexamic acid and the routine prescribing of iron and folic acid also reduce postoperative transfusion.

Better blood transfusion:

✸In recent times, attention has been focused on blood transfusion practice for a number of reasons these include:
✓ Concerns about the transmission of vCJD by blood transfusion
✓Increased costs associated with new safety measures such as leucocyte depletion
✓Documented variations in transfusion practice and recommendations arising from the SHOT scheme.
✸Better Blood Transfusion (BBT) programmes have been established in many countries with the purpose of promoting the safe, efficient and appropriate use of blood components and plasma derivatives.

Future trends:

✸Although red cell substitutes are under development:
✓Fluorocarbon oxygen carriers have found limited clinical application and concerns have been raised around potential toxicity of haemoglobin solutions
✓Recombinant human erythropoietin raises haemoglobin levels in patients with chronic renal failure but its use in the wider clinical setting has been limited
✸The objective in managing surgical patients should be to minimize anaemia and bleeding and hence the need for transfusion.

Summary

- Oxygen Delivery is the oxygen that delivered to the tissues measured by this equation **DO_2= COP x CaO_2** and Hgb is the main determinant of oxygen content in the blood.
- Up to **30%** of blood volume loss can be treated with crystalloids and thus will help to decrease the infection or diseases that transmitted by blood transfusion .
- There are many types of blood transfusion such as, **WHOLE BLOOD** , **PLATELETS** , **PLASMA** , **CRYPRECIPITATE** , **Packed RBCs** .
- Blood Transfusion can causes many Complications such as, circulatory overload , type 1 hypersensitivity , acid base disturbances , acute hemolytic transfusion reaction , transfusion associated infections (Hepatitis C , Hepatitis B,HIV) .
- Autologous transfusion (Pre-operative donation , Isovolaemic haemodilution , Intra-operative cell salvage).
- There are many Methods to reduce the need for blood transfusion (Intraoperative, Postoperative,……) .

MCQs

1. RBCs can be stored at a temperature of ?
   A) 1c
   B) 4c
   C) 10c
   D) 18c
2. For a 70kg patient, 1 unit of platelets transfusion increases platelets count by approximately ?
   A) 500-1000
   B) 5000-10000
   C) 15000-20000
   D) 25000-30000
3. Regarding disseminated intravascular coagulation ?
   A) Platelet count is normal
   B) Coagulopathy profile is within normal
   C) There is high platelet consumption
   D) Cannot occur secondary to sepsis
4. Standard screening tests on donors blood include all the following EXEPT ?

   A) Hepatitis C
   B) Hepatitis B
   C) Rubella
   D) Syphilis

5. Blood transfusions may cause all of the following EXCEPT ?

   A) Microcirculation thrombosis
   B) Transmission of malaria
   C) Allergic reaction
   D) Bronchospasm

1.B 2.B 3.C 4.D 5.E

Thank You..

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