Fourth Stage

General Surgery

م.د. علي سلمان جاسم

Lecture 6

Blood transfusion

The transfusion of blood and blood products has become commonplace since the first successful transfusion in 1818. Although the incidence of severe transfusion reactions and infections is now very low, in recent years it has become apparent there is an immunological price to be paid from the transfusion of heterologous blood, leading to increased morbidity and decreased survival in certain population groups (trauma, malignancy).

Blood and blood products

1-Whole blood

Whole blood is now rarely available in civilian practice as it is an inefficient use of the limited resource. However, whole blood transfusion has significant advantages over packed cells as it is coagulation factor rich and, if fresh, more metabolically active than stored blood.

2-Packed red cells

Each unit is approximately 330 mL and has a hematocrit of 50–70 per cent. Packed cells are stored

in a SAG-M solution (saline–adenine–glucose–mannitol) to increase shelf life to 5 weeks at 2–6°C.

3-Fresh-frozen plasma

Fresh-frozen plasma (FFP) is rich in coagulation factors and is removed from fresh blood and stored at −40 to −50°C with a two-year shelf life. It is the first-line therapy in the treatment of coagulopathic hemorrhage. Rh-positive FFP may be given to a Rh-negative patient. However, it is possible for seroconversion to occur with large volumes of transfusion due to the presence of red cell fragments, So, rhesus D immunization should be considered.

4-Cryoprecipitate

Cryoprecipitate is a supernatant precipitate of FFP and is rich in factor VIII and fibrinogen. It is stored at −30°C with a two-year shelf life.

It is given in low: A-fibrinogen states A-factor VIII deficiency.

5-Platelets

Platelets are stored at 20–24°C and have a shelf life of only 5 days. Platelet

transfusions are given to patients with thrombocytopenia or with platelet dysfunction who are bleeding or undergoing surgery.

Patients are increasingly presenting on antiplatelet therapy such as aspirin or

clopidogrel for reduction of cardiovascular risk. Aspirin therapy rarely poses a problem but

control of hemorrhage on the more potent platelet inhibitors can be extremely difficult. Patients on clopidogrel who are actively bleeding and

undergoing major surgery may require almost continuous infusion of platelets during the course of the procedure.

6-Prothrombin complex concentrates: Prothrombin complex concentrates (PCC) are highly purified concentrates prepared from pooled plasma. They contain factors II, IX and X. Factor VII may be included or produced separately. It is indicated for the emergency reversal of anticoagulant (warfarin) therapy in uncontrolled hemorrhage.

Autologous blood :It is possible for patients undergoing elective surgery to pre-donate their own blood up to 3 weeks before surgery for re-transfusion during the operation.

during surgery blood can be collected in a cell-saver which washes and collects red blood cells which can then be returned to the patient.

Indications for blood transfusion

Blood transfusions should be avoided if possible, and many previous uses of blood

and blood products are now no longer considered appropriate use. The indications for blood transfusion are as follows

- acute blood loss, to replace circulating volume and maintain oxygen delivery
- perioperative anemia, to ensure adequate oxygen delivery during the perioperative phase
- symptomatic chronic anemia, without hemorrhage or impending surgery.

Transfusion trigger Historically, patients were transfused to achieve a hemoglobin >10 g/dL. This has now been shown to not only be unnecessary but also to be associated with an increased morbidity and mortality compared to lower target values. A hemoglobin level of 6 g/ dL is acceptable in patients who are not actively bleeding, not about to undergo major surgery and are not symptomatic.

Perioperative red blood cell transfusion criteria level (g/dL) Indications:

• <6 Probably will benefit from transfusion

• 6–8 Transfusion unlikely to be of benefit in the absence of bleeding or

impending surgery

• >8 No indication for transfusion in the absence of other risk factors

Blood groups and cross-matching

ABO system

These are strongly antigenic and are associated with naturally occurring antibodies in the serum. Blood group O is the universal donor type as it contains no antigens to provoke a reaction. Conversely, group AB individuals are 'universal recipients' and can receive any ABO blood type as they have no circulating antibodies

Rhesus system :The rhesus D Rh(D)) antigen is strongly antigenic and is present in approximately 85 per cent of the population.

Acquired antibodies are capable, during pregnancy, of crossing the placenta and, if present in a Rh(D)-negative mother, may cause severe hemolytic anemia and even death (hydrops fetalis) in a Rh(D)-positive fetus in utero.

Transfusion reactions:

If antibodies present in the recipient's serum are incompatible with the donor's cells, a transfusion reaction will result. This usually takes the form of an acute hemolytic reaction. Severe immune-related transfusion reactions due to ABO incompatibility result in potentially fatal complement-mediated intravascular hemolysis and multiple organ failure.

Transfusion reactions from other antigen systems are usually milder and self-limiting. Febrile transfusion reactions are non-hemolytic and are usually caused by a graft-versus-host response from leukocytes in transfused components. Such reactions are associated with fever, chills or rigors. The blood transfusion should be stopped immediately. This form of transfusion reaction is rare with leuko-depleted blood.

Cross-matching

To prevent transfusion reactions, all transfusions are preceded by ABO and rhesus typing of both donor and recipient blood to ensure compatibility. The recipient's serum is then mixed with the donor's cells to confirm ABO compatibility and to test for rhesus and any other blood group antigen–antibody reaction.

Full cross-matching of blood may take up to 45 minutes in most laboratories. In more urgent situations, only ABO/rhesus matched can be issued within 10–15 minutes. Where blood must be given emergently, group O (universal donor) blood is given.

Complications of blood transfusion

Complications from blood transfusion can be categorized as those arising from a

single transfusion and those related to massive transfusion.

Complications from a single transfusion Complications from a single transfusion include:

1- incompatibility hemolytic transfusion reaction

2- febrile transfusion reaction

3- allergic reaction

4- infection

- bacterial infection (usually due to faulty storage)
- hepatitis
- HIV
- malaria

5- air embolism

6- thrombophlebitis

7- transfusion-related acute lung injury (usually from FFP).

Complications from massive transfusion

Complications from massive transfusion include:

1- coagulopathy

2- hypocalcaemia

3- hyperkalaemia

4- hypokalaemia

5- hypothermia.

In addition, patients who receive repeated transfusions over long periods of time (e.g. patients with thalassaemia) may develop iron overload. (Each transfused unit of red blood cells contains approximately 250 mg of elemental iron.) Management of coagulopathy Correction of coagulopathy is not necessary if there is no active bleeding or hemorrhage is not anticipated.

However, coagulopathy following or during massive transfusion should be anticipated and managed aggressively.

Standard guidelines are as follows:

1- FFP if prothrombin time (PT) or partial thromboplastin time (PTT) >1.5 times normal

2- cryoprecipitate if fibrinogen <0.8 g/L

3- platelets if platelet count <50 × 109/mL.

There are pharmacological adjuncts to blood component therapy, although their indications and efficacy are yet to be established. Antifibrinolytics such as tranexamic acid and aprotinin are the most commonly administered. Recombinant

factor VIIa is also under investigation for the treatment of non-surgical hemorrhage.

Blood substitutes

Blood substitutes are an attractive alternative to the costly process of donating,

checking, storing and administering blood and due to the immunogenic and potential infectious complications associated with transfusion.

There are several oxygen-carrying blood substitutes under investigation in animal or early clinical trials. Blood substitutes are either biomimetic or abiotic. Biomimetic substitutes mimic the standard oxygen-carrying capacity of the blood and are hemoglobin based. Abiotic substitutes are synthetic oxygen carriers and are currently primarily per fluorocarbon based.