

Blood storage and transportation factors



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The primary objective of preservation, storage and transportation of blood and blood components is to preserve the viability and function of each relevant constituent, prevent any physical changes of the blood constituent during storage and minimize bacterial growth.

Various anticoagulant-preservative mixtures have been formulated with the ultimate goal of preventing clotting and to provide proper nutrition for cell metabolism during storage. This ensures that blood and blood components are kept therapeutically viable for a fixed time.

Anticoagulation and Preservation

Various anticoagulant-preservative solutions have been formulated for better red cell preservation, which are listed below:

Acid Citrate Dextrose (ACD)

Citrate phosphate Dextrose solution (CPD)

Citrate phosphate dextrose adenine. (CPDA-1)

Heparin

Citrate (Calcium chelator)if Prevents coagulation & retards glycolysis

Dextroseif improves red cell viability, provides energy for ATP synthesis & decreases rate of hydrolysis of phosphorus.

Adenine if helps maintain high ATP levels

ACD

CPD

CPDA-1

Storage time

21 days

21 days

35 days

Temperature

1-6°C

1-6°C

1-6°C

Adenine

None

None

Yes

Volume

450 ml \pm 10%

450 ml \pm 10%

450 ml \pm 10%

Heparinif inhibits coagulation, inactivates FXa, IXa, XIa, plasmin, potentiates action of antithrombin III

Heparinized blood is rarely recommended for routine blood collection because it has no preservative property and its anticoagulant properties are neutralized by plasma. Heparinized blood should be transfused within 48 hours of collection(preferably within 8 hours).

Additive Solution for Preservation of Red Cells:

Different types of additive systems are now in use. These solutions contain saline, adenine and glucose and are added to the red cells after separating them from plasma. The advantages of using additive solution to red cells are as follows:

Blood is collected into a multiple bag system including one plastic bag containing 100 ml of optimal additive solution.

After collection the whole blood is centrifuged and maximum amount of plasma along with the buffy coat is expressed into a transfer bag for further processing. Red cells are now suspended by running down the additive solution (100 ml) to the main bag containing the red cells.

Advantages of Additive Solutions:

Provide the red cells with adequate nutrients.

Better storage condition for red cell preparation and lowering of viscosity for ease of transfusion.

Increased yield of plasma for plasma fractionation.

Removal of unwanted buffy coat

Additional 7 day storage time for red cell preparation (storage time= 42 days)

Avoid unnecessary transfusion of plasma

Physical and Biochemical Effects of Storage (storage lesion)

The conditions of storage will invariably produce changes in the physical and chemical properties of blood and blood components and in turn effect red cell recovery. The medical officers must be aware of these in order to consider the clinical efficacy of transfusion.

Abnormalities resulting from storage of blood are collectively known as storage lesions. These can be discussed as:

1. Effect of collection on red cell recovery

The cell drawn at the start of donor bleeding are subjected to an acidic and hypotonic anticoagulant solution which results in irreversible damage to some of the cells. These cells, in contrast to those drawn towards the end, of phlebotomy, deteriorate more rapidly on storage.

2. Effect on red cell function and survival

A) Storage effect on red cell metabolism : The red cell is dependent on anaerobic glycolytic pathway for the formation of ATP, which plays a central role in determining its viability and maintaining its shape. During

preservation the metabolic cycle must continue in vitro for red cells to remain viable with adequate post transfusion survival and function.

B) Effect on O₂ release and 2, 3 Diphosphoglycerate (DPG): 2, 3 DPG is known to profoundly lower the affinity of Hb for O₂ at concentration found in red cells. Depletion of 2, 3 DPG in stored blood temporarily adversely affects oxygen release by Hb.

C) Effect on survival in almost all cases cells that survive 24 hrs will remain viable and circulate for the remainder of their expected life span.

Maximum allowable storage time, referred to as shelf life is defined by requirement of 70% recovery at 24 hrs i. e. at least 70% of the transfused red cells remain in the recipient's circulation 24 hrs after transfusion.

3. Effect on pH

There is a gradual fall in pH during storage due to accumulation of lactic acid.

4. Effect of temperature

Optimum storage temperature for whole blood and red cells is between 2-6°C with occasional elevation to 10°C (e. g. during transportation) being acceptable.

Delaying refrigeration increases the loss of 2, 3 DPG over this period.

Refrigeration and freezing additionally minimize proliferation of bacteria that might have entered the unit during venipuncture.

5. Effect on electrolytes & coagulation factors

A. Electrolytes The only important electrolyte change in stored blood is that of K. During blood storage there is a slow but constant leakage of K⁺ from cells into the surrounding plasma. In severe kidney disease even small amount of K⁺ fluctuations can be dangerous and relatively fresh or washed red cells are indicated.

B. Coagulation factors : Labile coagulation factors, Factors V and VIII lose their activity by 50% within 48-72 hrs of storage.

6. Effect on cellular elements

White cells lose their phagocytic and bactericidal property within 4-6 hrs of collection and become non-functional after 24 hrs of storage. It is important to remember that they do not lose their antigenic property and are capable of sensitizing the recipient to produce non-haemolytic febrile transfusion reactions.

Few lymphocytes may remain viable even after 3 weeks of storage.

Platelets lose their haemostatic function within 48 hrs in whole blood stored at 4°C.

Component preparation:

A single blood donation can provide transfusion therapy to multiple patients in the form of RBCs, platelets, fresh frozen plasma and cryoprecipitate.

Whole blood(WB):

Indication:

To replace the loss of both RBC mass and plasma volume (symptomatic anemia with large volume deficient)

Shelf life

Storage Temperature

Volume

QC

CPD if 21 days

CPDA-1 if 35 days

1-6 oC

450-500 ml

Hct approx. 40%

Red blood cells (RBCs):

RBCs may be allowed to sediment during refrigerated storage of the WB, or cells and plasma may be separated by centrifugation at any time up to the date of expiration of the WB.

Indication:

to increase the RBC mass in patients who require increased oxygen- carrying capacity

Shelf life

Storage Temperature

Volume

QC

CPD if 21 days

CPDA-1 if 35 days

1-6 °C

250-300 ml

Hct % 80%

RBCs Irradiated:

Patients who are immunocompromised or who are receiving a bone marrow transplant, fetuses undergoing intrauterine transfusion and recipients of units from blood relatives must receive irradiated blood to inhibit the proliferation of T-cells and subsequent transfusion-associated graft-versus-host disease.

Shelf life

Storage Temperature

Volume

Content

Original outdate or 28 days from irradiation

1-6°C

250-300 ml

RBCs

RBCs leukoreduced:

The RBCs leukoreduced components have had most of the leucocytes and platelets removed. These are given to patients:

Who are already sensitized to HLA, granulocyte, and platelet antigens e. g., those who have had multiple transfusions and have had febrile reactions

Those to whom exposure to these antigens is contraindicated such as patients undergoing renal or bone marrow transplantation.

Various approaches have been used to prepare RBCs leukoreduced components such as washing, freezing and thawing, filtration, centrifugation, etc. Filtration is the most commonly used approach for leucodepletion.

Different types of leucodepletion filters are available which can either be used in the laboratory or at the bed side as inline filters. The 3rd generation leucodepletion filters remove 99% of leucocytes and about 60-70% of platelets.

Shelf life

Storage Temperature

Volume

QC

Original outdate

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1-6oC

250-300 ml

< 5 \times 10⁶ WBCs

≥ 85% RBC recovery

Platelets:

Platelets concentrates prepared from WB are generally referred to as random donor platelets to distinguish them from single donor platelets produced by apheresis. Random donor platelets produced from WB after removing of platelet rich plasma by additional centrifugation.

Indication:

Platelets are required for treatment of thrombocytopenic patients who are actively bleeding or who are at risk of haemorrhagic symptoms

Shelf life

Storage Temperature

Volume

QC

Random donor platelets

5 days

20-24oC

50-70 ml

5.5 × 10¹⁰ platelets

Single donor platelets

5 days

20-24°C

200-400 ml

3 × 10¹¹ platelets

Fresh Frozen Plasma(FFP):

To be labeled (Fresh Frozen Plasma), plasma must be separated from the red cells and placed at

(- 18°C) or below within 8 hours after collection.

Indication:

FFP should not be used simply as a volume expander for which safe alternatives e. g. albumin and plasma substitutes are available.

The only absolute indication for use of FFP is Thrombotic Thrombocytopenic Purpura. The other indications are: Broad-spectrum (multiple) coagulation factor replacement OR Replacement of single factor deficiency

Shelf life

Storage Temperature

Volume

Content

1 year

7 years

- 18oC

- 65oC

200-250 ml

1 U/ml clotting factors

Cryoprecipitate:

It is the cold insoluble portion of plasma remaining after FFP has been thawed between 1-6oC.

Indication:

Hemophilia A

VWF or FX111 deficiency

Fibrin sealant

hypofibrinogenemia

Shelf life

Storage Temperature

Volume

Content

Frozen: 1 year

Thawed: 6 hours

Pooled: 4 hours

- 18oC

20-24oC

10-25 ml

FV111: C (80-120 U)

VWF (40-70%)

FXIII (20-30%)

Fibrinogen (150-mg/dL)

Quality Control of Blood Storage

All efforts must be made to store and transport blood, blood components and plasma in as safe a way as possible. Important element of maintenance of temperature are :

1) Equipment to store and transport

2) Organization of staff responsible for maintenance of safe temperature controlled storage.

In some of the hospitals, operation theatre maintains a separate storage space for blood and blood components. The staff of blood transfusion centre should maintain the storage conditions in distant storage places also.

Temperature monitoring

The blood storage equipment must have uniform temperature distribution, an electric system to detect gross irregularities in temperature and a temperature chart recorder.

In all blood storage equipment, regular monitoring of temperature using good thermometers is essential. A daily temperature recording chart may be affixed on the front door of the refrigerator and an 8- hourly temperature recording should be done by responsible laboratory staff member.

Maximum and minimum thermometers can also be used to detect how low or high the temperature had been. The temperature should be recorded in different shelves on different occasions to check for uniformity of temperature.

If blood has to be stored in domestic refrigerator it should never be kept close to the freezer compartment or in the door of the refrigerator due to wide variation in temperature in these parts of the refrigerator.

The temperature recording is a must in a domestic refrigerator whether storing blood units or reagents and test kits. If wide variation in temperature is noted, the temperature may be adjusted using the adjustment knob and <https://assignbuster.com/blood-storage-and-transportation-factors/>

storage may be done according to the temperatures in different shelves of the refrigerator.

The outdated blood bags may be sent for bacterial culture, which can also act as a quality control for sterility of blood collection and storage condition.

Transportation of Blood and Blood Components

Blood units or blood components may need to be transported either within the hospital complex or from one centre to the other. On receiving the blood units, these should be grossly checked for any sign of deterioration or haemolysis either due to wide temperature variation or due to bacterial infection. Look for any:

- (1) leakage or breakage
- (2) any change in colour of plasma
- (3) change in colour of red cells
- (4) any clots or abnormal mass
- (5) any foul smell
- (6) any change in interface between cell and plasma as a fuzzy interface suggest haemolysis

Blood returned to blood bank

If a unit is being returned to the blood bank, note the time of arrival, look for any visible signs of haemolysis/contamination, leakage and check the temperature by hand. If the unit has any sign of opening or of haemolysis

and had been out of refrigerator for more than two hours, do not use the blood unit for therapeutic purposes.

Transportation of frozen blood components

As FVIII and FV are heat labile coagulation factors, fresh frozen plasma meant to supplement FVIII and FV levels in a patient with bleeding manifestation has to be stored and transported at 30°C or lower.

The temperature of plasma freezer must be checked twice a day and must be recorded. If temperature shows a wide fluctuation above - 200C, the storage freezer must be checked urgently. Fresh frozen plasma once thawed must be transfused within 4 hours and should not be refrozen. It should be discarded if not used.

Fresh frozen plasma or frozen plasma should be transported in light temperature proof containers with plenty of ice packs and should be placed in cardboard boxes to prevent the adjacent bags from getting frozen on the surface of the other bag.

Thawing of plasma

Once a request for fresh frozen plasma is received in the blood bank, the frozen plasma should be thawed as follows:

1. Place the plasma unit wrapped in a plastic overwrap in a temperature controlled water bath strictly maintained at 37°C. The ports of the bag should always be above the water level in the water bath. The water in the water bath must be clean and frequently changed to prevent bacterial or fungal growth.

2. If there is delay in issue of thawed plasma, the bag may be kept for few hours at 2-8°C till transfused.

Transportation of platelet concentrate

All efforts must be made to ensure that platelets (and granulocyte) concentrates are maintained at room temperature i. e. between 20-24°C during transportation. A well-insulated container without added ice is often sufficient. If the ambient temperature is high and the distance is great, transportation should be done with special coolant pouches that will maintain a temperature around 20°-24°C.