

# Therapeutic Plasma Exchange Self- Learning Package

# TABLE OF CONTENTS

## ***Introductory Information***

### **PURPOSE**

The RN will demonstrate knowledge of the theory and skill related to the nursing care of the patient receiving Therapeutic Plasma Exchange.

### **LEARNING OBJECTIVES**

Following the completion of the independent learning activities, the RN will be able to:

1. Understand the principles and goals of Therapeutic Plasma Exchange.
2. Identify complications of Therapeutic Plasma Exchange.
3. Perform appropriate access site care.
4. Perform Therapeutic Plasma Exchange (TPED using the Spectra Optia™).
5. Identify appropriate components to be documented about Therapeutic Plasma Exchange regimen.

### **REQUIREMENTS FOR COMPETENCY**

The RN will:

1. Perform the following learning activities via independent study:
  - a) Review the learning module for Therapeutic Plasma Exchange (TPE);
  - b) Review Clinical Policy and Procedures for TPE; and
  - c) Review the supplementary readings and video related to this policy/procedure
2. Attend a one-day training session conducted by the Hospital Services Educator.
  - a) The Charges Nurses will coordinate clinical sessions for hands-on patient care and TPE competency checklist.
3. Successfully complete the TPE Competency Skills checklists under the supervision of a certified RN.

### **Supplementary Resources (available through the Hospital Services Educator):**

- ⊕ Counts, C. (2008). Therapeutic Plasma Exchange. In American Nephrology Nurses Association, *Core Curriculum for Nephrology Nursing* (5<sup>th</sup> ed.) (pp. 279-309). New Jersey: ANNA

⊕

## INTRODUCTION

In therapeutic apheresis, whole blood is removed from the patient's blood stream and then separated into different blood components of which one or more of the diseased components are retained and discarded while the remaining elements are returned to the patient. While the diseased blood components are being removed, a suitable colloid and/or electrolyte solution is used to make up for the volume loss.

Treatment usually requires a 60 mL/kg exchange volume (with a practical maximum of 4 L over 3-4 hours) daily or intermittently.

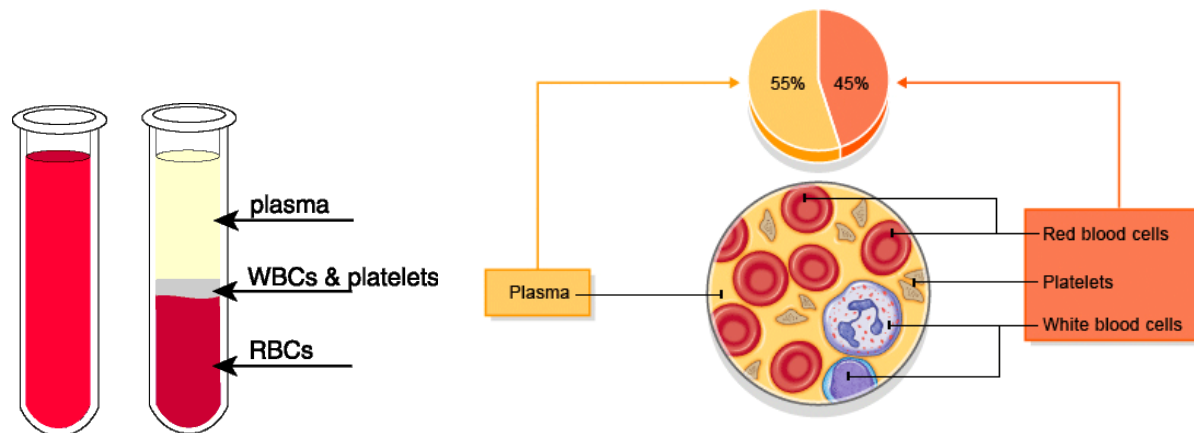
The term "therapeutic plasma exchange" (TPE) is the most commonly used term to describe a specific therapeutic procedure, where the goal is the rapid removal of the patient's plasma and its "exchange" with replacement solution.

### Definitions

- **Plasmapheresis:** plasma is separated, removed (i.e. less than 15% of total plasma volume) without the use of replacement solution
- **Plasma exchange (TPE):** plasma is separated, removed and replaced with a replacement solution such as colloid (e.g. albumin and/or plasma) or combination of crystalloid/colloid

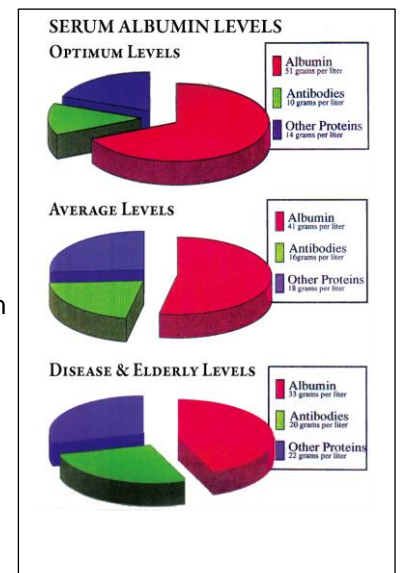
## WHAT IS PLASMA?

Blood is a viscous fluid in the body that constitutes approximately 8% of an adult's total body weight. 4-8 liters of blood flow through the vascular system. Whole blood is composed of 45% cellular components (i.e. red blood cells, white blood cells and platelets) and 55% plasma. Plasma consists mainly of water (91.5%) and carries the red blood cells, white blood cells and platelets around the body (8.5%). It also contains plasma proteins, electrolytes, vitamins, minerals hormones and antibodies. It is yellow in color.



### Plasma Proteins include:

- **Albumin:** most abundant protein in plasma. It is produced in the liver. Albumin constitutes about half of the blood serum protein. Albumin transports hormones, fatty acids, and other compounds, buffers pH, and maintains osmotic pressure, among other functions.
  - *Several drugs are bound to albumin and those drugs that are significantly protein bound and have a low volume of distribution may be removed with TPE.*
- **Immunoglobulins:** also known as Antibody—a large Y-shaped protein produced by B cells that is used by the immune system to identify and neutralize foreign objects such as bacteria and viruses. They include: IgA, IgD, IgE, IgG and IgM.
- **Fibrinogen:** is a soluble, plasma glycoprotein that is converted by thrombin into fibrin during blood clot formation. Fibrinogen is synthesized in the liver by the hepatocytes



The immune response to an antigen (such as chemicals, bacteria, viruses, or pollen. May also be formed within the body, as with bacterial toxins or tissue cells) leads to the formation of immunoglobulins (antibodies).

### Classes of Immunoglobulins:

- **IgA** : Found in mucosal areas, such as the gut, eyes, mouth, respiratory tract and urogenital tract, and prevents access and colonization by pathogens. Also found in breast milk.
- **IgD** : Functions mainly as an antigen receptor on B cells that have not been exposed to antigens. It has been shown to activate basophils and mast cells to produce antimicrobial factors.
- **IgE** : Binds to allergens and triggers histamine release from mast cells and basophils, and is involved in allergy. Also protects against parasitic worms.
- **IgG** : Smallest and most abundant (75%). Provides the majority of antibody-based immunity against invading pathogens. The only antibody capable of crossing the placenta to give passive immunity to the fetus.
- **IgM** : a basic antibody that is produced by B cells. Physically largest antibody in the human circulatory system. It is the first antibody to appear in response to initial exposure to antigen. The spleen is the major site of production.

### WHY IS TPE NECESSARY?

Certain diseases cause the formation of substances called auto antibodies or abnormal proteins which can attack the healthy cells and tissues and make you ill. Therapeutic plasma exchange (TPE) is a procedure in which these auto antibodies or proteins which are in plasma are removed from the blood

Examples of diseases treated with plasma exchange:

5 main groups

1) Antibody-mediated diseases:

Antiglomerular basement membrane antibody disease (Goodpasture's syndrome)  
Myasthenia gravis

2) Immune complex-mediated diseases:

Wegener's Granulomatosis  
Cryoglobulinaemia  
Systemic lupus erythematosus

3) Presumed immunological diseases:

Guillain-Barre syndrome

4) Thrombotic Microangiopathies (Thrombotic thrombocytopenia purpura / Hemolytic Uremic Syndrome [TTP/HUS])

Post-partum  
Drug-induced (cyclosporine, mitomycin)  
Bone marrow transplantation

5) Miscellaneous:

Poisoning (paraquat, mushrooms)  
Sepsis (meningococemia)  
Acute pancreatitis due to chylomicronaemia

In the treatment of acute or chronic autoimmune disease, the aim is to minimize irreparable end-organ damage, and to support the patient during the acute phase.

The exchange volume is usually 1 to 1.5 times the patient plasma volume. During plasma exchange there is progressive dilution, and decreasing efficiency as some components remain in the intravascular space. Therefore daily exchanges are preferable to longer or infrequent exchanges, and should be gauged according to the response to therapy.

### HOW IS PLASMA REMOVED?

In order for TPE treatment to be carried out, access into a large vein must be achieved.

This will be in the form of:

- (i) A catheter being inserted into a vein in the neck or groin
- (ii) A surgically created Arteriovenous Fistula/Graft in the arm.

Blood is drawn from the access and passes through tubes which connect to the machine centrifuge. The centrifuge separates the red blood cells, white blood and platelets from the plasma. A solution of fresh frozen plasma, 5% human albumin and normal saline or a combination of all three, is then given into the blood stream as replacement fluid. The process occurs simultaneously so that the amount of plasma being removed is being replaced at the same time.

### **REPLACEMENT SOLUTION OPTION FOR TPE**

Typically during TPE, a large volume of plasma (40-70 mL/kg) is collected which requires replacement with an appropriate colloid solution, usually at a 1:1 ratio. Use of lower replacement volumes is generally not recommended since this may deplete intravascular space and result in hemodynamic instability.

#### **Most common replacement solutions used:**

##### ➤ **Colloids**

- ❖ Albumin 5% : Most routinely used in TPE. Replaced in volume equal to that removed and helps to maintain patient's intravascular osmotic pressure. Contains no clotting factors. Rare incidence of allergic reactions, no ABO blood grouping required.

- Hypotensive episodes or anaphylactic reactions with concomitant use of ACE inhibitors.

- ❖ Fresh Frozen Plasma (FFP): Similar composition as plasma being removed during TPE. Increased risk of allergic reactions. . Must be ABO-compatible. Replaces coagulation factors and immunoglobulins. Typically used for hematological diseases (TTP/HUS).

##### ➤ **Crystalloids**

- ❖ Normal Saline 0.9% (NS): Should not be sole exchange solution. Use of NS may not allow maintenance of normal intravascular osmotic pressure and may result in instability. Typically mixed with Albumin 5%.

#### **Anticoagulation:**

- ❖ Citrate used with Centrifugal devices—to prevent clotting in the circuit. Citrate binds with calcium make it unavailable for the clotting cascade. The serum calcium will decrease and will require the usage of calcium replacement solution (calcium gluconate most common, can use calcium to avoid hypocalcemic.

### **ARE THERE RISKS ASSOCIATED WITH THE TREATMENT?**

There are certain risks and consequences associated with TPE as with any other medical procedure.

Possible complications include but are not limited to the following

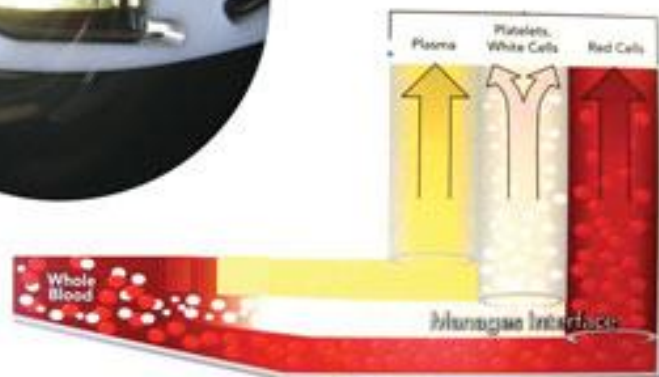
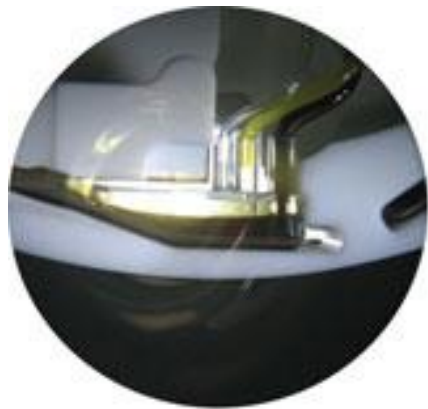
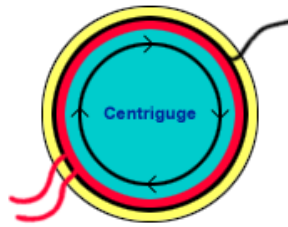
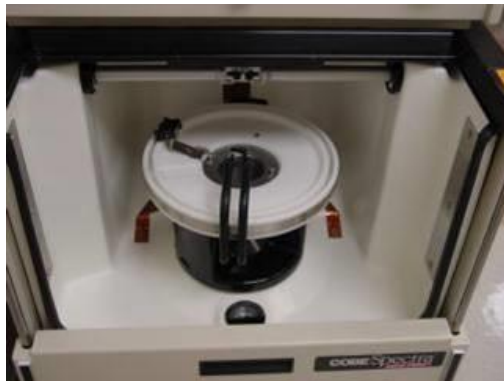
- A. Vascular access problems such as infection, clotting, bleeding or lung collapse
- B. Blood borne diseases such as Hepatitis, or other infections such as MRSA
- C. Potential for air embolism in which excessive air enters the blood via the blood circuit
- D. Possibility of irregular heartbeats, change in blood pressure
- E. Numbness and tingling of extremities
- F. Severe allergic reactions.

## PRINCIPLES UNDERLYING PLASMA EXCHANGE THERAPY

Apheresis procedures are most commonly done by centrifugation.

A centrifuge uses centrifugal force (g-force) to isolate suspended particles from their surrounding medium on either a batch or a continuous-flow basis.

Many particles or cells in a liquid suspension, given time, will eventually settle at the bottom of a container due to gravity ( $1 \times g$ ). However, the length of time required for such separations is impractical. Other particles, extremely small in size, will not separate at all in solution, unless subjected to high centrifugal force. When a suspension is rotated at a certain speed or revolutions per minute (RPM), centrifugal force causes the particles to move radially away from the axis of rotation.



The Spectra Optia Apheresis System is a centrifugal system that separates whole blood into its cellular and plasma components. The device is comprised of three major sub-systems:

- (1) The apheresis machine itself (centrifuge, pumps, valves, etc.)
- (2) A sterile, single-use, disposable tubing
- (3) Embedded software.

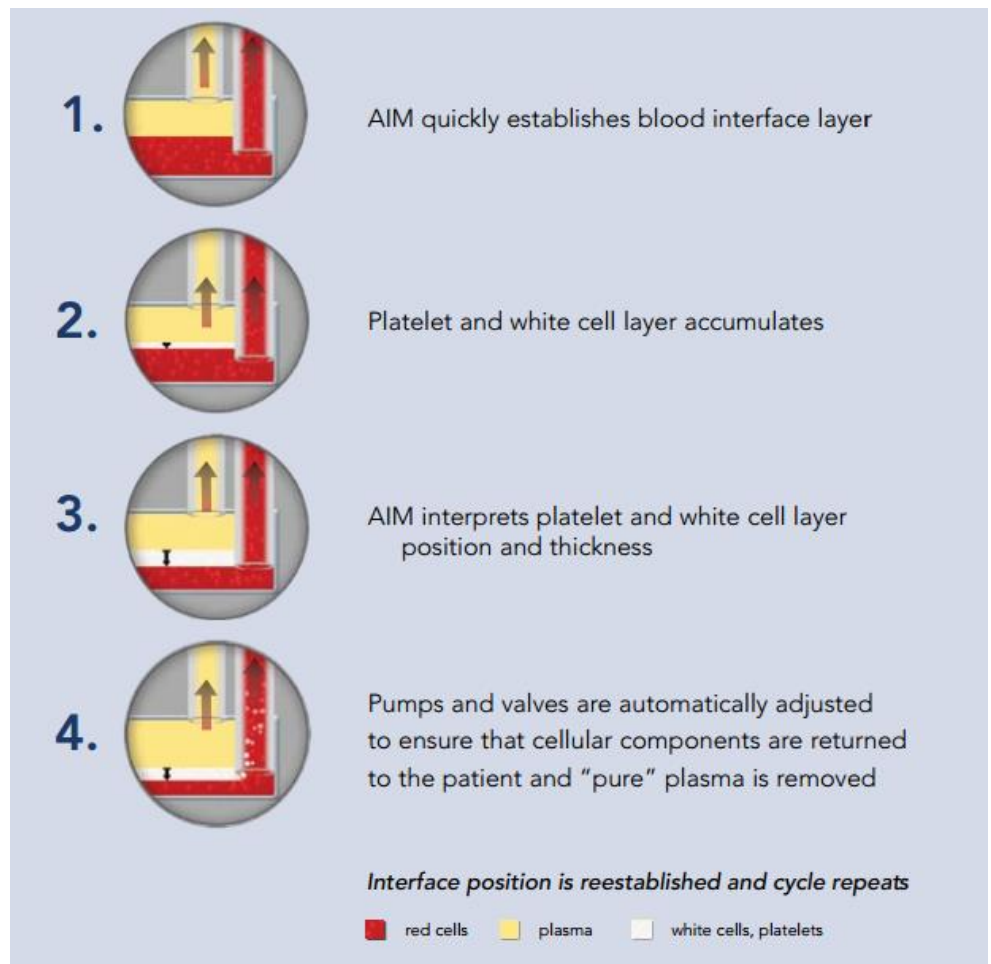
## Automated Interface Management

### THE PERFORMANCE YOU EXPECT

The Automated Interface Management system (AIM) provides real-time interface monitoring, interpretation and adjustment for safe, efficient TPE.

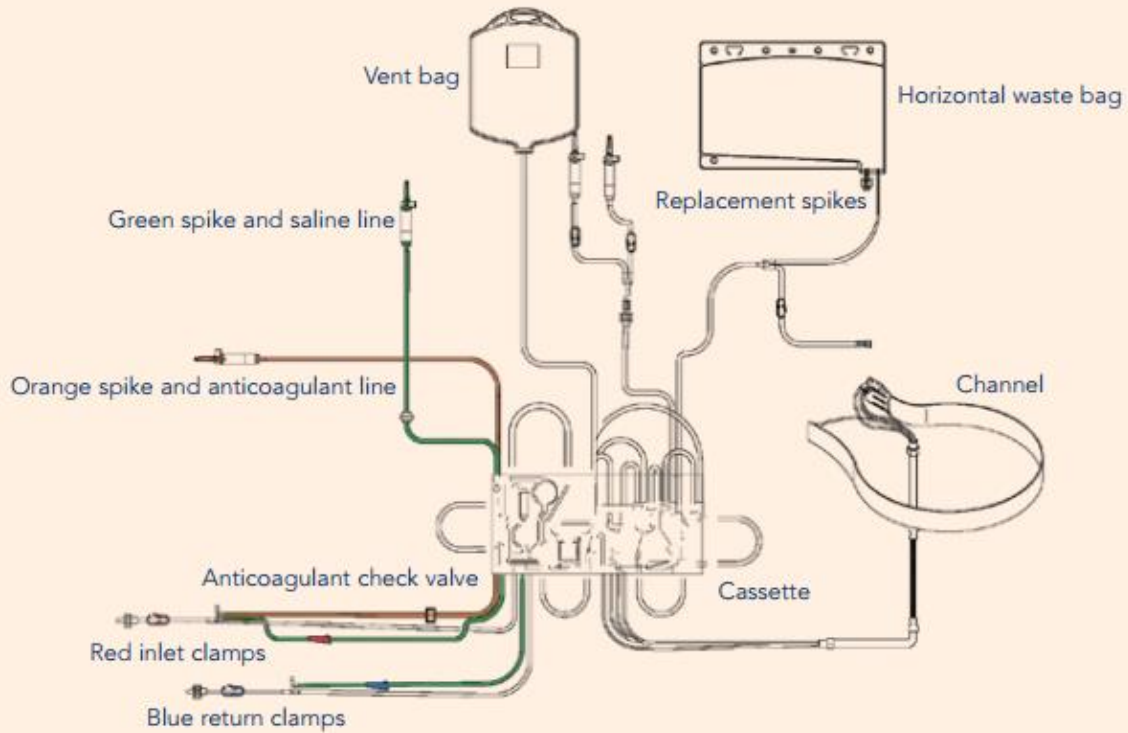
- **Monitors** the interface position and thickness of separated blood components
- **Interprets** interface information using a unique optical detection software
- **Adjusts** the pumps and valves to manage the interface position and efficiently remove targeted components

AIM ensures stability of the interface layers - automatically adjusting the pumps and valves to ensure that cellular components are returned to the patient and that "pure" plasma is collected.





## Spectra Optia Exchange Set used to perform TPE procedure



**PRE-TPE NURSING CARE ASSESSMENT/PATIENT ASSESSMENT PRIOR TO TPE**

- Assess patient's level of anxiety. Educate regarding TPE.
- Vascular access into the internal jugular or femoral vein is necessary for TPE. If an internal jugular is inserted the patient must have a chest x-ray which needs to be reviewed by medical team.
- Documentation in the patient's medical notes must indicate that the vascular access is positioned correctly.
- Assess vascular access for patency and signs of infection.
- Ensure aseptic technique is used when handling the patients vascular access at all times.
- Ensure emergency drugs are available and in date.
- Ensure emergency trolley is available and checked daily.
- Laboratory investigations prior to TPE.
- Coagulation screen
- Type and Screen
- CORRECTED CALCIUM
- Virology screen
- Specific laboratory analysis according to disease process as appropriate.
- Reduces anxiety and fears.
- Access is required to obtain access to the patient's blood.
- Verifies that no complications have resulted from insertion of catheter.
- To ensure the patient's vascular access is free from complications.
- Reduces the risk of complications.
- In case of anaphylactic reactions.
- In case of severe anaphylactic reaction.
- Uremia causes platelet dysfunction therefore increased risk of bleeding, also indicates renal impairment. Hyperkalemia may cause arrhythmias.
- When albumin is used as the replacement fluid, a depletion of all coagulation factors occurs including fibrinogen and antithrombin III. After one TPE treatment the serum levels of these factors are decreased by approximately 60%.
- T/S for determining ABO status which is required for ordering replacement fluids e.g. FFP or 5% albumin.
- Citrate induced hypocalcaemia is a common side effect of TPE if FFP is used as replacement fluid and citrate as anticoagulant. FFP is 15% citrate by volume.
- Determines patient's hepatitis status

## Self-Study Test

1. Examples of colloid solutions are
  - a. Normal Saline and Albumin 5%
  - b. Lactated Ringers and Normal Saline
  - c. FFP and Albumin 5%
  - d. Normal Saline only
2. What replacement solution options are safe to use during TPE?
  - a. Albumin 5%, NS 0.9%
  - b. NS 0.9%, Albumin 5%, FFP, D5W
  - c. FFP, Albumin 5%, NS 0.9%
  - d. All the above
3. Albumin 5% is the most commonly used replacement solution in TPE
  - a. True
  - b. False
4. Crystalloids such as NS can be used as the sole exchange medium for TPE
  - a. True
  - b. False
5. The terms plasmapheresis and TPE have the same meaning
  - a. True
  - b. False
6. The immune response to an antigen leads to the formation of a protein called immunoglobulin or antibody.
  - a. True
  - b. False
7. TPE procedures are mostly performed in the treatment of autoimmune diseases
  - a. True
  - b. False
8. If the immune system turns on its host, what type of a response does this constitute?
  - a. Foreign response
  - b. Autoimmune response
  - c. Fatal response
  - d. Lymphocyte response
9. Name 3 (three) cellular components of whole blood:
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_
  - c. \_\_\_\_\_
10. Albumin is a protein component of plasma
  - a. True
  - b. False
11. Name three protein components of plasma
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_
  - c. \_\_\_\_\_
12. Whole blood comprises of 45% \_\_\_\_\_ and 55% \_\_\_\_\_.