NEUROLOGICAL DISEASE INDICATIONS FOR PLASMA EXCHANGE

Apheresis refers to removing blood from a patient and separating the blood into its component parts. Therapeutic apheresis procedures allow us to remove certain portions of blood in an effort to treat disease. For more information on apheresis therapy refer to **Principles of Apheresis Technology, 4th Edition**[1]. Therapeutic Plasma Exchange (TPE) removes diseased plasma and replaces it with another solution or donated plasma. It can be used in the treatment of some neurological diseases including Myasthenia Gravis (MG), Guillain-Barre' Syndrome (GBS), Multiple Sclerosis (MS), Neuromyelitis Optica (NMO), and Chronic Inflammatory Demyelinating Polyradiculoneuropathy (CIDP). These diseases have an autoimmune component and plasma exchange will help remove the circulating auto antibodies. Respiratory compromise in GBS and MG are indications for emergent initiation of plasma exchange. The American Society for Apheresis (ASFA) Applications Committee has categorized the indications for therapeutic apheresis and published this in the Journal of Clinical Apheresis. For more information on the listed diseases, current management and treatment, and rationale for therapeutic apheresis refer to **Guidelines on the Use of Therapeutic Apheresis in Clinical Practice – Evidence Based Approach from the Writing Committee of the American Society for Apheresis**[2].

ASFA Category and Grade Recommendations

It is important to include the ASFA category and grade recommendation in the documentation for physician billing or insurance purposes. For more information on category and grade recommendations refer to the Guidelines on the Use of Therapeutic Apheresis in Clinical Practice – Evidence-Based Approach from the Apheresis Applications Committee of the American Society for Apheresis.[2]

Category I	Apheresis is accepted as first-line therapy, either as a primary stand alone treatment or in conjunction with other modes of treatment.
Category II	Apheresis is accepted as second-line therapy, either as stand alone treatment or in conjunction with other modes of treatment.
Category III	Optimum role of apheresis therapy is not established. Decision making individualized.
Category IV	Published evidence demonstrates or suggests apheresis to be ineffective or harmful.
Grade 1A	Strong recommendation, high quality evidence.
Grade 1B	Strong recommendation, moderate quality evidence.
Grade 1C	Strong recommendation, low quality or very low quality evidence.
Grade 2A	Weak recommendation, high quality evidence.
Grade 2B	Weak recommendation, moderate quality evidence.
Grade 2C	Weak recommendation, low quality or very low quality evidence.
MS:	Category II, Grade 1B
NMO:	*Acute:* Category II, Grade 1C *Maintenance:* Category III, Grade 2C
GBS:	Category I, Grade 1A
MG:	Category I, Grade 1B
CIDP:	Category I, Grade 1B

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Current Treatment

TPE and Intravenous Immune Globulin (IVIG) are effective therapy for GBS and exacerbations of MG. TPE can be used in some patients with exacerbations of MS that fail to respond to high dose corticosteroids. TPE and high dose corticosteroids can be used in acute attacks of NMO. Therapies for CIDP include IVIG, corticosteroids, or TPE[1,2,3]

General Procedure Recommendations

The dose and frequency of TPE is similar for the listed neurological diseases. The number and frequency of procedures varies with the clinical situation. It is important to follow the clinical condition of the patient and continue therapy if indicated. The number of procedures performed should be determined by the medical directors of both the apheresis service and the referring service. Some general guidelines are listed and include the recommended minimum number of procedures performed[1,2,3]:

- MG, GBS, MS and NMO – Dose is 1 to 1.5 plasma volumes exchanged every other day for 5 – 7 procedures. The replacement fluid often used is 5% albumin.
- CIDP - Dose is 1 to 1.5 plasma volumes exchanged 3 times per week until improvement for exacerbations of CIDP. The replacement fluid often used is 5% albumin. Some patients require long term maintenance procedures that range from weekly to monthly.
- Plasma use is reserved for special situations. Coagulation lab values may need to be monitored in some patients and 1-4 units of plasma may be used as part of the replacement fluid to help maintain normal clotting factors[4,5,6].

Calculating TPE Replacement Volume

DETERMINING TOTAL BLOOD VOLUME

Some cell separators will calculate Total Blood Volume (TBV) and/or plasma volume based on patient parameters such as gender, height, weight and hematocrit. These calculations may not be accurate for all patients. Refer to the instrument manufacturer recommendations.

There are a variety of ways to calculate a patient's Total Blood Volume (TBV). One common way to estimate TBV is Nadler's Formula listed below[6].

PATIENT	TOTAL BLOOD VOLUME (ML)
Male	(0.006012 x H3)/(14.6 x W) + 604
Female	(0.005835 x H3)/(15 x W) + 183

H = height in inches; W = weight in pounds

CALCULATING TOTAL PLASMA VOLUME

To calculate the Total Plasma Volume (TPV) of a patient with a Total Blood Volume (TBV) of 4000 ml and a hematocrit of 35%, perform the following calculation:

TBV x (1 – hematocrit) = TPV

Example: 4000 x (1 - 0.35) = 2600. *This patient's TPV is 2600 ml*

A one plasma volume exchange will require the removal of 2600 ml of plasma. Generally the replacement fluid volume, plus the amount of anticoagulant and rinseback fluid, equals the amount of volume removed. It may be necessary to leave the patient with a slightly negative or positive fluid balance depending on the patient's clinical status[6,7]. Patients with a

history of renal or cardiac dysfunction may require an isovolemic end fluid balance or slightly negative fluid balance to prevent fluid overload. Leaving the patient with a significantly negative fluid balance can have serious adverse effects and is not recommended[6,7].

Laboratory Values to Monitor

Laboratory values should be monitored to assess for anemia, hypocalcemia, electrolyte imbalances, and coagulopathy. Normal ranges will vary by facility. Some values to consider monitoring include CBC, Metabolic panel, fibrinogen, PTT, PT, INR, and ionized calcium. Depending on disease process other laboratory values may be monitored periodically.

Special Medication Considerations

It is very important to assess patients undergoing TPE therapy for the use of ACE inhibitors. These medications may cause severe bradykinin reactions in some patients. Symptoms may include flushing of the skin and hypotension that does not resolve quickly; this often results in discontinuation of the procedure for 24 hours. ACE inhibitors should be held 24 – 48 hours prior to TPE[6].

Medications that are plasma bound will be removed during TPE. Medications should be held until after completion of the TPE procedure whenever possible[4,6].

Tandem Procedures

In some cases it may be desirable to perform TPE in conjunction with other procedures, such as dialysis. Many patients tolerate this well and the total procedure time is reduced by performing them simultaneously. References on performing tandem procedures are listed below:

- Bhowmik, D. et al. Tandem Plasmapheresis and Hemodialysis. Therapeutic Apheresis 2001, 5(5): 439-441
- Mahmood, A. et al. Therapeutic Plasma Exchange Performed in Tandem With Hemodialysis for Patients With M-Protein Disorders. Journal of Clinical Apheresis 2006. 21: 100-104
- Dechmann-Sultemeyer, T. et al. Tandem plasmapheresis and Haemodialysis as a Safe Procedure in 82 Patients With Immune-Mediated Disease. Nephrology Dialysis Transplantation 2009. 24: 252-257

Risks and Side Effects

Plasma exchange is a safe procedure but side effects can occur. Common side effects include fatigue, nausea, dizziness, paresthesias in extremities and around the mouth, allergic reaction, and hypotension[4,6,7]. Serious complications such as arrhythmias, seizures, electrolyte abnormalities, and unexplained bleeding are rare. Placement of a central venous catheter also puts the patient at risk for complications that include arterial puncture, pneumothorax, cardiac arrhythmias, bleeding, malposition of catheter, infection, line occlusion and thrombosis[7].

Citrate anticoagulant used during TPE procedures can contribute to hypocalcemia. Some apheresis centers choose to monitor the patient's ionized calcium level and give calcium replacement when the level falls below normal, or the patient experiences side effects. Calcium supplementation can be achieved in a variety of ways based on the policies at your facility. It may be given orally or IV, and used prophylactically or if citrate toxicity occurs. IV calcium should be added to the closest return line port to the patient, or in a separate IV line. The following calcium supplements have been used:

- Oral calcium carbonate
- I.V. calcium gluconate
- I.V. calcium chloride

Some references are listed below with information on calcium replacement and dosing:

- McLeod B. Therapeutic Apheresis: A Physician's Handbook (1st Edition). Bethesda Maryland, AABB Press; 2005: 24-26.
- McLeod B. Apheresis Principles and Practice (3rd Edition). Bethesda Maryland, AABB: Press; 2010: 244-245, 284-285.
- Weinstein R. Prevention of Citrate Reactions During Therapeutic Plasma Exchange by Constant Infusion of Calcium Gluconate With the Return Fluid. Journal of Clinical Apheresis 1996; 11:204-210.
- KanKirawatana S., et al. Continuous Infusion of Calcium Gluconate in 5% Albumin Is Safe and Prevents Most Hypocalcemic Reactions During Therapeutic Plasma Exchange. Journal of Clinical Apheresis 2007; 22: 265-269.
- Bolan, C.D.et al. Randomized Placebo-Controlled Study of Oral Calcium Carbonate Administration in Plateletpheresis: I. Associations with Donor Symptoms. Transfusion 2003, 43:1403-1413.

Citrate anticoagulant can cause a decrease in magnesium levels. Magnesium replacement during plasma exchange is not routinely recommended in the literature. Its use may be considered in certain patient populations that include pediatric and patients with hypomagnesemia pre procedure. Consult with OB to determine if magnesium replacement should be considered in pregnancy. Some practitioners do not give magnesium replacement with patients diagnosed with Myasthenia Gravis due to the effect it has on decreasing muscle contractions. References discussing magnesium use are listed below:

- McLeod B. Apheresis Principles and Practice (3rd Edition). Bethesda Maryland, AABB: Press; 2010: 53-54.
- Haddad, S. et al. Placebo-Controlled Study of Intravenous Magnesium Supplementation During Large-Volume Leukapheresis in Healthy Allogeneic Donors. Transfusion 2005, 45: 934-944.
- Krishnan, R. G., Coulthard, M. G. Minimising. Changes in Plasma Calcium and Magnesium Concentrations During Plasmapheresis. Pediatric Nephrology 2007, 22: 1763-1766.

Procedure Orders:

Click here to access a sample Plasma Exchange order form.

Physician Documentation:

Click here to access sample physician documentation

Additional References:

1. *Linz W. Principles of Apheresis Technology (4th Edition). American Society for Apheresis; 2010.*
2. *Schwartz J, et al. Guidelines on the Use of Therapeutic Apheresis in Clinical Practice – Evidence Based Approach from the Writing Committee of the American Society for Apheresis. Journal of Clinical Apheresis 2013; 28: 145-284.*
3. *McLeod BC. Therapeutic Apheresis in Neurologic Disorders. In McLeod BC. Apheresis Principles and Practice (3rd Edition). Bethesda Maryland, AABB: Press; 2010.*
4. *Winters JL. Plasma Exchange: concepts, mechanisms, and an overview of the American Society for Apheresis guidelines. Hematology 2012; 1: 7-12.*
5. *Raval, J. If It's Yellow and Not Platelets, It's Plasma. AABB News, May 2012. 22-24.*
6. *Chibber V, King K. Management of the Therapeutic Apheresis Patient. In: McLeod BC Apheresis Principles and Practice (3rd Edition). Bethesda Maryland, AABB: Press; 2010.*
7. *Wilson J, et al. Therapeutic Apheresis Essentials. In Linz W. Principles of Apheresis Technology (4th Edition). American Society for Apheresis; 2010.*