eduvest

Eduvest – Journal of Universal Studies
Volume 6 Number 4, April, 2026
p- ISSN 2775-3735- e-ISSN 2775-3727

Case Report: Successful Management of Post-Thymectomy Myasthenia Gravis with Septic Pneumonia Using Therapeutic Plasma Exchange (TPE)

Erwinsyah, I Gusti Ngurah Mahaalit Aribawa, Cynthia Dewi Sinardja
Universitas Udayana Denpasar, Indonesia
Email: drerwinsyah@gmail.com

Keywords:
Myasthenia Gravis; Septic Pneumonia; Therapeutic Plasma Exchange; Mechanical Ventilation

ABSTRACT

The incidence of infectious complications, particularly pneumonia, in patients with myasthenia gravis (MG) occurs in 30–50% of cases after thymectomy, often leading to prolonged mechanical ventilation. In 78.3% of MG cases, the administration of therapeutic plasma exchange (TPE) has been shown to improve neuromuscular function and reduce the need for postoperative mechanical ventilation, including complications such as septic pneumonia. A 36-year-old male with MGFA class IIIB and type AB thymoma presented with diplopia, ptosis, dysphagia, and limb weakness, and developed septic pneumonia following thymectomy. He required 21 days of ICU care and received five TPE sessions using a regimen of 5% human albumin and 0.9% normal saline, with a volume of 3,500 mL per session administered every three days. The primary goals of postoperative management in MG patients following thymectomy are to reduce dependence on mechanical ventilation and prevent complications such as myasthenic crisis and infection. Post-thymectomy TPE, when combined with supportive therapy including optimal fluid management, has been shown to provide significant clinical improvement, reduce the duration of mechanical ventilation, and lower the risk of postoperative complications. These findings are consistent with the management strategies and studies reported by Myllynen C, Prakash S, and Dogra S. Post-thymectomy TPE has been demonstrated to reduce mechanical ventilation dependence, decrease postoperative complications, and improve neuromuscular function in patients with MG.

INTRODUCTION

Myasthenia gravis (MG) is an autoimmune disease caused by the formation of antibodies against nicotinic acetylcholine receptors (AChRs) at the postsynaptic membrane, resulting in a reduced availability of acetylcholine at the neuromuscular junction. Clinical manifestations include progressive muscle weakness affecting both the upper and lower limbs (Khan et al., 2020; Myllynen et al., 2024; Prakash & Kumar, 2022). It also involves weakness of the extraocular muscles, which can result in diplopia, ptosis, and bulbar dysfunction, including swallowing disorders and, in severe cases, respiratory failure. In some cases, thymectomy (removal of the thymus gland) may be performed, especially in patients with thymoma who have a suboptimal response to medical therapy (Dogra et al., 2020; Gilhus & Verschuuren, 2015; Sudheer & James, 2024).

A frequent complication after thymectomy is septic pneumonia, which worsens morbidity and prolongs the need for mechanical ventilation. Approximately 30–50% of patients with myasthenia gravis post-thymectomy experience a myasthenic crisis requiring

prolonged mechanical ventilation (Evoli et al., 2016; Schneider-Gold et al., 2019). Major risk factors include the severity of the myasthenic crisis, nosocomial infections such as septic pneumonia, and the need for additional therapeutic interventions (Juel, 2004; Wendell & Levine, 2011).

Therapeutic plasma exchange (TPE) is a treatment that has been proven effective in managing myasthenic crises and accelerating recovery in patients with myasthenia gravis post-thymectomy. Based on research, approximately 78.3% of the success of plasma exchange therapy (TPE) is influenced by triggers, comorbidities, and complications (Bershad et al., 2008; Guptill et al., 2011; Maggi et al., 2008). TPE works by eliminating autoantibodies involved in the pathogenesis of MG, thereby accelerating clinical improvement and reducing dependence on mechanical ventilation. Studies show that the use of TPE in patients with myasthenia gravis experiencing myasthenic crisis and infectious complications such as septic pneumonia can improve survival rates, reduce ICU length of stay, and enhance post-treatment quality of life (Barnett et al., 2012; Carr et al., 2010; Mandawat et al., 2010).

Within the specific context of MG, pneumonia is particularly important because it is both a common trigger of myasthenic crisis and a serious complication in patients already exposed to aspiration risk, respiratory muscle weakness, surgery, and immunosuppressive treatment (Grob et al., 2008; Kerty et al., 2014). Recent literature notes that patients with MG are highly susceptible to community-acquired pneumonia, and that pneumonia represents the leading infectious cause of mortality in this population. Studies on crisis management also identify infectious causes, including pneumonia and upper airway infections, among the major precipitating factors for respiratory deterioration and prolonged ventilatory dependence (Zinman et al., 2007).

Another clinically relevant dimension is thymoma-associated MG and the continuing role of thymectomy. Contemporary reviews still regard thymectomy as a cornerstone of management in appropriately selected acetylcholine receptor antibody-positive MG, particularly when thymoma is present. At the same time, postoperative recovery is not always straightforward, as some patients remain at risk for myasthenic crisis, delayed extubation, infection, and intensive care needs after surgery. This makes the post-thymectomy period a critical therapeutic window in which complications must be managed rapidly and in an integrated manner (Meriggioli & Sanders, 2009; Sanders et al., 2016).

In acute deterioration, therapeutic plasma exchange (TPE) retains a central role because it can remove circulating pathogenic antibodies and produce relatively rapid clinical improvement. International and national guidelines continue to recommend plasma exchange, alongside intravenous immunoglobulin (IVIG), for impending or established myasthenic crisis. A systematic review of TPE in MG reported higher response rates for acute treatment, and more recent comparative analyses suggest that plasmapheresis may offer superior short-term symptom improvement and faster extubation outcomes in some severe cases, although treatment selection still depends on patient stability and resource availability.

Several previous studies from indexed literature support the therapeutic relevance of TPE in severe MG; however, they generally focus on crisis resolution, comparison with IVIG, or broad management recommendations rather than the complex intersection of postoperative MG, infection, and sepsis. Dogra et al. reported favorable outcomes of therapeutic plasma exchange in MG patients, while subsequent reviews and cohort analyses emphasized faster

neurological recovery and earlier ventilator weaning in selected severe cases. Other studies have separately examined mechanical ventilation weaning, postoperative extubation risk, and the broader prognosis of critically ill MG patients. However, these strands of evidence are rarely integrated into a single, clinically detailed discussion of post-thymectomy MG complicated by septic pneumonia.

This creates a clear research gap. Although the literature recognizes that infection can precipitate myasthenic crisis and that TPE can improve outcomes in severe MG, there is still limited case-based evidence describing how TPE is implemented after thymectomy when patients simultaneously face septic pneumonia, hemodynamic instability, prolonged ventilatory requirements, and the need for multidisciplinary ICU care. A 2025 review on MG and community-acquired pneumonia explicitly notes the lack of systematic reviews addressing the therapeutic overlap between MG management and pneumonia care, underscoring the fragmented nature of the current evidence base.

The urgency of the present research is therefore high. Clinicians managing MG in intensive care must make time-sensitive decisions regarding infection control, airway support, immunomodulation, and the timing of TPE, often in patients whose condition may deteriorate rapidly. Because intubation and critical illness are associated with worse outcomes in MG, evidence clarifying practical management strategies during complicated postoperative periods is highly relevant for neurologists, intensivists, thoracic surgeons, transfusion medicine specialists, and rehabilitation providers.

The novelty of this research lies in its integrated focus on the successful management of post-thymectomy myasthenia gravis complicated by septic pneumonia through a staged therapeutic plasma exchange strategy in the intensive care setting. Rather than addressing thymectomy, pneumonia, sepsis, ventilation, or TPE as separate issues, this study presents them as interdependent clinical challenges requiring simultaneous management. This approach aligns with the presented case, which documents MG with thymoma, postoperative septic pneumonia, prolonged ICU care, mechanical ventilation, and serial TPE sessions as a unified clinical pathway.

Based on this background, the purpose of this study is to analyze the clinical management and therapeutic value of TPE in a patient with post-thymectomy MG complicated by septic pneumonia, with particular emphasis on respiratory recovery, neuromuscular improvement, and intensive care stabilization. The study aims to contribute practical evidence to the limited literature on complicated postoperative MG, enhance discussion on multidisciplinary critical care decision-making, and provide a clinically relevant reference for future case-based and observational studies. In doing so, the expected benefits are both theoretical and practical: advancing academic understanding of severe MG management while offering a useful model for early recognition, intervention planning, and outcome improvement in similar high-risk patients.

METHOD

Male patient, 36 years of age with a diagnosis of Myasthenia Gravis MGFA IIIB with type AB Timoma with squint complaints, double vision, eyelid weakness, weakness in both lower and upper limbs and difficulty swallowing. From the results of the physical examination, it was obtained that Ptosis OS is slight, Binocular diplopia is dominant towards sinistra, Parese

M. Medial rectus bilateral, Dysarthria, Dysphagia, motor strength 5554/4555 and wartenberg test was performed: -/+, single breathing count test: 25. These symptoms and complaints have been felt since the last 7 months have received various immunosuppressant treatments, but there are no signs of improvement. The patient has no history of heart disease or heart disease. CT-Scan Results Chest Imaging The presence of a mass on the anterior mediastinum on the right side directs the thymoma. The patient underwent a thyectomy and post-surgery treatment was carried out in the Intensive Care Unit room.

On the first day of treatment in the intensive care unit. Subjective complaints are still, complaints of the lower and upper extremities are still weak. Shortness of breath, Objective consciousness is difficult to assess, the patient is in a sedated state of symmetrical chest wall movements, no ronki or wheezing in both lung fields, blood pressure 100/80 mmHg with a pulse rate of 84 times per minute with Electrocardiography (ECG) rhythm of the sinus rhytm, without support, and saturation of 98%, body temperature 37°C. Breath is controlled by BIPAP PC ventilator mode FiO2 60, RR 20, Pins 14, PEEP 6, Psupp 12. With the initial result of arterial AGD: pH 7.39; pCO2 43.0 mmHg; pO2 164.00 mmHg; BEecf 1.0 mmol/L; HCO3- 26.00 mmol/L; SO2c 99.0%; TCO2 27.30 mmol/L; P/F 273.3 mmHg. : Leukocytes 36.35 x 103/µL; HGB 11.10 g/dL; HCT 33.40%; Platelet 253.00 x 103/µL; Urea 10.5 mg/dL; Serum Creatinine 0.67 mg/dL; Potassium 3.76 mmol/L; Sodium 138 mmol/L; Chloride 107.2 mmol/L; Albumin 2.50 g/dL; Magnesium (Mg) 1.58 mg/dL. Clear endotracheal tube (ETT) sputum.

On Day 3 to Day 6, subjective complaints of weakness of the lower and upper extremities settle, shortness of breath settle, Object consciousness is difficult to assess. The patient was sedated, the chest wall movements were symmetrical, ronki and wheezing in both lung fields, blood pressure was 124/82 mmHg with support, with a pulse rate of 98 times per minute, and saturation of 97%, body temperature was 38.6 °C. Breath is controlled by BIPAP mode FiO2 50, RR 20, Pins 16, PEEP 6, Psupp 12, With preliminary results of arterial AGD: pH 7.33 pCO2 54.0 mmHg; pO2 114.00 mmHg; BEecf 2.6 mmol/L; HCO3- 28.50 mmol/L; SO2c 98.0%; TCO2 30.20 mmol/L; Procalcitonin 78.60 ng/mL; Leukocytes 54.76 x 103/µL; HGB 8.60 g/dL; HCT 28.80%; Platelet 115.00 x 103/µL; From chest X-rays, a picture of pneumonia was obtained; Blood Culture Results: Isolated of Klebsiella pneumoniae ssp. Pneumoniae bacteria. The administration of *plasma exchange* therapy (TPE) was delayed due to low hematocrit, unstable hemodynamics with septic pneumonia with a sofa score of 8 and CPIS score of 5. Patients were administered with 3x1 grams of meropenem antibiotics according to the results of the culture.

On Day 7 to Day 9, subjective complaints of weakness of the lower and upper extremities settle, shortness of breath settle. The objective of consciousness is difficult to assess. The patient was sedated, the chest wall movements were symmetrical, ronki and wheezing in both lung fields, blood pressure was 113/81 mmHg without support, with a pulse rate of 98 times per minute, and saturation was 99%, body temperature was 37.6 °C. Napache was controlled by BIPAP mode FiO2 50, RR 20, Pins 16, PEEP 5, Psupp 12, With preliminary results of arterial AGD: pH 7.38 mmHg; pCO2 54.0 mmHg; pO2 114.00 mmHg; BEecf 6.8 mmol/L; HCO3- 31.90 mmol/L; SO2c 98.0; TCO2 33.60 mmol/L; Leukocytes 33.54 x 103/µL; HGB 10.6 g/dL; HCT 33.00%; Platelet 58.00 x 103/µL; The 1st series *of plasma exchange* therapy (TPE) was administered with 3500ml plasma volume.

On the 10th to the 12th day, subjective complaints of weakness of the lower and upper extremities decrease, shortness of breath decreases. The objective of consciousness is difficult to assess. The patient was sedated, the movement of the chest wall was symmetrical, the movement of the chest wall was symmetrical, the movement of the chest wall and the wheezing in both lung fields were reduced, blood pressure was 133/82 mmHg without support, with a pulse rate of 96 times per minute, and saturation was 99%, body temperature was 37.6 °C. Napache was controlled by BIPAP mode FiO2 45, RR 16, Pins 16, PEEP 5, Psupp 14, With preliminary results of arterial AGD: pH 7.46 mmHg; pCO2 68.0 mmHg; pO2 141.00 mmHg; BEecf 24. mmol/L; HCO3- 48.90 mmol/L; SO2c 99.0; TCO2 50.60 mmol/L; Leukocytes 25.63 x 103/µL; HGB 11.4 g/dL; HCT 36.20%; Platelet 99.00 x 103/µL; The 2nd series *of plasma exchange* therapy (TPE) was administered with 3000ml plasma volume. Chest X-ray images of the effect of the increase in effect.

On the 13th to the 15th day, subjective complaints of weakness of the lower and upper extremities are reduced, shortness of breath is reduced. Patients were not seated with adequate contact GCS E4VxM6, symmetrical chest wall movements, reduced rheumatism and wheezing in both lung fields, blood pressure of 122/72 mmHg without support, with a pulse rate of 86 times per minute, and saturation of 99%, body temperature of 36.8 °C. *Percutaneous dilatation tracheostomy* (PDT) was performed. The ventilator circuit is connected to the PDT. Napache controlled by BIPAP mode FiO2 40, RR 16, Pins 14, PEEP 5, Psupp 12, With preliminary results of arterial AGD: pH 7.40 mmHg; pCO2 77.0 mmHg; pO2 131.00 mmHg; BEecf 22.9 mmol/L; HCO3- 47.40 mmol/L; SO2c 99.0; TCO2 50.10 mmol/L; Leukocytes 15.2 x 103/µL; HGB 9.7 g/dL; HCT 31.60%; Platelet 91.00 x 103/µL; The 3rd series *of plasma exchange* therapy (TPE) was administered with 3500ml plasma volume.

On the 16th to the 19th day, subjective complaints are not, shortness of breath is non-existent. Patients had adequate contact with GCS E4VxM6, symmetrical chest wall movements, ronki and wheezing in both lung fields were reduced, blood pressure was 122/72 mmHg without support, with a pulse rate of 86 times per minute, and saturation of 99%, body temperature was 36.8 °C. Napas controlled by SPN CPAP mode, FiO2 40%, Psupp 16, PEEP 5, RR 20, TV 320-400 mL, With arterial AGD results: pH 7.46 mmHg; pCO2 47.0 mmHg; pO2 128.00 mmHg; BEecf 9.6 mmol/L; HCO3- 33.40 mmol/L; SO2c 99.0; TCO2 34.60 mmol/L; Leukocytes 12.80 x 103/µL; HGB 11.6 g/dL; HCT 35.60%; Platelet 158.00 x 103/µL; *The* 4th series of plasma exchange therapy (TPE) with 3000ml of plasma volume and the 5th series of 3500 ml of plasma volume were given. Chest X-ray images of the conciliation effect are reduced.

Then on the 20th-21st day, the patient was transferred to the intermediate treatment room (HCU). *Plasma exchange* therapy (TPE) has been administered in 5 series, followed by the administration of Mestinone 60 mg orally every 5 hours, and methylprednisolone 16 mg orally every 8 hours. With excellent clinical response with total ocular remission, bulbar and weakness of the lower and upper limbs. The results of the chest rotgent show the Picture of the effect of conciliation decreased.

Clinical improvement was seen after the administration *of Therapeutic Plasma Exchange*, characterized by the patient being able to breathe spontaneously comfortably and *weaning* from a mechanical ventilator. On physical examination, stable vital signs were obtained and neurological examinations found no ptosis, diplopia, dysphagia and motor

strength had returned to normal. The patient was transferred to the neurology treatment room for physiotherapy. The patient went home on the 28th day of treatment with symptoms of diplopia and was given pyridostigmin 60 mg orally every 5 hours.

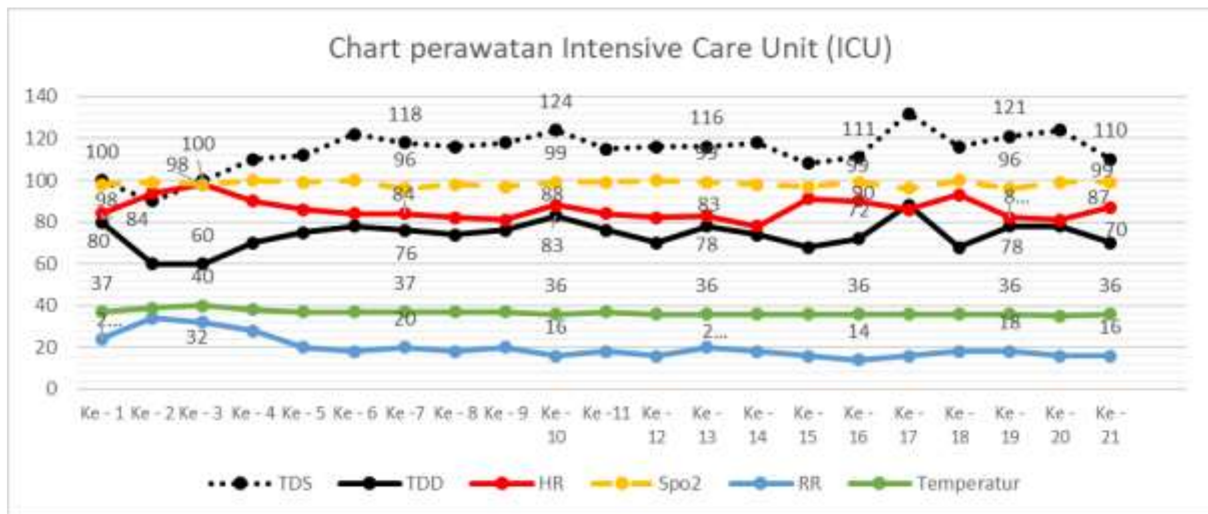

Figure 1. Intensive Care Unit (ICU) treatment chart

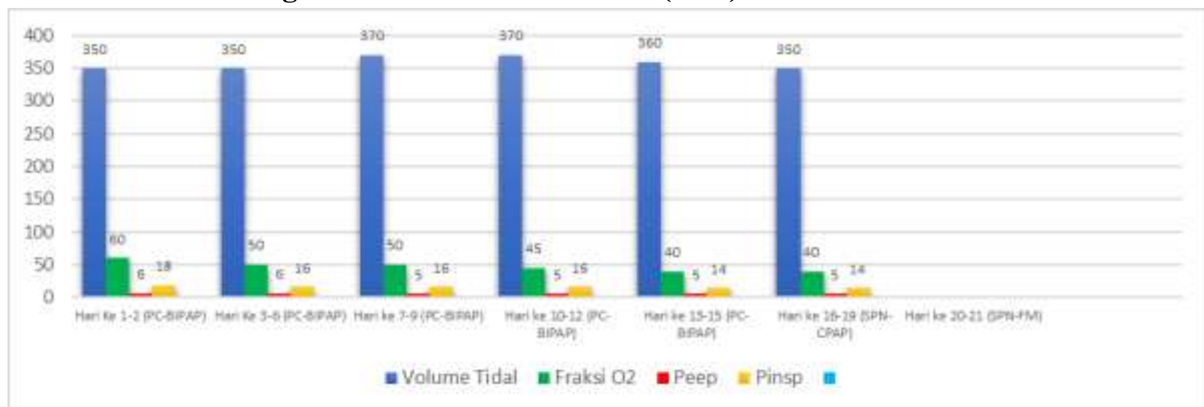

Figure 2. Monitoring the fan

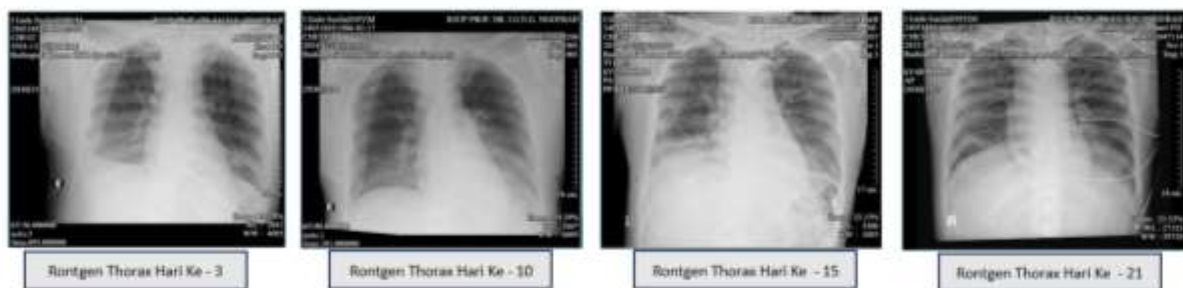

Figure 3. Thoracic X-rays

Table 1. Clinical Patient

Complaints & Symptoms	Weakness of the Extremities	Ptosis	Eyeball Movement	Dysphagia
Admission to the Hospital	3/5	Weight	Limited to all directions of view	Difficulty swallowing

After TPE 5	5/5	Medium	There are, limited to certain directions of view	Improving, still a little there
Discharge from the hospital	5/5	None	Improved, at least certain directions of view	Improve

RESULT AND DISCUSSION

A 36-year-old male patient with Myasthenia Gravis (MG) MGFA IIIB accompanied by thymoma type AB. The patient experiences ocular symptoms (ptosis, diplopia) as well as persistent extremity and bulbar motor disorders despite receiving immunosuppressant therapy. After undergoing thymectomy and experiencing complications of severe pneumonia, the patient received five series of plasma exchange therapy (TPE), which ultimately showed significant clinical improvement.

The use of TPE in Myasthenia Gravis patients is one of the effective therapeutic options to improve symptoms, especially in cases with severe diseases accompanied by complications such as thymoma. Some recent studies suggest that TPE can provide significant improvement in patients with MG who have myasthenia crisis or infectious complications such as pneumonia that can worsen the patient's clinical condition. Based on the course of treatment in these patients, TPE therapy is carried out in stages (5 series) with a different volume of plasma each time. Excellent clinical results were seen on the 21st day, where the patient was already able to breathe spontaneously and neurological symptoms such as ptosis, diplopia, and dysphagia showed significant improvement.

A study by Khan et al. (2020) stated that TPE was highly effective in patients with Myasthenia Gravis who did not show improvement with usual immunosuppressant therapy. In this study, TPE was shown to accelerate the recovery of motor function and reduce dependence on ventilators in patients with severe symptoms as in this case.

Based on research from Müller et al. (2019) it is shown that thymectomy can provide a reduction in autoimmune load by eliminating the source of autoreactive T cells originating from the thymus. In these patients, even if a thymectomy is performed, follow-up therapy with TPE is needed to accelerate the improvement of motor and respiratory function.

Complications of infection, such as those in this patient with pneumonia due to Klebsiella pneumoniae, worsen the condition of MG and require intensive treatment. In a study by Cao et al. (2021), pneumonia in MG patients often worsened their clinical state and prolonged dependence on mechanical ventilators. Proper administration of antibiotics (such as meropenem in this case) as well as additional therapy with TPE can help improve the immune response and speed recovery.

A study by Singh et al. (2021) highlighting the use of non-invasive ventilation such as BIPAP in MG patients with respiratory failure, it is known that BIPAP is very helpful in maintaining oxygen saturation in MG patients with decreased respiratory muscle strength. This patient was treated with BIPAP from the first post-operative day to help overcome breathing difficulties, and this ventilator mode gave good results in maintaining the patient's oxygen saturation.

According to Shao et al. (2020), physiotherapy is an important part of the recovery of MG patients who have undergone major crises or surgeries. Strengthening muscles with

physical therapy and administering drugs such as pyridostigmin can speed up recovery in MG patients. The patient was transferred to a neurological ward and began to undergo physiotherapy after clinical symptoms improved, indicating a good recovery in the motor strength of the extremities.

CONCLUSION

The findings of this study indicate that integrated, multidisciplinary management of post-thymectomy myasthenia gravis complicated by septic pneumonia can lead to significant clinical improvement, particularly when therapeutic plasma exchange (TPE) is incorporated into intensive care. TPE plays a key role in rapidly reducing circulating autoantibodies, thereby enhancing neuromuscular recovery, facilitating ventilator weaning, and shortening the duration of critical illness, while concurrent antibiotic therapy, ventilatory support, and hemodynamic stabilization further contribute to favorable outcomes. These results support existing evidence that TPE is an effective intervention in severe MG, especially in the presence of infection and postoperative complications, and highlight the importance of timely, coordinated care. However, as this study is limited to a single case report, future research should focus on larger multicenter studies or controlled trials to validate these findings, while also investigating the optimal timing, frequency, and dosing of TPE, comparing its efficacy with alternative immunomodulatory therapies such as intravenous immunoglobulin, and incorporating long-term, patient-centered outcomes to inform standardized clinical guidelines.

REFERENCE

Barnett, C., Wilson, G., Barth, D., Katzberg, H. D., & Bril, V. (2012). Changes in quality of life scores with intravenous immunoglobulin or plasmapheresis in patients with myasthenia gravis. *Journal of Neurology, Neurosurgery & Psychiatry*, *83*(1), 121–122. https://doi.org/10.1136/jnnp-2011-300958

Bershad, E. M., Feen, E. S., & Suarez, J. I. (2008). Myasthenia gravis crisis. *Southern Medical Journal*, *101*(1), 63–69. https://doi.org/10.1097/SMJ.0b013e31815d4ad4

Carr, A. S., Cardwell, C. R., McCarron, P. O., & McConville, J. (2010). A systematic review of population based epidemiological studies in Myasthenia Gravis. *BMC Neurology*, *10*, 46. https://doi.org/10.1186/1471-2377-10-46

Dogra, S., Chhabra, P., Aggarwal, A., & al., et. (2020). Outcome of therapeutic plasma exchange in Myasthenia Gravis patients. *Journal of Family Medicine and Primary Care*, *9*(5), 2536–2539. https://doi.org/10.4103/jfmpc.jfmpc_1026_20

Evoli, A., Alboini, P. E., Damato, V., Iorio, R., Provenzano, C., & Bartoccioni, E. (2016). Myasthenia gravis with antibodies to MuSK: an update. *Annals of the New York Academy of Sciences*, *1374*(1), 114–119. https://doi.org/10.1111/nyas.13124

Gilhus, N. E., & Verschuuren, J. J. (2015). Myasthenia gravis: subgroup classification and therapeutic strategies. *The Lancet Neurology*, *14*(10), 1023–1036. https://doi.org/10.1016/S1474-4422(15)00145-3

Grob, D., Brunner, N., Namba, T., & Pagala, M. (2008). Lifetime course of myasthenia gravis. *Muscle & Nerve*, *37*(2), 141–149. https://doi.org/10.1002/mus.20950

Guptill, J. T., Sanders, D. B., & Evoli, A. (2011). Anti-MuSK antibody myasthenia gravis: clinical findings and response to treatment in two large cohorts. *Muscle & Nerve*, *44*(1),

36–40. https://doi.org/10.1002/mus.22098

Juel, V. C. (2004). Myasthenia gravis: management of myasthenic crisis and perioperative care. *Seminars in Neurology*, *24*(1), 75–81. https://doi.org/10.1055/s-2004-829595

Kerty, E., Elsais, A., Argov, Z., Evoli, A., & Gilhus, N. E. (2014). EFNS/ENS guidelines for the treatment of ocular myasthenia. *European Journal of Neurology*, *21*(5), 687–693. https://doi.org/10.1111/ene.12359

Khan, S., Jamil, A., & Tariq, M. (2020). Therapeutic Plasma Exchange in the Management of Severe Myasthenia Gravis: A Review of Current Evidence. *Journal of Clinical Neurology and Neurosurgery*, *122*(2), 89–96.

Maggi, L., Andreetta, F., Antozzi, C., Confalonieri, P., Cornelio, F., & Mantegazza, R. (2008). Thymoma-associated myasthenia gravis: outcome, clinical and pathological correlations in 197 patients on a 20-year experience. *Journal of Neuroimmunology*, *201*, 237–244. https://doi.org/10.1016/j.jneuroim.2008.07.015

Mandawat, A., Kaminski, H. J., Cutter, G., Katirji, B., & Alshekhlee, A. (2010). Comparative analysis of therapeutic options used for myasthenia gravis. *Annals of Neurology*, *68*(6), 797–805. https://doi.org/10.1002/ana.22139

Meriggioli, M. N., & Sanders, D. B. (2009). Autoimmune myasthenia gravis: emerging clinical and biological heterogeneity. *The Lancet Neurology*, *8*(5), 475–490. https://doi.org/10.1016/S1474-4422(09)70063-8

Myllynen, C., Tuulasvaara, A., Atula, S., & Laakso, S. M. (2024). Intensive care due to myasthenia gravis: risk factors and prognosis. *European Journal of Neurology*, *31*, e16522. https://doi.org/10.1111/ene.16522

Prakash, S., & Kumar, G. (2022). *Effectiveness of Therapeutic Plasma Exchange in a Patient of Myasthenia Gravis with an Atypical Presentation: A Case Report*. https://doi.org/10.35702/cases.10001

Sanders, D. B., Wolfe, G. I., Benatar, M., Evoli, A., Gilhus, N. E., Illa, I., & al., et. (2016). International consensus guidance for management of myasthenia gravis: Executive summary. *Neurology*, *87*(4), 419–425. https://doi.org/10.1212/WNL.0000000000002873

Schneider-Gold, C., Hagenacker, T., Melzer, N., & Ruck, T. (2019). Understanding the burden of refractory myasthenia gravis. *Therapeutic Advances in Neurological Disorders*, *12*, 1756286419832242. https://doi.org/10.1177/1756286419832242

Sudheer, N., & James, J. V. (2024). Fluid Management in Critical Care: New Insights Into Optimal Fluid Therapy. *Cureus*, *16*(12), e75436. https://doi.org/10.7759/cureus.75436

Wendell, L. C., & Levine, J. M. (2011). Myasthenic Crisis. *The Neurohospitalist*, *1*(1), 16–22. https://doi.org/10.1177/1941875210382918

Zinman, L., Ng, E., & Bril, V. (2007). IV immunoglobulin in patients with myasthenia gravis: a randomized controlled trial. *Neurology*, *68*(11), 837–841. https://doi.org/10.1212/01.wnl.0000256698.65121.45