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# High flow oxygen therapy via tracheostomy to wean from Guillain-Barre Syndrome associated prolonged mechanical ventilation: A case report

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**Abstract**

Guillain- Barre Syndrome (GBS) is an autoimmune condition that can cause life-threatening respiratory failure, necessitating prolonged mechanical ventilation (MV). High flow oxygen can also be administered through a tracheostomy (HFOT) with an adapter, although evidence for its benefit in difficult-to-wean tracheostomized patients is scarce. A 60-year-old male with acute myeloid leukemia (AML) underwent allogeneic stem cell transplantation and achieved complete remission. Six months later, he developed GBS involving limb and respiratory muscle paralysis. Negative inspiratory force was -15 cm $H_2O$. He required endotracheal intubation, tracheostomy, and treatment with Rituximab and immunoglobulin. For more than two months on the ventilator repeated trials of tracheostomy collar were unsuccessful. After 78 days on the ventilator, HFOT via tracheal adapter with 50% $FiO_2$ at 60 L/min was introduced daily, initially for 1h for the first couple of days, then 3h twice a day, and increased as tolerated to 24 h. After 99 days of either intermittent or continuous ventilator support, he tolerated 24 h off ventilator on HFOT and was transitioned to tracheostomy collar, decannulated, and discharged to rehab after five months. Our case highlights successful use of high flow oxygen via tracheostomy (HFOT) in a difficult-to-wean patient with Guillain-Barre Syndrome.

**Keywords:** High-flow oxygen therapy, tracheostomy, prolonged mechanical ventilation, Guillain-Barre syndrome, stem cell transplant

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## Introduction

Guillain-Barre Syndrome (GBS) is an autoimmune condition that can cause life-threatening respiratory failure necessitating mechanical ventilation in 20-30% of patients [1-3] and subsequent prolonged ventilatory support. [4,5] Prior studies demonstrated worse outcomes for patients who required mechanical ventilation compared to those who did not. [4,5] GBS is a known complication of allogeneic stem cell transplantation. [7]

High-flow oxygen therapy via nasal cannula (HFOT-NC) improves oxygenation and work of breathing by supplying heated and humidified oxygen gas. The physiologic mechanism and clinical benefits of HFOT-NC include reduction in physiologic dead space and carbon dioxide "washout", increased tidal volume, delivery of positive end-expiratory pressure (PEEP), and higher end-expiratory volume. [8,9] High-flow oxygen therapy can also be administered via tracheostomy with an adapter (HFOT-T), [10,11] although evidence for its use and benefit in difficult-to-wean tracheostomized patients is scarce. Prior investigators have purported that the mechanisms and physiological effects of HFOT-NC may differ from HFOT-T. [12,13]

Here, we report a case in which respiratory support with HFOT-T was successful in weaning from prolonged mechanical ventilation an adult male patient with leukemia who developed GBS-associated respiratory failure after undergoing hematopoietic stem cell transplant.

## Case presentation

A 60-year-old male with acute myeloid leukemia underwent allogeneic stem cell transplantation (SCT) and achieved complete remission. Six months after SCT, he developed adenovirus infection. A month later, he was admitted to our Neurological Acute Care Unit with one week of ascending paresthesia and severe weakness. Physical examination demonstrated severely decreased muscle strength and tone to bilateral lower and upper extremity areas of hips (2/5) and deltoids (2/5). His respiratory rate and oxygen saturation on room air were normal, and his negative inspiratory force (NIF) ranged from -28 to –30 cm $H_2O$, and vital capacity was 1.1 to 1.2L. Lumbar puncture showed elevated cerebrospinal fluid protein (1300 mg/dL) and electromyography was consistent with axonal GBS.

Over the next two days, the patient's symptoms rapidly progressed to involve facial and respiratory muscles including diaphragmatic paralysis requiring intubation for respiratory failure and ICU admission. His NIF deteriorated from -30 to -15 cm $H_2O$. He was initiated on a 5-day cycle of intravenous immune globulin (IVIG) (0.4 mg/kg daily), monthly for 5 months and 7 doses of Rituximab (375 mg/m2) over 4 months with a plan to continue monthly. Monthly monitoring of B cells on flow cytometry was performed. Eleven days after intubation, he underwent percutaneous tracheostomy. Post-procedure, chest tube placement was required for a left sided pneumothorax. Two days later, he experienced a pulseless electrical arrhythmia (PEA) cardiac arrest due to mucus plugging which resolved after pulmonary toilet was performed. After one month in the ICU, he was transferred to our stepdown unit for continued ventilator weaning.

For the next four weeks, the patient tolerated weaning mode of low levels (4-8 cm $H_2O$) of pressure support ventilation (PSV) and PEEP of 5 cm $H_2O$ and 40% $FiO_2$). However, multiple attempts to obtain a NIF calculation failed due to the patient's inability to generate substantial tidal volume. During this time, the patient experienced sepsis and pneumonia, received planned monthly course of IVIG, and round the clock bronchodilators, regular physiotherapy/occupational therapy sessions, chest physiotherapy, and pulmonary toileting. Radiography-guided repeat LP showed CSF protein had decreased from 1300 mg/dL to 447 mg/dL. As he regained sensation and neuromuscular control, NIF improved and ranged from -23 to –29 cm $H_2O$. A trial of PSV level of 2 cm $H_2O$ and PEEP of 0 cm $H_2O$ was successful, but repeated weaning attempts on standard tracheostomy collar failed. To illustrate, initial attempt of tracheostomy collar trial using standard tracheostomy collar/mask on day 74 of MV was curtailed at 10 minutes as the patient experienced profound hypoxia requiring prolonged manual ventilation with a bag mask valve and high PEEP valve before returning on MV. Consequently, tracheostomy collar trials were postponed for the next four days. Of note, the tracheostomy cuff was deflated during weaning with HFOT and conventional trach collar.

On Day 78 of mechanical ventilation, weaning with HFOT-T was introduced at settings of 50% $FiO_2$ and 60 L/min flow rate and was tolerated for 1 hour. The next day, weaning was again successfully attempted using HFOT-T for 1 hour. The patient was next tried on HFOT 30% $FIO_2$ and 30L for 3-hour sessions twice a day for 2 days and over the following three weeks, the duration of weaning was gradually increased as tolerated until Day 99 when the patient tolerated 24 hours of HFOT-T without resting on the ventilator. During this time, the tracheostomy cuff was deflated. The patient was then switched from HFOT-T to conventional collar 40% $FiO_2$ with plan to support with HFOT-T or PSV as needed. The patient continued to tolerate trach collar for 4 consecutive days

straight and by Day 102, he was weaned completely off the ventilator as well as supplemental oxygen and maintained on humidified medical air.

On Day 104, the patient was transferred from the stepdown unit to the regular ward. On Day 129, his tracheostomy tube was downsized and subsequently removed two weeks later. He then gradually regained progressive return of full sensation and function to all extremities. He was discharged to an acute rehabilitation facility on Day 150 and eventually discharged home after three months.

## Discussion

Our case describes the safe and successful use of HFOT-T in a difficult-to-wean patient with GBS-associated respiratory failure. Severe limb weaknesses associated with GBS with inability to lift the arms and develop axonal degeneration, as in our patient, have been shown to be the strongest predictors of delayed or prolonged liberation from mechanical ventilation. [6,14]

As our patient was effectively managing his secretions, the tracheostomy cuff was deflated during weaning with HFOT and conventional trach collar to allow for increased airway diameter for better airflow. [15,16] This institutional practice is consistent with the most recent expert clinical guidelines for ventilator weaning. [17] Prior studies demonstrated that peak flow and forced vital capacity were improved with cuff deflation during weaning [16] and subsequently yielded ventilator liberation success by reducing the duration of weaning and occurrence of respiratory infections. [18]

The underlying mechanism and benefits of HFOT-T likely involves reduction of inspiratory effort and increase in tidal volume in patients with restrictive pulmonary dysfunction. However, in a study of 14 tracheostomized patients at high risk of weaning failure from mechanical ventilation, Stripoli et al found that HFOT-T did not improve neuro-ventilatory drive (measured by electrical diaphragmatic activity), work of breathing, respiratory rate and gas exchange compared with conventional low-flow oxygen therapy via tracheostomy tube. [13] Similarly, in a randomized crossover physiologic study, Lersritwimanmaen et al showed that HFOT-T did not provide any significant additional benefit in inspiratory effort and breathing frequency compared to patients on conventional oxygen therapy via tracheostomy tube in 22 patients with prolonged mechanical ventilation. [15] In contrast, several case reports have documented the benefits of HFOT-T in liberating patients with restrictive lung disease [16] and COVID-19-induced acute respiratory distress syndrome. [17] Natalini et al demonstrated that 50 L/min flow rate of HFOT-T resulted in improved oxygenation, reduced respiratory rate, and a small degree of positive airway pressure as compared to standard oxygen therapy. [18] Lytra et al similarly noted positive differences in ventilation, breathing pattern, and oxygen without raising inspiratory effort with HFOT-T in patients with prolonged mechanical ventilation. [19] A recent systematic review of the observational and interventional studies of HFOT-T surmised that the main physiological effect of HFOT-T as compared to conventional oxygen therapy in this patient population was improved oxygenation that is likely flow-dependent since there was no significant difference in neuro-ventilatory drive, and ventilation. [20]

HFOT through tracheostomy (HFOT-T) may not be beneficial if there is ineffective positive end expiratory pressure (PEEP) due to pressure escape; because the upper airway is bypassed, the "stenting" effect of PEEP is significantly reduced. Also, if the tracheostomy tube is uncuffed or the patient has a significant air leak around the stoma, the pressure benefits required to keep alveoli open (atelectasis prevention) are often lost. Furthermore, the delivery of a very high $FiO_2$ with HFOT can lead to a "false sense of security" whereby a patient's oxygen saturation may remain stable while their underlying work of breathing increases or their $CO_2$ levels rise. Thus, clinicians may miss progressive respiratory muscle fatigue, potentially delaying a necessary return to mechanical ventilation. Additionally, while tracheostomies generally reduce dead space, the small diameter of some tracheostomy tubes can actually increase the resistive work of breathing compared to a native airway when high flows are pushed through them. Finally, HFOT-T eliminates the natural humidification and warming performed by the nose. Thus, if the high-flow equipment's heater or humidifier fails, the delivery of cold, dry air directly into the trachea can cause secretions to become thick (or inspissated), leading to tube blockage, making HFOT-T ineffective.

Figure 1: Tracheal adapter applied to tracheostomy

Figure 2: Conventional trach collar

## Conclusions

Our case demonstrated the effectiveness of HFOT-T in weaning a patient with GBS-associated respiratory failure from prolonged mechanical ventilation. Improved oxygenation with HFOT-T that is likely flow-dependent appears to be the main physiological mechanism. The clinical benefits result from reduction in inspiratory effort and increase in tidal volume with HFOT-T. It is a potential resource for the nurse practitioner and other clinicians who provide care to patients experiencing prolonged MV as it delineates a strategy to attempt in a challenging-to-wean patient with tracheostomy. Future investigations into the subtypes of underlying respiratory pathophysiology like GBS-associated respiratory failure or restrictive etiology might be helpful in discerning the patient population likely to benefit from HFOT-T.

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