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CASE REPORT

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Integrating incentive spirometry and progressive muscle training in managing respiratory compromise in Guillain–Barré syndrome

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Abstract

Background Guillain–Barré syndrome (GBS) is one of the most common causes of acute neuromuscular paralysis in developed and developing countries. It is a complex autoimmune disorder characterized by progressive skeletal muscle weakness, potentially involving respiratory muscles. The purpose of this case report was to explore the importance of combined use of incentive spirometry and progressive muscle training as essential therapies in a 20-year-old male diagnosed with GBS.

Case presentation This is a case report of a 20-year-old Nigerian male university student who was brought to the trauma center on a wheelchair with weakness of both upper and lower limbs which was said to be progressive, and a diagnosis of GBS was made by the attending physician. On examination, he was discovered to have quadriparesis with mild respiratory muscle involvement. He deteriorated with cardiopulmonary compromise and was transferred into intensive care unit. He was managed with supplementary oxygen therapy until there was significant improvement and he was weaned off oxygen therapy and then needed further evaluation and management. The patient was placed on immunoglobulin in conjunction with incentive spirometry, progressive strengthening exercise and exercise training which proved to be effective as he regained all the lost function within a few weeks of symptoms.

Results This intervention delves into the synergistic potential of fortifying respiratory muscles and improving respiratory function alongside overall muscle strength which resulted in the patient regaining all the lost function within a few weeks.

Conclusions The combined use of incentive spirometry and progressive muscle training in addition to immunoglobulin was effective in modulating GBS related impairments. We recommend the use of a multifaceted strategy in the management of patients with GBS and other similar health conditions.

Keywords Guillain–Barré syndrome, Incentive spirometry, Progressive muscle training, Respiratory muscle weakness, Respiratory support

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Background

Guillain–Barré syndrome (GBS) is less known and poses a significant challenge due to its autoimmune nature (Almeida et al. 2023; Kapre et al. 2022), often characterized by ascending muscle weakness (Kurup et al. 2023), sensory disturbances and in severe cases, respiratory involvement (Veltsista et al. 2023; Yadav et al. 2022) with global mortality rate of 2–10% (Kurup et al. 2023; Diale 2021). It is a complex autoimmune disorder characterized by progressive skeletal muscle weakness (Korinthenberg et al. 2020), potentially involving respiratory muscles (Almeida et al. 2023). The occurrence of GBS has been linked to several infectious agents with the outbreak of Zika virus epidemic associated with clusters of the disease (Yadav et al. 2022). An autoimmune response triggered by a preceding infection is responsible for the axonal degeneration and demyelination of nerve root and peripheral nerves in GBS. In rare case, GBS has been associated with treatment with immunomodulatory agents (biologic drugs or vaccines) (Chauhan et al. 2023).

The true incidence of GBS in many low- and middle-income countries (LMIC) is unclear due to scarcity of data. The presence of poor hygiene and high exposure to infectious renders most individual residing in LMIC vulnerable to the outbreaks of GBS, hence a need for an increased understanding of disease (Kurup et al. 2023). Furthermore, inadequate diagnostic and health-care services including electrodiagnostic machines in LMIC contribute to late and wrong diagnosis among patients who presents with severe symptoms of GBS (Papri et al. 2021). Additionally, the absence of affordable rehabilitation and effective treatments and lack of national clinical guidelines contribute to higher mortality and worse outcomes in LMIC (Petkevičiūtė et al. 2022). Therapeutic approaches involve immunomodulatory treatments (Bhagwatkar and Harjpal 2023) and rehabilitative strategies to manage neuromuscular and respiratory complications (Sulli et al. 2021).

The integration of incentive spirometry and progressive muscle training aims to provide a comprehensive intervention targeting respiratory and musculoskeletal aspects of GBS (Mohammed Yusuf et al. 2023). This study aimed to explores the importance of combined use of incentive spirometry and progressive muscle training as essential therapies in a 20-year-old male diagnosed with GBS.

Case presentation

This a case report of a 20-year-old male 200 level university student, was wheeled into accident and emergency department of Federal Medical Centre Azare with a history of sudden ascending muscle weakness and sensory changes. There was a history of high-grade fever which lasted for a few hours. There was also a history of headache said to be generalized, not severe enough to prevent him from his activities of daily living (ADL). There was no history of loss of consciousness, dizziness, or abnormal body movement or difficulty in swallowing; however, there was the presence of tingling sensations all over the patient's body. He had a preceding history of diarrhea 3 days ago. There was no history of trauma to the neck or back; however, he admits to history of mucoid stool and respiratory tract infection about 2 weeks prior to presentation. There was a history of weight loss 3 months ago. There was no cough or drenching night sweats or a history of recent vaccination or treatment for tuberculosis. He was not a known hypertensive, diabetic, or asthmatic. He does not smoke or drink alcohol and had no known drug allergies.

Patient was conscious, alert, and fully oriented in time place and person (TPP). Clinical evaluation and cerebrospinal fluid analysis confirmed the diagnosis of GBS. About 4 h later, signs of respiratory muscle weakness emerged while on admission, leading to respiratory difficulty, decreased lung function and the requirement for non-invasive ventilation (NIV) support. He was rushed to the intensive care unit (ICU) to receive supplementary oxygen therapy, and a physiotherapist was involved in the team to take care of his respiratory needs and improve skeletal muscle strength and function.

The patient's rapid progression into the acute phase of GBS presented a challenge in managing both neuromuscular and respiratory complications. Despite prompt initiation of immunoglobulin therapy and supportive care, the development of respiratory muscle weakness necessitated additional interventions to prevent further respiratory compromise.

Upon admission to ICU, the patient was weak. On examination, respiratory sounds were mildly decreased in the basal parts of both lungs. The neurological examination reveals the absence of swallowing or speech disorder, and intact cranial nerves. Both superficial and deep sensations were intact. Peripheral oxygen saturation (SpO_2) was 86%, respiratory rate was 18 cycles/min, arterial blood pressure was 118/75 mmHg, pulse rate was 80 b/min, and temperature was 36.8 °C. In both lower limbs, gross muscle power was 3/5 (knee flexor and extensors) and 3/5 at hip flexors and extensor on the oxford muscle grading scale. Ankle dorsiflexion was poor. Both lower extremities (LE) had numbness and tingling sensation; however, there was no superficial sensory defect. In the upper extremity (UE), muscle power was 2/5 according to oxford muscle grading scale. Hand grip was poor; however, there was no loss of sensation in the UE.

In addition to the treatment given due to respiratory symptoms, intravenous immunoglobulin (IVIG) treatment was started. In his daily follow-ups, muscle strength was found to increase every day. After receiving a total of 5 weeks of progressive physiotherapy treatment, there was marked improvement of LE muscle strength considering the Medical Research Council (MRC) scale (Table 1). The patient, whose respiratory symptoms and oxygen need decreased, was discharged from ICU.

Recognizing the need for a multifaceted approach, the patient underwent a tailored and intensive intervention regimen combining incentive spirometry and progressive muscle training under the guidance of a multidisciplinary team. The incentive spirometry sessions involved sustained maximal inspiratory effort to enhance lung expansion and optimize respiratory muscle function. Simultaneously, progressive muscle training comprised a structured program targeting specific muscle groups, including resistance exercises tailored to progressively strengthen the respiratory muscles and overall musculature.

Procedure

Incentive spirometry is a handheld mechanical device developed to encourage lung tissue reinflation, sustained maximal inspirations to resolve or prevent atelectasis. To achieve this, an incentive spirometer that provides feedback at predetermined volumes or flow following sustain patient inhalation for 5 s was employed. Incentive spirometry was adequately explained and taught to the patient, after which he was asked to exhale normally while holding the spirometer upright followed by tight grip of the mouthpiece of the device with the lips and then inhale slowly raising the plate/piston (volume-oriented) or the ball (flow-oriented) to a set target in the chamber. The mouthpiece was removed at peak inhalation, followed by a normal exhalation and breath-hold. Other care givers, parents, and guardians of the patient were also instructed on the proper use of the incentive spirometer which helps encourage adherence to therapy and facilitates the patient's appropriate use of the technique.

The patient was encouraged to perform incentive spirometry independently, following adequate instruction and return demonstration.

The frequency of spirometry exercise was ten (10) breaths every 2 h while the patient was awake (8:00 am to 10:00 pm). The visible feedback was also monitored and recorded. Initially, the maximum inspiration was less than 600 cc. However, with continuous training and performance, inspiration improved to 1200 cc.

The patient also performed endurance exercises. The exercise training (e.g., treadmill, cycling, and walking) was carried out for 5 days/week at an intensity of 70% of the O2 uptake reserve (difference between peaked and resting O_2 uptake) or heart rate (HR) reserve (difference between actual and predicted HRmax) for > 20 min (as convenient ~ 60–80% of peak work rate on a ramp exercise test), as a series of exercise-rest intervals or continuously (Gosselink et al. 1997; Holland et al. 2014).

The endurance exercise was immediately followed by resistance exercise. The exercise consists of 2–4 sets, with each set repeated for 6–12 times, at an intensity of 70% of the maximum weight that can be lifted, i.e., once one-repetition maximum (1-RM) (Holland et al. 2014). One repetitive maximum was determined to be 6 kg; therefore, a weight of 4.2 kg was calculated to be appropriate for LE training, whereas the UE repetitive maximum was determined to be 5 kg and 3.5 kg was calculated to be appropriate for the resistance training program.

Other progressive strengthening exercises used were assisted bridging exercises, assisted curl-up exercises, therapeutic positioning, and sit to stand training.

Table 1 Muscle strength before and after treatment based on MRC scale for muscle strength

Manual muscle strength	Before treatment		5 weeks after treatment	
	Right	Left	Right	Left
(A) Shoulder abductors	2	2	3	3
(B) Elbow flexors	3	3	4	4
(C) Wrist extensors	2	2	4	4
(D) Hip flexors	3	3	4	4
(E) Knee extensor	3	3	5	5
(F) Ankle dorsiflexors	2	3	4	4
Total (out of 60)	31		48	

Results

Throughout his hospitalization, the patient diligently adhered to the combined intervention regimen. The rehabilitation process encouraged a gradual increase of respiratory and skeletal muscle strength and led to functional recovery. Assessments were conducted to evaluate respiratory muscle strength, respiratory function, and overall muscle strength. His endurance improved from inability to tolerate exercise before intervention, to exercising for < 30 min and to ability to tolerate exercise for over 30 min after intervention. The SpO_2, Blood pressure, pule rate, respiratory rate, and temperature improve from 86%, 118/75 mmHg, 80 b/min**,** 18 cycles/min, and 36.8 °C at base line to 96%, 110/70 mmHg, 72 b/min, 16cycles/min, and 36.6 °C, respectively, after the intervention.

Treadmill walking at initial speed of 1.5 KMPH, progressed to 3.5 KMPH and longer duration of up to 20 min. The muscle strength of the LE increased from 3/5 at knee flexor and extensors and 3/5 at hip flexors and extensor to 5/5 at the knee flexor and extensors and 4/5 at hip flexors while that of the UE increase from 2/5 (wrist extensors) and 3/5 (elbow flexors) to about 4/5 at both wrist extensor and elbow flexors (Table 1). The maximal inspiratory capacity increased from 600 cc to about 1200 cc.

Discussion

The integration of a multidisciplinary approach including management in the ICU, chest physiotherapy (incentive spirometry and progressive muscle training), and immunotherapy in the management of neuromuscular and cardiorespiratory compromise has been supported in the literatures (Womboh et al. 2024). This case report explores the importance of the combined use of incentive spirometry and progressive muscle training as essential therapies in addition to immunotherapy in the management of a case of GBS.

The comprehensive and integrative approach of combining incentive spirometry and progressive muscle training in managing GBS-associated respiratory compromise proved effective in this case. The tailored interventions addressed the immediate respiratory concerns and the broader spectrum of muscle weakness, fostering improvements in overall physical function and quality of life for the patient. Similar cases were reported (Sulli et al. 2021).

Progressive muscle strengthening has also been reported to be effective in muscle weakness seen in neurological disorders (Petkevičiūtė et al. 2022; Wankhade et al.2024; Ewah et al. 2024). This is also evident in this case as patients showed remarkable improvement in functional activities including walking and other ADL. There was also improvement in muscular and cardiorespiratory endurance. These results corroborate with reports from other studies (Leale et al. 2024; Calatayud et al. 2020).

The patient young age and educational background and the absence of cognitive impairment may have influenced the patient's response to treatment. Since patient was educated in the use of the incentive spirometer as an inpatient patient there was no challenge carrying out the exercise at home. However, this may not be the case in elderly patients with respiratory compromise and cognitive impairment or among patients with poor educational background. In such cases, spirometer training exercise needs to be taught to the patient with verbal feedback from patient and in the presence of their caregiver to enhance correct adherence to the training at home (Womboh et al. 2024).

Limitations and strengths of the study

This study should be interpreted in lieu of some limitations. This study was focused on a single patient who was managed in the hospital by a multidisciplinary team, hence there should be caution as regards the generalization of the outcome to community-based patients using a single medical approach. Additionally, due to lack of appropriate laboratory diagnostic tools, electromyography, nerve conduction studies, and cerebrospinal fluid analysis were not carried out. However, there was adequate follow-up of the patient for about 5 weeks after treatment, which confirms that the patient's improvement was maintained.

Conclusions

The integration of incentive spirometry and progressive muscle training presents a promising avenue in managing respiratory muscle weakness and preserving lung function in individuals with GBS. This comprehensive intervention offers a multifaceted strategy to optimize both respiratory and musculoskeletal outcomes in GBS patients, potentially serving as a model for holistic management in similar cases.

Abbreviations

GBS	Guillain–Barré syndrome
UE	Upper extremity
LE	Lower extremity
MRC	Medical Research Council
LMIC	Low- and middle-income countries

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Not applicable.

Author contributions

BSB conceived the idea to conduct this study and was involved in patient management, preparing and writing the manuscript, LM was also involved in management of the patient. ID, PAE, and JM provided expert opinion concerning the care offered to the patient and contributed to preparation and writing of the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The data of this study are available upon request.

Declarations

Ethics approval and consent to participate

A detailed explanation of the purpose and procedure of the intervention was given to the patient. Written and verbal informed consents were obtained before starting the intervention.

Consent for publication

Not applicable.

Competing interests

All authors declare that they had no conflict of interest associated with this manuscript.

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