DOI: 10.21088/ip.2347.1506.13125.4

International Physiology
Volume 13 Number 1 January - June 2025

REVIEW ARTICLE

Guillain-Barré Syndrome: Unraveling the Mystery and Understanding the Pathophysiology

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HOW TO CITE THIS ARTICLE:

Amitava Khan. Guillain-Barré Syndrome: Unraveling the Mystery and Understanding the Pathophysiology. Int.Phy. 2025; 13(1): 33–39.

ABSTRACT

GBS stands as a unique autoimmune disease which prompts the body's immunity system to attack peripheral nervous system structures resulting in swift deteriorating muscle weakness coupled with total loss of reflexes and extreme cases lead to respiratory failure. The precise causes of GBS remain unknown although the majority of GBS cases begin following infections by *Campylobacter jejuni*, influenza and the Zika virus and rarely by vaccines and surgical procedures. Precise categories of Guillain-Barre syndrome include Acute Inflammatory Demyelinating Polyradiculoneuropathy (AIDP) and Acute Motor Axonal Neuropathy (AMAN) and Miller Fisher Syndrome (MFS). These subtypes show different patterns of nervous system damage. The combination of clinical features with cerebrospinal fluid tests showing albuminocytologic dissociation, nerve conduction studies serves to diagnose the condition. Protocols for management consist of immunotherapy applications combined with plasma exchange and intravenous immunoglobulin therapy which support patients through respiratory failure complications along with autonomic instability manifestations.

Patients normally recover within six to twelve months of diagnosis yet some patients face persistent deficits along with persistent symptoms including fatigue and neuropathic pain. The patients' expected outcomes are determined by their age at diagnosis together with their disease pronunciation and when they began treatment. Research today prioritizes discovering disease mechanisms while finding biomarkers alongside therapeutic strategy development. Progress in GBS care has cut the mortality rate and decreased long-term disabilities but ongoing

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➢ **Received:** 30-01-2025 ➢ **Accepted:** 18-04-2025

clinical research needs to push forward both treatment quality and patient care outcomes. This review demonstrates why healthcare professionals must actively raise awareness and immediately react to this complex condition while scientists must intensify their research into its ongoing challenges.

KEYWORDS

• Guillain-Barré Syndrome • Peripheral Nervous System • Neuropathy • Motor activity

INTRODUCTION

The French neurologists Georges Guillain and Jean Alexandre Barré and André Strohl first presented Guillain-Barré Syndrome (GBS) in 1916 and now it is recognized as the leading cause of acute flaccid paralysis globally[1]. Unfortunately both acute respiratory failure and life-threatening complications can occur when the swift development of muscle weakness in this uncommon neurological impairment goes unmanaged. On an average GBS affects one to two individuals per 100,000 people per year across all age ranges. Research shows that males get the disorder slightly more often than females do[1]. As of January 23, 2025, Pune in India reported 59 suspected GBS cases, with 35 new cases identified in a single day. Among the affected, 39 are males and 20 are females, with 12 patients requiring ventilator support. Researchers have not discovered the exact cause of Guillain-Barré Syndrome but accept the conclusion that it manifests because of autoimmune dysfunction. The disease's development starts after an additional infection triggers irregular responses from the body's immune system. Research shows *Campylobacter jejuni* functions as the leading bacterial microorganism that spurs gastroenteritis. Research supports the role of several different types of infections including cytomegalovirus and Epstein-Barr virus and influenza virus infections in triggering this syndrome[1-2]. While the majority of patients experience a single episode of GBS and recover fully or partially, some may develop long-term complications, highlighting the importance of early diagnosis and supportive care.

Pathophysiology

Guillain-Barre Syndrome (GBS) appears as an autoimmune condition where the body attacks peripheral nerves and nerve root structures thus creating diverse neurological dysfunction. Constellations of nerve damage appear in the peripheral nervous system after the body launches an immune response to fight infections. The various pathological mechanisms in GBS follow from demyelination alongside both axonal degeneration and these processes based on individual disease subtypes.[1-3] Molecular mimicry functions as a fundamental mechanism in GBS pathogenesis. Nerve tissue damage occurs when the immune system incorrectly attacks target cells thereby causing declining muscle function which may occasionally lead to whole-body immobility. GBS encompasses several subtypes, each with its own distinct pathological and clinical features: There are different ganglioside antibodies in Guillain-Barré syndrome named Anti-GM1, Anti-GM2, Anti-GD1a, Anti-GT1a, Anti-GQ1b[4]. This molecular mimicry between its surface lipo-oligosaccharide (LOS) and host peripheral nerve gangliosides. This triggers the production of cross-reactive antibodies targeting gangliosides like GM1, GD1a, and GQ1b, resulting in axoglial damage. Other pathogens associated with GBS include Epstein–Barr virus (EBV), cytomegalovirus (CMV), hepatitis E virus (HEV), *Mycoplasma pneumoniae*, *Haemophilus influenzae,* influenza A virus, and Zika virus. Mycoplasma pneumoniae is associated with anti-galactocerebroside antibodies of the IgG isotype, more frequently in children. The surface of nerve cells displays gangliosides which microbes use to generate antigen structures with comparable cellular signatures. Molecular similarities between pathogens and peripheral nerves prompt immune system attacks that ultimately cause the distinctive GBS features.

1. **Acute Inflammatory Demyelinating Polyneuropathy (AIDP):** North American and European populations most often experience this particular subtype of GBS. Widespread demyelination (loss of the nerve's insulating layer)

throughout peripheral nerves marks Acute Inflammatory Demyelinating Polyneuropathy. The damaged insulation layer of nerves inside peripheral nerve cells causes impaired signals and slower gradual onset of muscle weakness which mostly affects leg and arm muscles. The rehabilitation process from AIDP progresses slower than other GBS subtypes yet most patients restore strength after treatment with proper medical interventions.[3-4]

2. **Acute Motor Axonal Neuropathy (AMAN):** This form mainly appears in South American and Asian populations because its characteristics include axonal damage that does not trigger substantial demyelination. The immune response in AMAN attacks the axonal portions of motor neurons that transmit nerve signals to muscles thereby causing motor dysfunction. This subtype usually causes major limb muscle weakness but does not harm sensory nerves. The clinical outcome of AMAN is unpredictable because patients sometimes endure serious complications after recovery.[3-4]
3. **Acute Motor and Sensory Axonal Neuropathy (AMSAN):** Axonal neuropathy's severe AMSAN form targets both motor and sensory axons to produce total motor system impairment alongside extreme sensory deficiencies. People who have AMSAN face permanent disability due to the severe damage because this subtype leads to worse outcomes than other. Among GBS types AMSAN represents the most debilitating form because of its severe features.[3-4]
4. **Miller Fisher Syndrome (MFS):** The uncommon GBS subtype consists of three defining symptoms including paralysis or weakness affecting eye muscles combined with impaired coordination and lost reflexes. The autoimmune connection of MFS targets gangliosides present on both brainstem cells and peripheral nerves. Although the prognosis for MFS is generally better than for other forms of GBS, patients can still experience significant disability, and treatment is essential to manage symptoms and improve recovery[3-4].

While the clinical manifestations of GBS may vary depending on the subtype, all forms of the disorder share the potential for rapid progression and the need for urgent medical intervention. Early diagnosis and treatment are crucial in minimizing the risk of long-term disability, as therapies like intravenous immunoglobulin (IVIG) or plasmapheresis can help modulate the immune response and promote recovery. However, despite treatment, some individuals with more severe forms of GBS may experience lasting deficits or complications, underscoring the importance of ongoing monitoring and rehabilitation during recovery.

Clinical Features of Guillain-Barré Syndrome (GBS)

An acute autoimmune disorder called Guillain-Barré Syndrome (GBS) involves a rapid and often aggressive attack of the body's immune system on peripheral nervous system tissues. Slowing muscle weakness moves up the body beginning in the feet and reaching all parts of the body symmetrically during Guillain-Barré Syndrome. The following are key clinical features.[5-6]

1. Weakness:

Rapid Progression: When it first appears GBS initially causes weakness that rapidly expands during a few days starting with the legs before spreading to the upper body. The weakness moves upward through the body until it reaches the four major limb muscles in advanced cases leading to quadriplegia. The progressive nature of illness which manifests itself within hours or days represents a key GBS diagnostic feature.

Muscle Paralysis: Ventilatory support becomes necessary for patients who develop advanced GBS because the condition causes paralysis of breathing or limb movements.

2. Areflexia:

Loss of Reflexes: Transition to a state of areflexia characterizes GBS by disappearing deep tendon reflexes during the early disease phase. The knee-jerk reflex along with other reflexes develops either minimal response or complete disappearance in this condition.

3. Sensory Symptoms:

Paresthesia: Patients develop sensory disturbances that present as tingling and "pins

and needles" sensations (paresthesia) in their hands and feet.

Numbness: Sensory deficits related to numbness develop alongside motor symptoms to impair overall functional capacity yet they usually appear at lower levels than motor problems.

4. Autonomic Dysfunction:

Cardiovascular Symptoms: GBS patients commonly develop autonomic dysfunction which produces abnormal rapid heart rates and low blood pressure as well as irregular heart rhythm. Hospital monitoring together with necessary medical treatment becomes essential when these symptoms become dangerous during illness progression.

Respiratory Issues: Autonomic dysfunction causes respiratory problems which eventually lead to serious breathing failure during advanced stages of the condition. This may require mechanical ventilation.

5. Cranial Nerve Involvement:

Facial Nerve Palsy: The facial nerve (cranial nerve VII) suffers weakness as a common presentation in GBS disease. A diminished ability to show facial expressions occurs as a result of weak facial muscles. Individuals encounter problems with emotional expressions because they cannot smile and their eyelids fail to close properly.

Other Cranial Nerve Effects: The neural dysfunction affecting these cranial nerves can result in swallowing troubles combined with abnormalities in vision including double images (diplopia) or blurring.

Progression and Phases:

Acute Phase: The full extent of disease severity appears typically four weeks after symptoms begin. Weakness alongside sensory problems intensifies dramatically during this period[6].

Plateau Phase: Symptoms reach a stabilization point in which patients remain consistent between the acute phase and the plateau phase.

Recovery Phase: The plateau phase concludes with an incremental improvement process which starts with increased strength in patients' lower limbs. The recovery process typically lasts between seven months and one year but complete recovery rates are common and certain patients maintain mild persistent neurological abnormalities.

The clinical course of GBS is highly variable, with some patients experiencing a mild illness and others developing severe disability or requiring life support. Early diagnosis and supportive care are crucial to managing the disease and improving outcomes[7].

Diagnosis

The diagnosis of neurological disorders including Guillain-Barré Syndrome (GBS) and its different forms requires both a detailed clinical assessment together with laboratory tests and electrophysiological studies. The following diagnostic tools are commonly used[4-7]**:**

1. Lumbar Puncture (CSF analysis):

A lumbar puncture serves as a vital procedure to test cerebrospinal fluid (CSF). The diagnostic indicator of GBS shows elevated cerebrospinal fluid protein levels with normal white blood cell count which represents the albuminocytological dissociation pattern. The examination results demonstrate abnormal blood-brain barrier function coupled with elevated permeability among nerve roots which is characteristic of demyelinating diseases.

2. Electromyography (EMG):

The EMG diagnostic tool reveals information about how electricity works within neurological tissues including both nerves and muscles. Electromyography reveals both demyelinatory characteristics and indications of axonal injury in GBS diagnostic testing. Nerve conduction velocities are slowed in patients with demyelinating patterns whereas those with axonal damage demonstrate either reduced or totally absent motor response amplitudes. Specific test results separate GBS from alternative neuromuscular conditions.

3. Serology:

Doctors use laboratory tests to identify particular germs and antigens that show up in blood samples. Laboratory studies show *Campylobacter jejuni***,** cytomegalovirus (CMV), Epstein-Barr virus (EBV) and multiple other infections can trigger GBS development. The measurement of anti-GQ1b antibodies is essential for diagnosing patients with Miller Fisher Syndrome (MFS) and the related GQ1b subunit variant of GBS. The confirmation of

MFS often rests on antibody examinations that differentiate MFS from related GBS forms.

4. Imaging (MRI):

A spinal cord and nerve root examination with magnetic resonance imaging (MRI) might show nerve root enhancements representing signs of swelling. Medical professionals can use this technology to diagnose GBS and separate it from competing diagnoses that include transverse myelitis or spinal cord compression. The diagnostic results from MRI tests usually appear faint which encourages medical teams to use them together with other examination techniques.

Management

Proactive disease management focuses on stopping neuronal damage and easing symptom intensity and controlling disease-related disorders while helping patients recover fully. The successful treatment of this condition requires multidirectional approach which includes immunological interventions with supportive treatments alongside rehabilitation methods. Key interventions include[5-7]:

1. Immunotherapy

Intravenous Immunoglobulin (IVIG): Medical professionals start therapy with IVIG as their primary choice. The treatment mechanism of this therapy involves stopping pathogenic antibodies which fuel nervous system attacks yet disease manifestations persist due to biochemical issues. The administration of immunoglobulins from healthy donor pools enables immune regulation to protect myelin and axons from increasing damage.

Plasma Exchange (PLEX): During PLEX, medical staff extracts autoantibodies along with immune complexes from blood circulation. Treatment shows maximum results when used for emergency situations with quick-deteriorating diseases. PLEX serves two functions including treatment of inadequate IVIG responses and protection against life-threatening complications.

2. Supportive Care

Monitoring Respiratory Function: The respiratory systems of patients require careful tracking because 20-30% experience respiratory failure. The requirement for mechanical ventilation exists for patients who experience severe respiratory failure and have weak respiratory muscles together with diaphragmatic involvement. Recovery from GBS needs extended medical intervention including mechanical ventilation together with respiratory therapeutic practices.

Managing Autonomic Dysfunction: The autonomic nervous system dysfunction in patients leads to diverse problems with heart rhythms alongside blood pressure fluctuations and digestive system impairments. Treatment for these symptoms requires medications alongside proper hydration and available supportive measures. It remains vital to take proper measures that stop both deep vein thrombosis (DVT) formation and infections. Medical staff must use both anticoagulants and correct body positions to reduce deep vein thrombosis (DVT).

3. Rehabilitation:

Physical and Occupational Therapy: Physical and occupational therapy should start right after injury because it helps avoid prolonged disability. Through these therapies healthcare professionals can restore muscle strength while concurrently improving motor coordination and attaining functional independence.

Prognosis

The outcome for each patient varies extensively based on three main factors which include disease severity patient age and the time it takes to start treatment. The time span of significant recovery for most patients stretches from multiple months to approximately a year however their treatment outcomes can vary widely[8-9].

1. Favorable Prognosis

Younger Age: Young individuals usually experience superior recovery outcomes than older patients. Their bodies possess better nervous system capabilities which allow tissue healing through regeneration.

Rapid Initiation of Treatment: Prompt and appropriate treatment, especially within the first few weeks of symptom onset, increases the likelihood of recovery. The combination of early intervention prevents permanent tissue loss and helps the nervous system heal itself.

Mild Initial Symptoms: The recovery process becomes shorter and produces fewer long-term problems for people whose first symptoms

were mild. When patients present with sensory symptoms and limited motor issues they frequently achieve complete or almost complete recovery.

2. Poor Prognosis

Advanced Age: Full recovery after a stroke hinges on patient age because older people typically take more time for healing with reduced chances of complete restoration of function. With increasing age the body's natural ability to heal itself weakens which makes severe tissue damage more challenging to treat.

Severe Axonal Damage: Irreversible deficits occur when axonal tissues which support nerve signaling incur severe damage. The result is patients experiencing either permanent paralysis or prolonged muscle weakness.

Prolonged Mechanical Ventilation: Patients who need extended exposure to mechanical ventilators tend to show poorer recovery potential. Too much time spent on mechanical ventilation creates secondary healthcare issues that slow down the recovery process and result in both muscle muscle wasting as well as respiratory system infections.

3. Mortality and Residual Deficits

Mortality Rate: This condition has a mortality rate which falls between 3-7 percent. Respiratory failure caused by diaphragm paralysis and severe autonomic system complications affecting blood pressure control systems are the leading causes of mortality in these patients.

4. Residual Deficits

Despite successful treatment, about 20-30% of patients may experience some form of long-term disability, including weakness, fatigue, or sensory abnormalities. These deficits may improve over time with further rehabilitation but can be persistent for some individuals, especially if the damage was extensive.

CONCLUSION

As an acute disabling condition Guillain-Barré Syndrome (GBS) represents an autoimmune attack on peripheral nerves which develops after infections or vaccinations although some cases appear without known onset factors. GBS presents as a medical emergency because of its fast course and severe danger to life which necessitates quick diagnosis and therapy. Intravenous immunoglobulin (IVIG) therapy and plasmapheresis make up the standard GBS treatments by working to control the immune response and prevent nerve damage. Survival rates and treatment results for patients have improved as a result of these therapeutic approaches administered early during disease progression together with supportive measures including mechanical ventilation when respiratory failure occurs.

The treatment advances for immunotherapy together with critical care have not eliminated the ongoing challenges in severe GBS cases specifically when patients present with Miller Fisher Syndrome resulting in severe eye muscle paralysis or when GBS leads to lasting disability. Many GBS survivors need extensive recovery time followed by residual sensory and motor impairment that reduces their quality of life as a result.

The scientific community continues to study GBS's fundamental pathophysiological processes. Scientific evidence suggests peripheral nerve attacks by the immune system stem from a combination of genetic susceptibility conditions with potential environmental triggers. Accurate understanding of GBS pathogenesis through detailed studies of nerve immune attacks remains essential for developing advanced medicines and vaccines which might lower the development of GBS or reduce its severity.

The medical community has not discovered any treatments that can eliminate either GBS despite the availability of present treatment methods. Medical investigators continue their work to find better treatments for immunomodulation and investigate anti-inflammatory therapies as well as methods to prevent GBS relapses in patients who achieve recovery. The complex nature of the disease maintains an urgent necessity to conduct medical study for enhancing both immediate medical treatments and long-term rehabilitation solutions for those affected by GBS.

Conflict of Interest: None

Funding: None

REFERENCES

1. Willison, H.J., Jacobs B.C., van Doorn P.A. Guillain-Barré syndrome. The Lancet. 2016; 388(10045): 717-727.

2. Yuki N., Hartung, H.P. Guillain-Barré syndrome. New England Journal of Medicine. 2012; 366(24): 2294-2304.

3. Sejvar J.J., Baughman A.L., Wise M., Morgan OW. Population incidence of Guillain-Barré syndrome: a systematic review and meta-analysis. Neuroepidemiology. 2011; 36(2): 123-133.

4. Bellanti R., Rinaldi S. Guillain-Barré syndrome: a comprehensive review. Eur J Neurol. 2024; 31: e16365.

5. Khan S.A., Das P.R., Nahar Z., Dewan S.M.R. An updated review on Guillain-Barré syndrome: Challenges in infection prevention and control in low and middle-income countries. SAGE Open Medicine. 2024; 12: 1–8.

6. Leonhard S.E., Mandarakas M.R., Gondim FAA, Bateman K *et al.* Diagnosis and management of Guillain–Barré syndrome in ten steps. Nature Reviews Neurology. 2019; 15: 671-683.

7. Abuawwad T.M., Taha M.J.J., Taha A.J., Kozaa Y.A., Falah O., Abuawwad T.I., Hammad E.M., Mahmoud A.A., Aladawi A., Serhan HA. Guillain-Barr´e syndrome after COVID-19 vaccination: A systematic review and analysis of case reports. Clinical Neurology and Neurosurgery. 2024; 238: 108183.

8. Winer J.B. Guillain-Barré syndrome. B.M.J. 2008; 337: a671.

9. Esposito S., Longo M.R. Guillain–Barré syndrome. Autoimmunity Reviews. 2017; 16: 96–101.