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Guillain-Barre Syndrome: Pathogenesis, Variants, and Evolving Treatment Strategies

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Abstract: Guillain-Barré Syndrome (GBS) is an acute, immune-mediated polyneuropathy that represents one of the leading causes of rapid-onset neuromuscular paralysis worldwide. It is commonly triggered by preceding infections such as Campylobacter jejuni, cytomegalovirus, Epstein-Barr virus, Zika virus, and SARS-CoV-2, which induce an aberrant immune response through molecular mimicry, resulting in demyelination, axonal injury, or both. GBS encompasses several clinical subtypes, including acute inflammatory demyelinating polyneuropathy (AIDP), acute motor axonal neuropathy (AMAN), acute motor-sensory axonal neuropathy (AMSAN), Miller Fisher syndrome (MFS), and chronic inflammatory demyelinating polyneuropathy (CIDP), each exhibiting unique pathophysiological mechanisms and clinical patterns. Early diagnosis and prompt intervention remain crucial for preventing severe complications, including respiratory failure and autonomic dysfunction. Therapeutic strategies such as intravenous immunoglobulin (IVIG) and plasma exchange (PLEX) are the mainstay treatments and significantly improve functional recovery. Despite advancements, challenges persist in predicting disease progression and individual patient outcomes due to its heterogeneous nature. This review consolidates current insights into the epidemiology, pathogenesis, clinical variants, diagnostic approaches, and management of GBS. Furthermore, it highlights recent findings on immune dysregulation and potential therapeutic targets, emphasizing the need for ongoing research to develop precision-based treatment strategies and improve long-term outcomes for affected individuals.

Keywords: *Guillain-Barré Syndrome, Immune-Mediated Neuropathy, Molecular Mimicry, Demyelination, Intravenous Immunoglobulin, Plasma Exchange.*

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I. INTRODUCTION

This ailment, which is often known as Landry's paralysis, was initially described by a French physician in 1859. Guillain-Barre, and Strohl described this syndrome in 1916, following the French physicians. The illness, known as Guillain-Barre Syndrome, has gained widespread recognition on a global scale. In modern times, Guillain-Barre syndrome is the most common cause of acute neuromuscular paralysis. (35) Although the typical type of sudden paralysis caused by the nerve damage is Guillain-Barre syndrome, yet it is still curable. (1) (3) It could involve malfunctioning autonomic or sensory nerves, or both. (4) For a better prognosis, early therapy is essential. (3) Results are greatly enhanced by prompt beginning care. This condition typically happens after infections such as Campylobacter jejuni, cytomegalovirus, coronavirus for severe acute respiratory syndrome, Zika virus (which is spread by Aedes aegypti mosquitoes), rabies, Epstein-Barr virus, Mycoplasma pneumoniae, varicella zoster virus, swine influenza, or other immune triggers GBS that attacks the spinal roots and peripheral nerves that triggers an atypical immune response. (1,2,5) Men are affected more likely than women to have the condition, and the prevalence rises with age. 0.6 instances per 1,00,000 in children and 2.7 cases per 1,00,000 in those 80 years of age and older. Peaks are observed in the elderly, late adolescence, and early adulthood. It is believed that weakened immune suppressor systems are the cause of the peak in the elderly, while the exact cause is uncertain.

GBS patients usually exhibit tingling dysesthesias in their extremities along with weakness. Legs are more frequently affected than arms by this weakness, which is mostly in the proximal muscles. When paresthesia happens, they usually spread proximally but typically go beyond the ankles and wrists. Deep tendon reflexes go away in the initial days after the beginning of symptoms. Following the stage of rising, a plateau phase occurs where the symptoms remains constant. It will start to improve within a few days of the plateau. Symptom relief takes different amounts of time for different patients. (6) It is advantageous to plasma exchange or to administer intravenous immunoglobulin (IVIg) as soon

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as possible. It is believed that Guillain-Barre syndrome is an immune-mediated condition that affects many nerve roots, causes about 1,00,000 new cases each year worldwide. (2) About half of all patient's experience pain, which is another typical symptom of GBS. It can be regarded as intense and can happen with even the smallest movement.

The back, posterior thighs, and shoulder girdle are where the pain is most intense. Muscle cramps may accompany the pain, which is at its worst at night. (31) While there are several symptoms associated with GBS, the most common ones are a growing weakness of the axial, face, respiratory, or limb muscles, together with or without autonomic or sensory abnormalities. (32) Acute or subacute weakness in limbs or muscles innervated by cranial nerves is a common feature of a series of immunological illnesses known as Guillain-Barre Syndrome. Subsets of Guillain-Barre Syndrome can be categorized using a variety of unique characteristics in pathogenesis and clinical presentation. (33, 34) It is an acute polyneuropathy mediated by the immune system. Rapidly increasing symmetrical limb weakness is its defining feature; sensory abnormalities and decreased or missing deep tendon reflexes are frequently present as well. In 1916, Andre Strohl, Jean Alexandre Barré, and Georges Guillain initially identified this condition. Since then, it has been recognized as a group of similar conditions that includes acute inflammatory demyelinating polyneuropathy (AIDP), Miller Fisher syndrome (MFS), acute motor axonal neuropathy (AMAN), and acute motor-sensory axonal neuropathy (AMSAN). (36) Campylobacter jejuni, CMV, Epstein-Barr virus, or, more recently, SARS-CoV-2 are the infections typically occur early to GBS. Axonal injury and/or demyelination result from the pathogenesis's molecular mimicry, in which host immune responses against microbial antigens interact with peripheral nerve components. (37)

Although this can rise during viral outbreaks, the annual global incidence of GBS is roughly 1-2 cases per 100,000 people (5). To lower morbidity and avoid consequences like respiratory failure and autonomic dysfunction, early diagnosis and timely treatment such as plasma exchange or intravenous immunoglobulin (IVIG) are essential. (38) This review presents a thorough analysis of Guillain-Barre Syndrome's clinical subtypes, pathogenesis, diagnostic techniques, and contemporary therapeutic options.

- *Definition:*

As per the WHO, it is a rare condition where the body's immune system attacks the peripheral nerves, causing muscle weakness and sometimes paralysis. Guillain- Barre syndrome is potentially life-threatening. (7)

As per NIH, Guillain-Barre syndrome (GBS) is a rare but serious post-infectious immune-mediated neuropathy. It results from the autoimmune destruction of nerves in the peripheral nervous system, causing symptoms such as numbness, tingling, and weakness that can progress to paralysis. (8)

II. HISTORY OF GBS

Early accounts from 1859 to 1900 described patients with sensory problems, paralysis, and muscle weakness; however, these conditions were not yet recognized as a separate syndrome. These cases were commonly referred to as "ascending paralysis" due to the fact that they generally originated in the lower limbs and worked their way up. In 1916, French neurologists Jean-Alexandre Barre and Gustave Guillain-Barre collaborated to report on several cases, providing the groundwork for the eventual identification of Guillain-Barre Syndrome as a separate clinical entity. The first official identification of what is now known as GBS was made in one of their publications, which reported patients with sudden flaccid paralysis, sensory abnormalities, and high CSF fluid protein levels (albuminocytologic dissociation).

Although the syndrome was recognized between the 1920s and 1940s, nothing was known about its underlying origins. Many doctors thought it might be related to other viral infections or a type of polio. Concerns regarding potential connections to immunological responses brought on by vaccines or infections throughout the 1940s and 1950s were aroused by the increased incidence of GBS among troops during and after World War II, especially among those who had received vaccinations. The association between GBS and infections received more attention as bacterial and viral illnesses, such as influenza and Campylobacter jejuni, were found to be possible triggers. During this period, several studies began to discover the ascending paralysis pattern, even if the exact mechanism causing GBS was still unknown. (10) The immune-mediated theory of GBS gained popularity in the 1960s and 1970s. Studies suggest that a demyelinating process in which the body's immune system attacks peripheral nerves may be the cause of GBS.

This information was crucial for developing future treatments. (10) 1976: A pivotal point in GBS history was the introduction of the swine flu vaccination in the United States. Researchers discovered a sharp rise in GBS cases after immunization, which alarmed the public and led to the mass vaccination campaign's termination. However, subsequent studies showed that the risk of acquiring GBS following vaccination was far lower than the risk of acquiring the illness without vaccination. (10) 1980s: The primary focus of the study was on the abnormalities in cerebrospinal fluid (CSF) in GBS and the associated phenomenon of albuminocytologic dissociation, which is a rise in protein with a normal white blood cell count.

The diagnosis of GBS depends primarily on the discovery. (11) In the 1980s and 1990s, the plasma exchange (plasmapheresis) method was initially applied to treat GBS. It was predicated on the notion that improved outcomes would arise by removing harmful antibodies from the blood. Then came intravenous immunoglobulin (IVIg) therapy, which became a popular kind of treatment in the 1990s. (11) 2000s: Advances in immunology have led to a better understanding of how GBS develops, showing that the body's immune system attacks the myelin sheath of peripheral

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neurons, often after a bacterial or viral infection. Research also emphasized the genetic factors that may predispose individuals to develop GBS. (12) 2010s: The 2015–2016 Zika virus outbreak raised concerns regarding a potential link to GBS because numerous Zika virus infections led to the development of the illness. This led to more studies on viral illnesses, such as GBS. (12) GBS and COVID-19: The COVID-19 pandemic led to a sharp rise in GBS cases associated with SARS-CoV-2 infections. This prompted further research into the idea that autoimmune reactions brought on by viral infections could result in GBS. (12)

III. EPIDEMIOLOGY

GBS is evenly dispersed over the western hemisphere, according to observations made as of 1998. According to data from the USA, the incidence of GBS increased from 1·2 per 100,000 in 1935–1956 to 2·4 per 100,000 in 1970–1980. The incidence in Ferrara, Italy, rose from 1·09 in 1981–1983 to 2·73 in 1991–1993. Using hospital records, a 1997 study in the USA found that the annual incidence among persons over 70 was 8·6 per 100,000. Morbidity and mortality increased in tandem. (6) As of 2016, this syndrome is a prevalent and post-infectious disease. 25–50% of adult patients had the most common infection C jejuni in Asian countries. Additional diseases that cause GBS includes cytomegalovirus (CMV), Mycoplasma neumoniae, Epstein-Barr virus, Haemophilus and influenza A virus, influenzae. Guillain-Barre syndrome, which is the worldwide pandemic spreads, is increasingly being related to acute arbovirus infections like Zika and chikungunya. GBS has also reported quickly after receiving the Semple rabies vaccine and a number of influenza A virus vaccine. Guillain-Barre syndrome was developed in 1976 during the H1N1 influenza A vaccine campaign. However, in 2009, a similar correlation was proposed for the H1N1 influenza A vaccination. (1) According to population-based research carried out in North America and Europe, the incidence is between 0·81 and 1·91 cases per 100,000 person-years as of 2021. The prevalence of GBS syndrome is higher in males than in women. (2) Finland (0.84), Tanzania (0.83), China (0.67), and Japan (0.44) have the lowest estimated yearly incidence, while Chile (2.12) and Bangladesh (3.25) have the highest estimates, according to 2024. (3) *(fig. 1)*

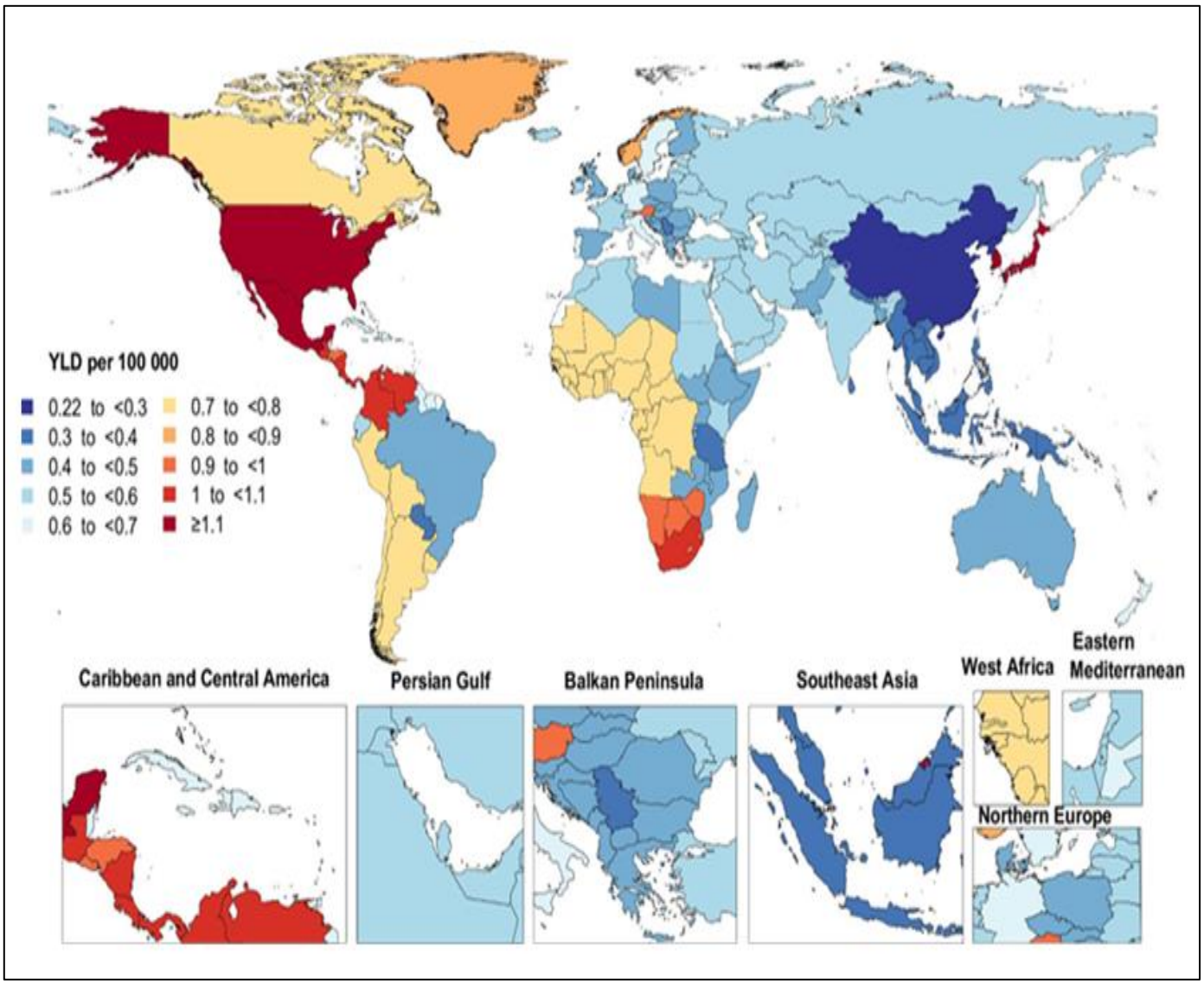

Fig 1 Global Epidemiology and Incidence Trends of Guillain-Barré Syndrome (GBS)

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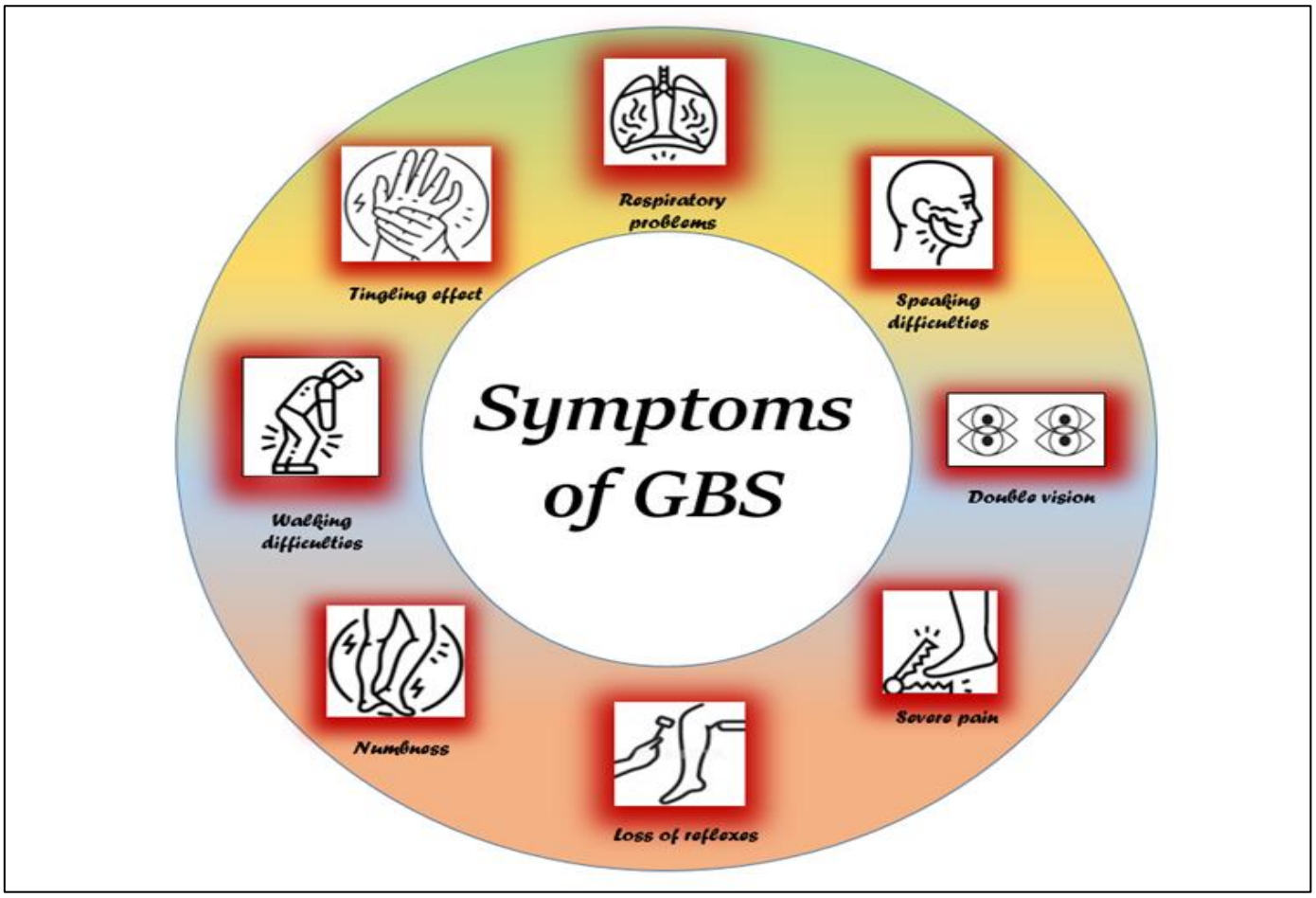

Fig 2 Symptomatology of Guillain-Barré Syndrome

IV. PATHOGENESIS OF GBS

In most patients, the major cause of GBS is the preceding infection. Cross linking of the antibodies to the different antigen is found to be the infectious reason except other than Campylobacter jejuni (C. jejuni) and Mycoplasma pneumoniae (M. pneumoniae). Three fourth of the patients experienced enteric infections and respiratory infection before the occurrence of neurological symptoms. (39) *(fig. 3)*

- *C. Jejuni:*

C. jejuni bacterium is one of the major cause of GBS in 30% of patients. GBS and C. jejuni are connected via bacterial lipo-oligosaccharides and peripheral nerve gangliosides. Some C. jejuni strains, including GM1, GD1a, and GQ1b, have lip oligosaccharides (LOS) on their surface that structurally resemble human gangliosides. Certain genes in C. jejuni, including as cst-II, cgtA, and cgtB, are involved in the manufacture of sialylated LOS structures that resemble these gangliosides, which is why this mimicry occurs. When the immune system comes into contact with these mimic structures during an infection with C. jejuni, it creates antibodies that specifically target the bacterial LOS. An autoimmune attack on nerve tissues may result from these antibodies' cross-reaction with the body's own peripheral nerve gangliosides, though, because of their structural similarities. These cross-reactive antibodies cause inflammation and injury to the nerve axons by binding to nerve gangliosides and activating the complement system. This immune-mediated injury leads to the characteristic muscle weakness and paralysis observed in GBS patients. (14) *(fig. 4)*

- *Cytomegalovirus:*

Antibodies against the peripheral nerve membrane component ganglioside GM2 can be produced as a result of CMV infection. Because human gangliosides and CMV antigens have structural similarities, the body's immune system attacks its own nerve tissues, triggering an autoimmune response. The demyelinating variant of GBS is specifically linked to this mechanism. The GM2 epitope is expressed on the surface of CMV-infected fibroblasts, according to research. The immune system may create anti-GM2 antibodies in response to this abnormal expression, which can then cross-react with peripheral nerve components to cause demyelination and the clinical signs and symptoms of GBS. Apart from molecular mimicry, CMV infection can also lead to an increased immune response, characterized by the production of inflammatory cytokines and T-cell activation. This inflammatory condition can exacerbate nerve injury and play a role in the development of symptoms of GBS. (15) *(fig 5)*

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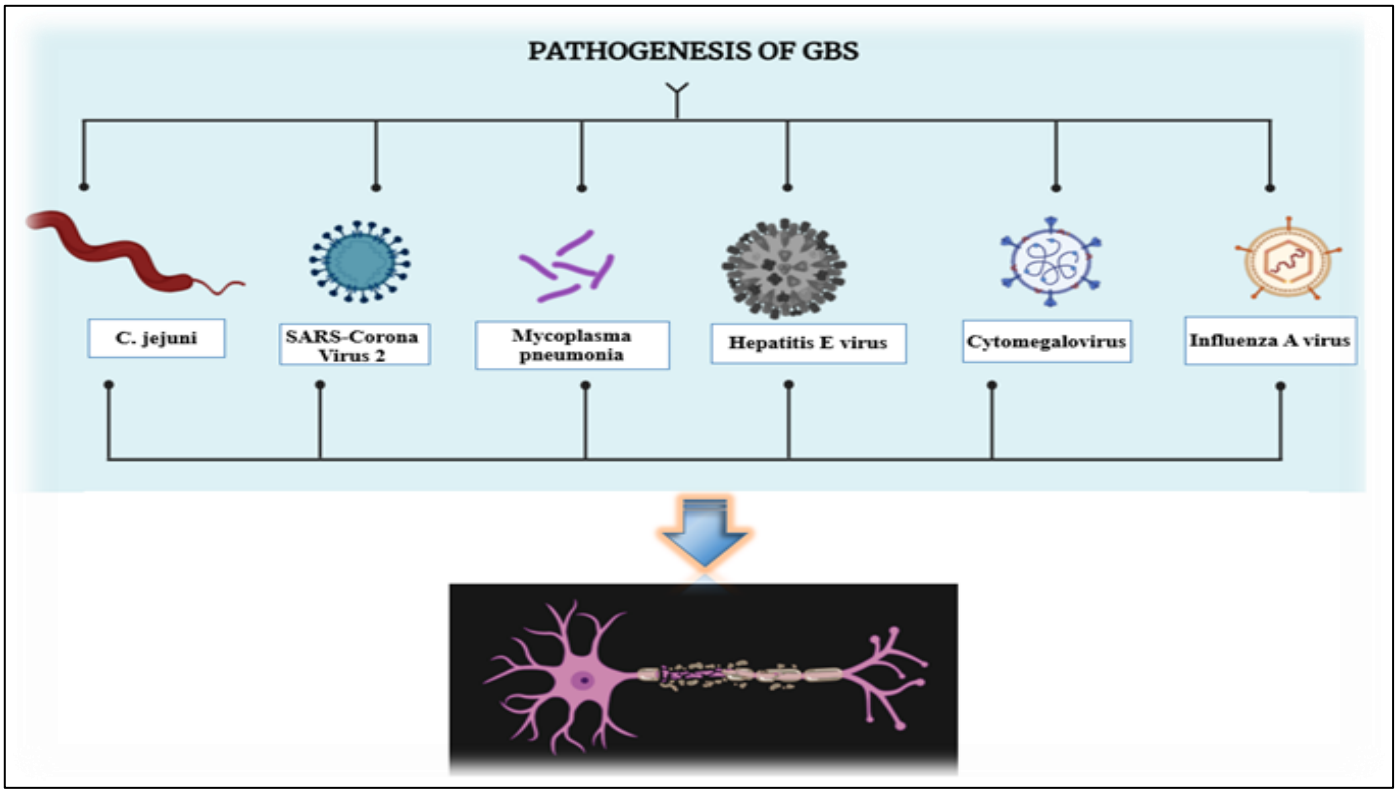

Fig 3 Pathogenesis of GBS

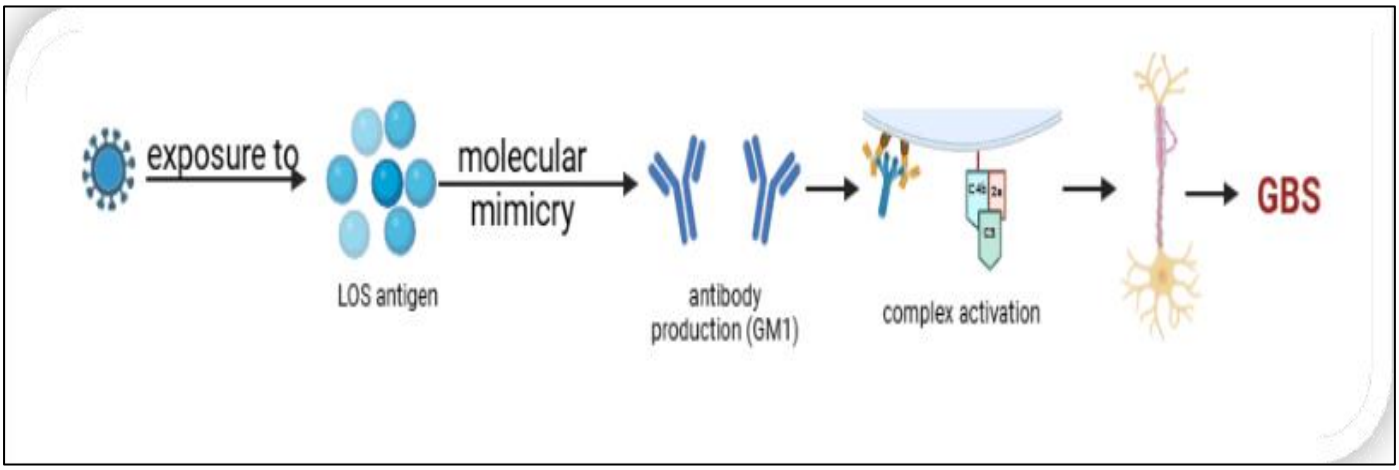

Fig 4 Immunopathogenesis of Guillain-Barré Syndrome via Molecular Mimicry by C.jejuni

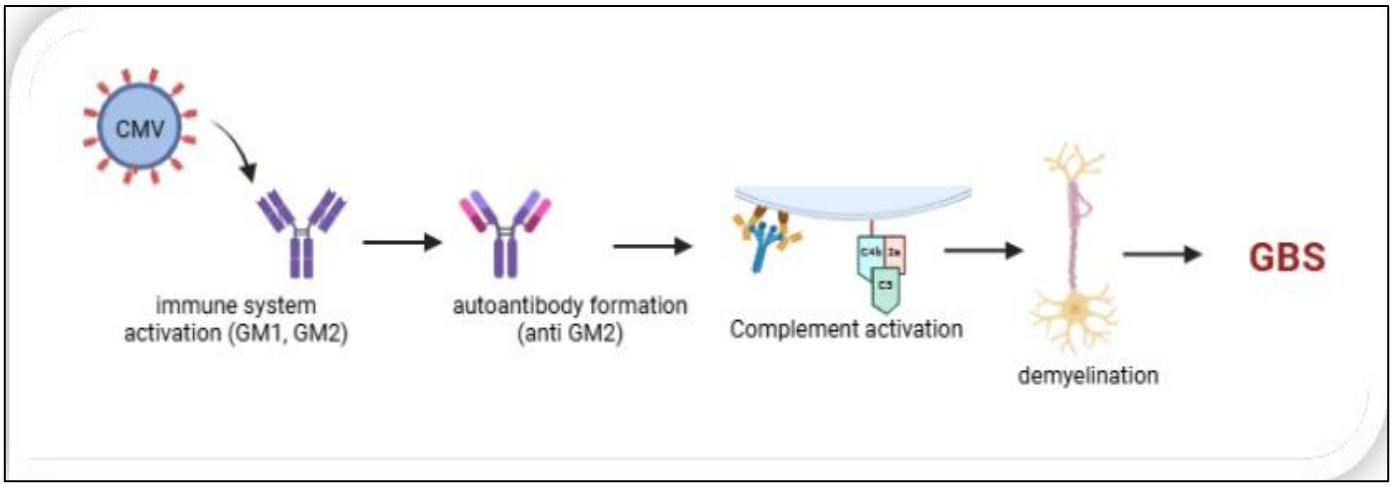

Fig 5 GBS Development Triggered by Cytomegalovirus (CMV) Infection

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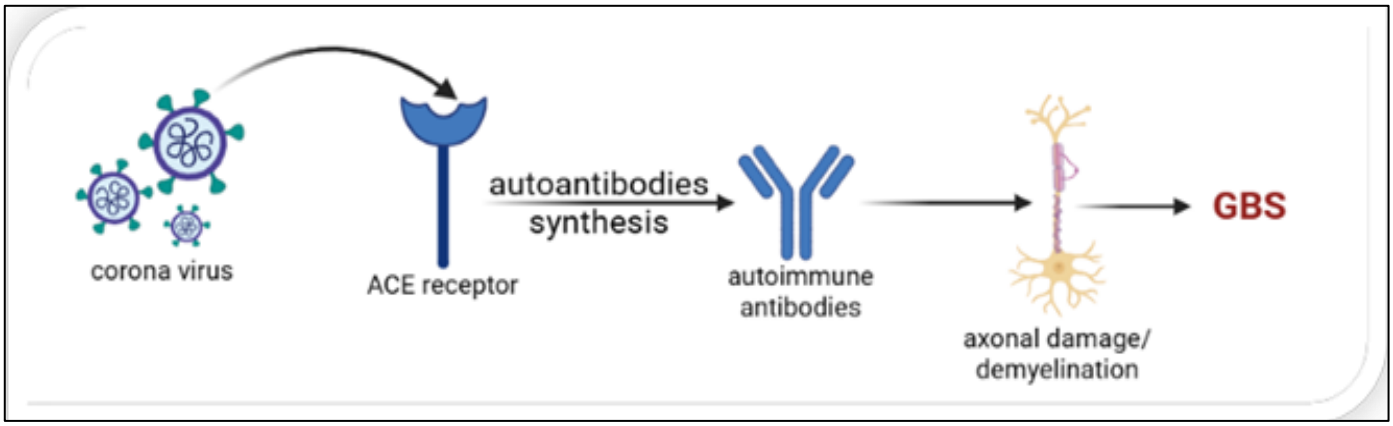

Fig 6 SARS-CoV-2–Induced Pathogenesis of Guillain-Barré Syndrome

➢ *Coronavirus:*

Peripheral nerve components are structurally identical to those of the SARSCoV- 2 virus. Because of this similarity, antibodies may be produced that inadvertently target nerve tissues, triggering an autoimmune reaction. Pro-inflammatory cytokines can be released when COVID-19 activates the immune system. GBS can develop as a result of these cytokines' propensity to raise the blood-nerve barrier's permeability, which permits immune cells and antibodies to target nerve structures. SARS-CoV-2 may cause inflammation and harm to the peripheral nervous system by directly infecting nerve cells. GBS may develop as a result of this direct neurovirulence. The bloodnerve barrier may be disrupted as a result of microvascular dysfunction linked to COVID-19. This disruption can facilitate the entry of immune cells into nerve tissues, promoting inflammation and the development of GBS. (16) *(fig 6).*

V. PRINCIPLE SUBTYPES OF GBS

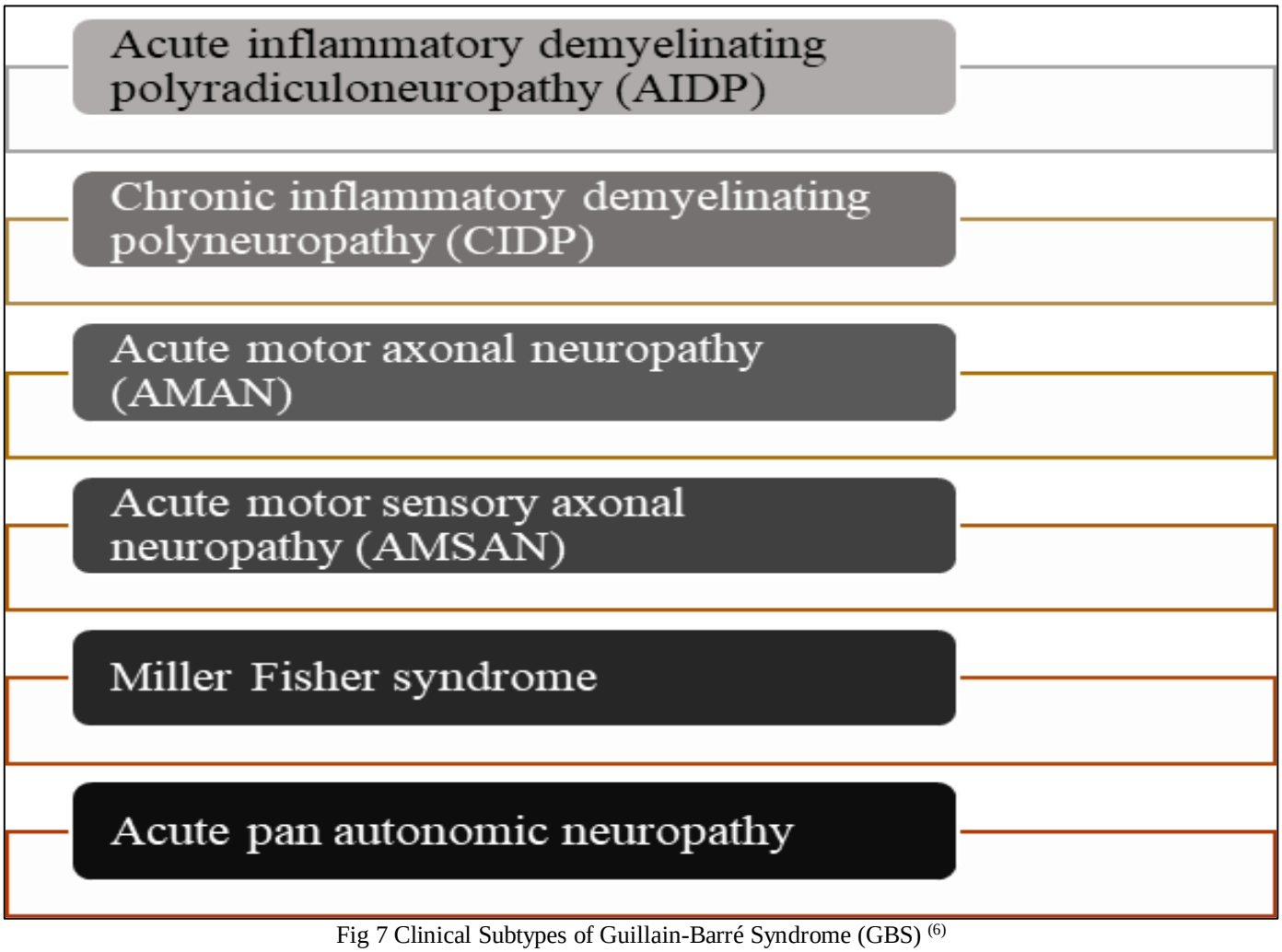

Fig 7 Clinical Subtypes of Guillain-Barré Syndrome (GBS) [6]

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- *Acute Inflammatory Demyelinating Polyradiculoneuropathy (AIDP):*

Moderate sensory abnormalities and progressive reflex weakening are markers of acute inflammatory demyelinating polyneuropathy (AIDP). Motor weakness is sometimes preceded by sensory complaints. Respiratory failure affects 20% of patients. AIDP is the most common type of Guillain-Barré syndrome (GBS), accounting for over 90% of patients in North America and Europe. (17) The term "GBS" refers to a group of different but related acute-onset peripheral nerve diseases that are usually postinfectious and believed to be carried on by an autoimmune mechanism. Acute motor axonal neuropathy (AMAN), which accounts for 10% of GBS cases, and AIDP are the two most prevalent types of GBS. These regional disparities in the incidence of AIDP and AMAN could be a sign of variances in infectious forces and immunogenic repertoire. (17) The most prominent form of acquired demyelinating polyneuropathy is acute inflammatory demyelinating polyneuropathy (AIDP). The annual incidence is between 0.6 and 1.7 cases per 100,000. Usually, ventilation-related complications result in mortality. Over 75% of patients recover completely or almost completely, with either no impairment or just slight residual weakness and weariness in the distal region. About 15% of people develop severe neurological aftereffects. Only 2% to 6% of patients die, and the most common causes are sepsis, pneumonia, severe bronchospasm, ARDS, pulmonary embolism, and cardiac arrest. (17,18) A tingling feeling in the fingers, wrists, ankles or toes, weakness in the legs that spreads to the upper body, unsteady walking, difficulty climbing stairs, Problems with facial mobility, include difficulties in moving the eyes, having double vision or having trouble in speaking, eating, or swallowing, shooting, Achy, or cramping discomfort that may be worse at night, trouble regulating one's urine or intestines, an elevated heart rate, Regardless of the level of blood pressure, Breathing problems are among the symptoms that persons with GBS may experience. Hepatitis A, B, C, and E, Epstein-Barr virus, Zika virus, Mycoplasma pneumonia, trauma, Hodgkin lymphoma, surgery. Rarely, childhood or influenza vaccines and the COVID-19 virus will be the main causes of AIDP in GBS patients. (18) A characteristic of AIDP, according to certain post-mortem examinations, is inflammatory infiltrates made up of T cells and macrophages involved in macrophagemediated demyelination. The activated complements can be found on Schwann cells, suggesting antibody-mediated nerve damage. The target antigens in AIDP are still unclear. Myelin proteins PMP22, P0, and P2 and the nodal protein neurofascin are likely targets, in accordance to research on experimental autoimmune neuritis. Based on the research, recovery is determined by the remyelination process and the extent of subsequent axonal degradation. (2) Nonetheless, the pathophysiology of the most prevalent AIDP variant of GBS remains poorly understood. *(fig 8)*

- *Chronic Inflammatory Demyelinating Polyneuropathy (CIDP):*

In 1/20 of patients, due to repeated relapse, they experience acute onset chronic inflammatory demyelinating polyneuropathy (A-CIDP). CIDP is considered to be a distinct disease system for both management and treatment. (39) In compliance with European Federation of Neurological Societies and Peripheral Nerve Society, the symptoms of this condition worsen over at least 8 weeks/2 months. The cause of this condition are pathologic of peripheral nerve demyelination, immunosuppression or immune modulating therapies. (40) It can be treated with IVIG, plasma exchange and steroids. CIDP usually develops slowly and causes muscle weakness, reduced or absent reflexes, numbness, tingling, and onset of weakness. There are 2 types of CIDP, “typical” and “Atypical”. (41) “Typical form of CIDP is the common phenotype seen in 50% of patients affecting the motor neurons. “Atypical form of CIDP involves various entities such as sensory, motor, focal, multifocal or distal neurons.

- *Acute motor Axonal Neuropathy (AMAN):*

In contrast with AIDP, patients with AMAN have initial axonal damage without significant T-cell inflammation or demyelination. According to a review of AMAN, it causes conduction to slow down because nodal membrane capacitance rises. AMAN symptoms, such as motor neuropathy, circulating anti-GM1 antibodies, and pathological signs of IgG deposition on motor axons and periaxonal macrophages, was developed from GM1 ganglioside vaccination in rabbits, said a research. The severity of axonal changes brought on by antibody deposition impacts recovery from AMAN. When autoantibody-mediated conduction block resolves, a tiny percentage of AMAN patients recover quickly. The absence of A T cells, as in AIDP, in AMAN patients raises the possibility that patients with demyelinating and axonal GBS have different immunopathological processes. Respiratory failure seems to be more common in patients with AMAN, while the difference is not statistically significant. It implies that respiratory failure and persistent paralysis over a few days are more likely to occur in patients with AMAN. (3) When rapid recovery is not observed despite the use of IVIg or PE, early tracheostomy is advised, especially for individuals with dysphagia, AMAN, and AMSAN. The most prodromal risk factors for AMAN are ganglioside administration, immunization, and gastrointestinal infections (mostly C. jejuni). Serum GM1, GD1a and GM1b antibodies, as well as CSF proteins, are frequently elevated in case of AMAN. (4) Sporadic AMAN instances have been reported globally; in current prospective series, they account for 10–20% of GBS patients. (19) AMAN was first used to describe case reports of acute ascending paralysis, which was a summertime epidemic that affects the remoter area children in northern China every year. In addition to being seropositive for C jejuni, 76% of Chinese AMAN cases also showed IgG antibodies to G¬1. (20) Since the ability for nerve regeneration is likely to be greatest during childhood, regeneration of motor-nerve terminals over the necessary short distance can occur quickly. This may account for the swift recovery from paralysis and generally favorable prognosis of many children with AMAN. (21) *(fig 9)*

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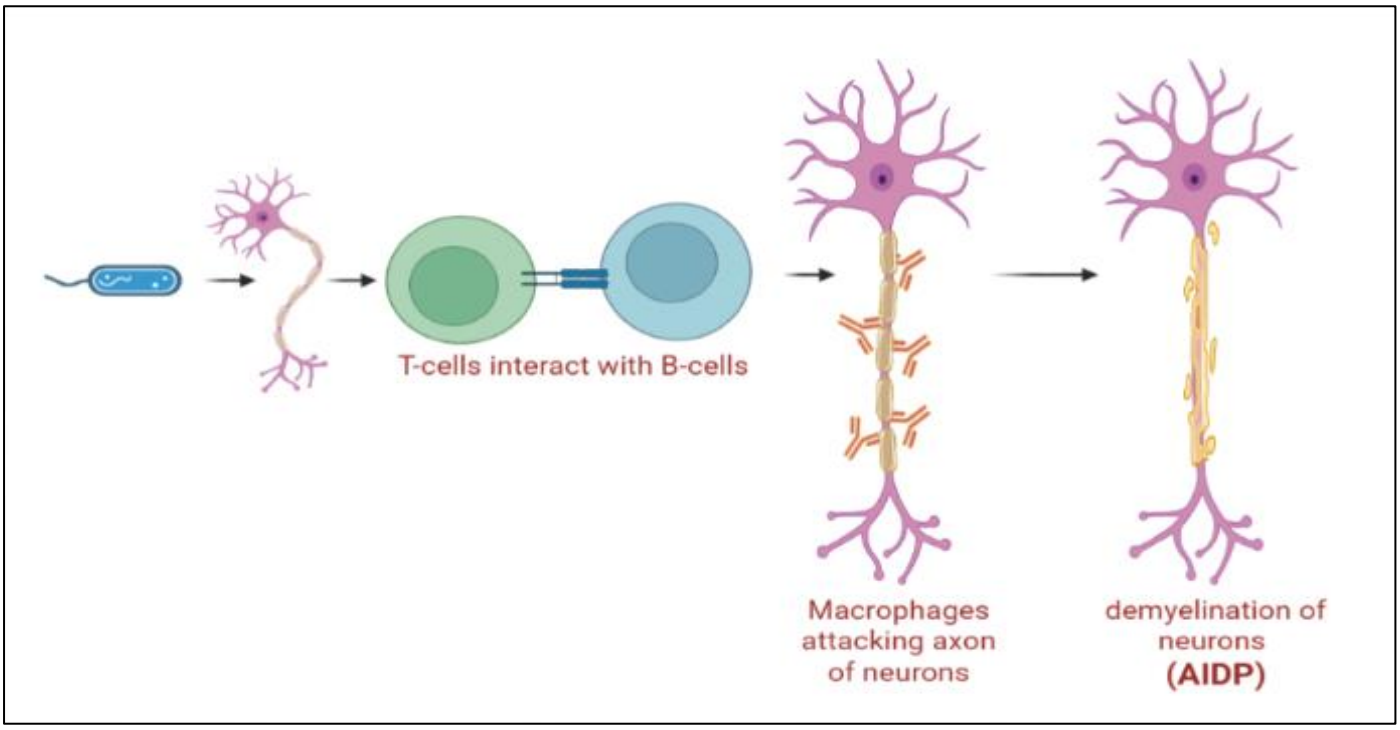

Fig 8 Immunopathogenesis of Acute Inflammatory Demyelinating Polyradiculoneuropathy (AIDP)

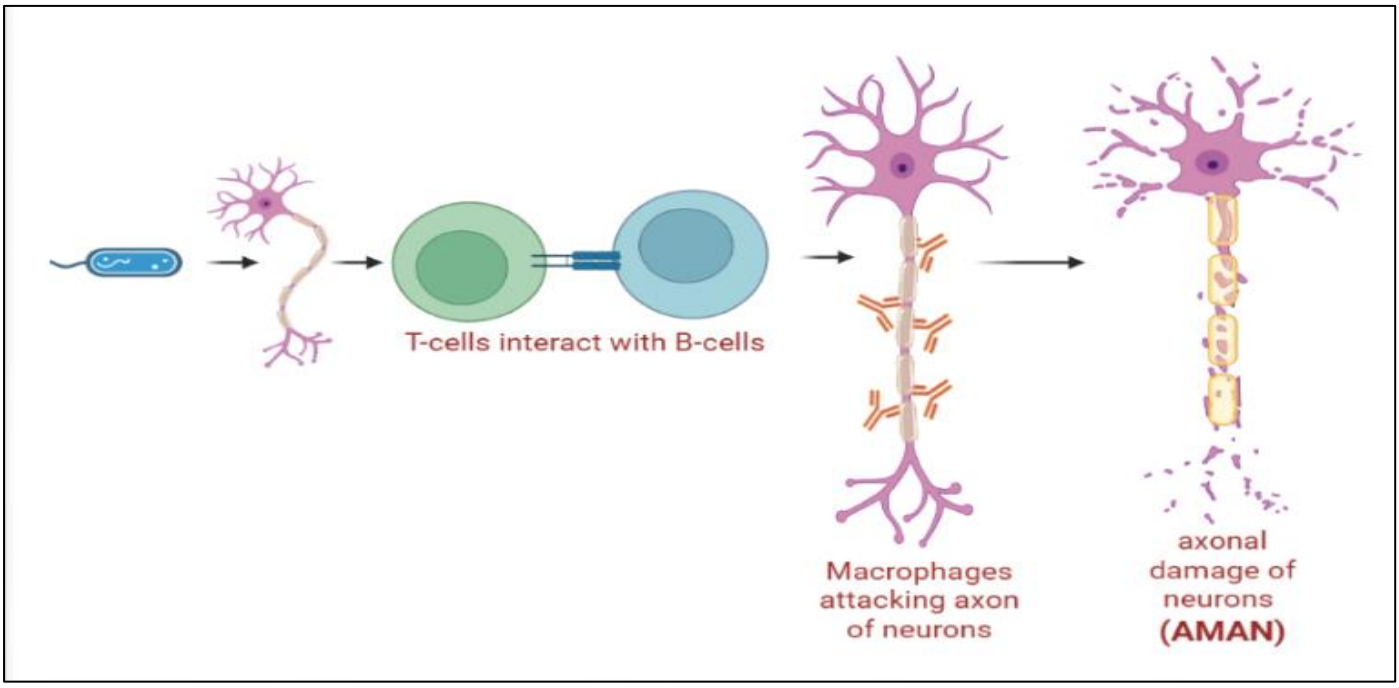

Fig 9 Immunopathogenesis of Acute Motor Axonal Neuropathy (AMAN)

➢ *Acute Motor Sensory Axonal Neuropathy (AMSAN):*

AMSAN is a rare and severe variant of Guillain-Barre Syndrome (GBS). Its defining characteristic is the acute development of motor and sensory deficits, which is facilitated by axonal injury in both motor and sensory nerves. The main signs of AMSAN are thought to be rapidly increasing weakness, sensory loss (numbness, tingling), and absent or diminished reflexes. The main therapy and management strategy for AMSAN is plasmapheresis or IVIG (Intravenous Immunoglobulin). (1,21) AMSAN is comparable to AMAN, with the exception that it impacts sensory roots and nerves. The subtypes AMAN and AMSAN were shown to be more common than the subtype AIDP in the GBS patients infected with C. jejuni, according to electrophysiological classification. (22) In their 2021 study, 10 subjects out of 83 had the condition of AMSAN. Twenty percent of cases with AMSAN, involve cranial nerve involvement and respiratory failure, which leads to ventilator support, tracheostomy, and autonomic involvement such as variable blood pressure, tachycardia, and abnormal respiratory parameters. Acute muscle weakness, discomfort, sensory disruption, and impaired tendon reflexes are the

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hallmarks of AMSAN. (23). Although there are differences between AMSAN instances and the AMAN pattern of GBS syndrome (GBS), which is marked by fiber involvement, sensory inflammatory infiltrates in the spinal roots and nerves, significant demyelination, and slow recovery, but the pathologies are quite similar. (24) The link between AMAN and AMSAN is still unclear, despite the appealing theory that they are both components of the spectrum of a single immunological attack on the axon. (25)

- *Miller-Fisher Syndrome:*

C. Miller Fisher originally defined Fisher's syndrome in 1956 that "it is a triad of acute ophthalmoplegia, ataxia, and areflexia". Ataxia, areflexia, and ophthalmoparesis are typical characteristics of acute-onset immune-mediated neuropathies in condition of MFS. (26) An 11-year retrospective study carried out in Taiwan revealed a relative frequency of 18%, although earlier research suggested a 9% prevalence in Hong Kong and a 7.7% incidence in Thailand. MFS is more common in Asian nations and may be the cause of 15–25% of GBS infections. In the West, where it accounts for 1–7% of GBS cases, it is less prevalent. According to an Italian study, 6.6% of GBS patients in Europe had an incidence of 0.04 to 0.18 instances per million. In Spain, the prevalence was 7%. (27, 28) The classic trio of symptoms of MFS includes areflexia, ataxia, and ophthalmoplegia. A viral or bacterial infection, most commonly Campylobacter jejuni, frequently precedes MFS. Because of molecular mimicry, the immune system's produced antibodies—in particular, anti-GQ1b IgG—cross-react with peripheral nerve components, mostly impacting cranial nerves. The incidence is extremely low (about 1-2 instances per million per year), and it is more common among Asian populations and men. Certain strains of C jejuni cause the MFS pattern, which results in a distinctive pattern of antibodies to GQ1b ganglioside. 96% of MFS sufferers have IgG antibodies against GQ1b, which follow the progression of the illness. The antibodies detect epitopes expressed only in the nodal regions of oculomotor nerves, as well as dorsal-root ganglion cells and cerebellar neurons. (29, 30) Serum containing anti-GQ1b from MFS patients disrupted neuromuscular transmission in a mouse phrenic nerve/diaphragm preparation, most likely by preventing motor nerve terminals from releasing acetylcholine. Because of this effect, MFS can be treated with molecular mimicry. (30)

VI. DIAGNOSIS AND TREATMENT [31,32]

- *Acute Inflammatory Demyelinating Polyneuropathy (AIDP)*

The diagnosis of AIDP is confirmed by cerebrospinal fluid (CSF) analysis, which typically shows elevated protein levels without an increase in white blood cells, a condition known as albuminocytologic dissociation. Nerve conduction studies (NCS/EMG) demonstrate demyelinating changes, including slowed conduction velocity, prolonged distal latencies, temporal dispersion, conduction block, and extended F-wave latencies. In some cases, laboratory findings indicate hyponatremia due to SIADH, and MRI scans enhanced with gadolinium may reveal nerve root swelling. Treatment primarily involves intravenous immunoglobulin (IVIG) therapy, using formulations such as Gamunex-C, Privigen, Panzyga, or Gammagard Liquid. Alternatively, plasma exchange (plasmapheresis) performed over two weeks is highly effective. Corticosteroids like prednisone or methylprednisolone may also be used in certain resistant cases, although they are generally less preferred than IVIG and plasmapheresis.

- *Acute Motor Axonal Neuropathy (AMAN)*

AMAN is diagnosed using nerve conduction studies, which reveal absent or delayed F-waves, normal sensory nerve action potentials (SNAPs), and significantly reduced compound muscle action potentials (CMAPs). Blood tests often detect anti-GM1 and anti-GD1a IgG antibodies, which are strongly associated with this subtype.

The first-line treatment is IVIG therapy using preparations such as Gamunex-C, Privigen, Panzyga, or Gammagard Liquid. In severe or treatment-resistant cases, additional options include FcRn blockers (e.g., Efgartigimod), complement inhibitors (e.g., Eculizumab), and B-cell depleting agents like Rituximab.

- *Acute Motor-Sensory Axonal Neuropathy (AMSAN):*

The diagnosis of AMSAN relies on nerve conduction studies, which show markedly reduced or absent CMAPs and SNAPs, indicating severe axonal damage. Serological tests may identify positive antiganglioside antibodies, such as anti-GM1 or anti-GD1a.

Treatment primarily involves IVIG therapy (e.g., Gamunex, Privigen, Panzyga, or IVIGlob), which helps control immune-mediated damage. Plasma exchange is another effective option, especially for patients with rapidly worsening symptoms.

- *Miller Fisher Syndrome (MFS)*

MFS is diagnosed based on CSF analysis, which usually reveals high protein levels with a normal white blood cell count. Nerve conduction studies often show reduced sensory nerve action potentials, and serological testing demonstrates the presence of anti-GQ1b antibodies in up to 95% of cases. In addition, MRI scans may be used to rule out other neurological conditions like brainstem stroke or demyelination.

Treatment includes supportive care along with IVIG therapy or plasmapheresis, both of which help speed up recovery and reduce complications.

VII. CONCLUSION

Guillain-Barré Syndrome (GBS) is an acute, immune-mediated disorder of the peripheral nervous system that remains a significant cause of neuromuscular paralysis worldwide. Its pathogenesis primarily involves molecular mimicry, where antibodies generated against infectious agents such as Campylobacter jejuni, cytomegalovirus, Epstein-Barr virus, and SARS-CoV-2 mistakenly target peripheral nerve components, leading to demyelination, axonal injury, or both. The disease exhibits diverse clinical

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subtypes, including acute inflammatory demyelinating polyneuropathy (AIDP), acute motor axonal neuropathy (AMAN), acute motor-sensory axonal neuropathy (AMSAN), Miller Fisher syndrome, and chronic inflammatory demyelinating polyneuropathy (CIDP), each with distinct pathological mechanisms and clinical profiles. Early diagnosis and timely initiation of treatment are crucial for reducing morbidity and mortality. Therapeutic interventions such as intravenous immunoglobulin (IVIG) and plasma exchange have proven highly effective in managing the disease and improving recovery outcomes. Despite advancements, challenges remain in understanding the variability in clinical presentations and predicting patient prognosis. Future research focusing on immune dysregulation, genetic susceptibility, and novel therapeutic strategies will be essential to enhance early detection, personalize treatment, and improve long-term recovery in affected individuals. A deeper understanding of the disease's molecular pathways may also contribute to the development of targeted therapies, potentially minimizing complications and improving the overall quality of life for GBS patients.

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