International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Scholarly Publisher
RS Global Sp. z O.O.
ISNI: 0000 0004 8495 2390

Dolna 17, Warsaw,
Poland 00-773
+48 226 0 227 03
editorial_office@rsglobal.pl

ARTICLE TITLE	MULTIPLE SCLEROSIS EXPLAINED: FROM PATHOPHYSIOLOGY TO DIAGNOSIS AND MANAGEMENT
DOI	https://doi.org/10.31435/ijitss.4(48).2025.4147
RECEIVED	05 October 2025
ACCEPTED	18 December 2025
PUBLISHED	26 December 2025
LICENSE	The article is licensed under a **Creative Commons Attribution 4.0 International License.**

MULTIPLE SCLEROSIS EXPLAINED: FROM PATHOPHYSIOLOGY TO DIAGNOSIS AND MANAGEMENT

Anna Rakoczy *(Corresponding Author, Email: annaa.rakoczy@gmail.com)*
University Teaching Hospital them. F. Chopin in Rzeszów, Rzeszów, Poland
ORCID ID: 0009-0001-1096-161X

Patrycja Walkiewicz
University Teaching Hospital them. F. Chopin in Rzeszów, Rzeszów, Poland
ORCID ID: 0009-0002-0492-9485

Karolina Ochyra
Medical Center in Łańcut, Łańcut, Poland
ORCID ID: 0009-0009-7525-3014

Martyna Bukała
Medical Center in Łańcut, Łańcut, Poland
ORCID ID: 0009-0002-9288-4140

Kornelia Pudło
Independent Public Health Care Complex No. 1 in Rzeszów, Rzeszów, Poland
ORCID ID: 0009-0007-1415-6048

Jowita Frydrych
University Teaching Hospital them. F. Chopin in Rzeszów, Rzeszów, Poland
ORCID ID: 0009-0003-5416-7252

Gabriela Godek
University Teaching Hospital them. F. Chopin in Rzeszów, Rzeszów, Poland
ORCID ID: 0009-0003-6633-6498

Karolina Ryba
University Teaching Hospital them. F. Chopin in Rzeszów, Rzeszów, Poland
ORCID ID: 0009-0007-4305-8375

Katarzyna Znamirowska
University Teaching Hospital them. F. Chopin in Rzeszów, Rzeszów, Poland
ORCID ID: 0009-0005-6760-2174

Klaudia Zacher
Medical Center in Łańcut, Łańcut, Poland
ORCID ID: 0009-0003-8839-9668

ABSTRACT

Multiple sclerosis (MS) is a chronic, autoimmune disease of the central nervous system that leads to the destruction of the myelin sheaths in the brain and spinal cord, resulting in progressive disability. It most commonly affects young adults, with a higher prevalence in women. The exact causes of MS remain unclear. It is believed that genetic and environmental factors, such as viral infections and vitamin D deficiency, play a significant role in the disease's development. MS typically follows a relapsing-remitting course, with periods of exacerbation and clinical improvement. The symptoms of MS are highly variable and depend on the location of demyelinating lesions. The onset of the disease may be asymptomatic. Early symptoms often include vision disturbances, paresthesia, and aphasia. In advanced stages, patients may experience spasticity, tremors, bowel and bladder dysfunction, sexual dysfunction, dizziness, cognitive impairments, and pain. Treatment of MS requires an individualized approach that combines pharmacotherapy with rehabilitation. Despite advances in therapy, the disease can still shorten life expectancy by several years and significantly impact the quality of daily functioning.

Aim of the Study: The aim of this article is to present the current state of knowledge on multiple sclerosis, including a discussion of its causes, symptoms, diagnostic methods, and available therapeutic options.

Materials and Methods: A review of the available literature of Google Scholar, PubMed.

Results: Multiple sclerosis (MS) is a chronic, autoimmune inflammatory disease that leads to damage to the myelin sheaths in the central nervous system, resulting in a variety of neurological symptoms. The pathogenesis of the disease involves genetic, environmental, and immunological factors. Patients with MS experience a decline in quality of life, particularly in terms of social and professional functioning, due to progressive disability and psychological symptoms. Disease-modifying treatments (DMTs), and biologic drugs, significantly reduce the frequency of relapses and delay disease progression.

KEYWORDS

Multiple Sclerosis, Demyelination, Central Nervous System Pathology, Disease Mechanisms, Neurological Symptoms, Therapeutic Approaches

CITATION

Anna Rakoczy, Patrycja Walkiewicz, Karolina Ochyra, Martyna Bukała, Kornelia Pudło, Jowita Frydrych, Gabriela Godek, Karolina Ryba, Katarzyna Znamirowska, Klaudia Zacher. (2025) Multiple Sclerosis Explained: From Pathophysiology to Diagnosis and Management. *International Journal of Innovative Technologies in Social Science*. 4(48). doi: 10.31435/ijitss.4(48).2025.4147

Introduction

Multiple sclerosis (MS) is a chronic and progressive disease of the central nervous system, representing one of the most common neurological causes of disability among young adults. The course of the disease is variable. Symptoms may worsen as the disease progresses, significantly impacting the daily functioning of patients. MS also has a significant effect on the quality of life of patients and their families. Early diagnosis of the disease, initiation of treatment, and provision of social and psychological support are crucial.

Definition and etiopathogenesis

Multiple sclerosis (MS) is a chronic disease of the central nervous system (CNS), characterized by dispersed inflammatory-demyelinating lesions occurring over time and in different regions. These processes lead to the loss of axons, atrophy of nervous tissue, and gradual neurological dysfunction and progressive disability. [1,3] Demyelinating changes may appear even before the onset of the first clinical symptoms. [14] These changes most commonly localize in the white matter, including the optic nerves, corpus callosum, infratentorial regions, periventricular areas, and the spinal cord. [1,14] The disease affects women more often than men and typically begins in young adults, between the ages of 20 and 40. Cases occurring before the age of 10 account for approximately 3–5% of all cases, while those occurring after the age of 50 represent about 1–6%. [13] MS is more prevalent in the white population, particularly in northern latitudes. [14]

Despite the progress in scientific research, the pathogenesis of multiple sclerosis (MS) has not been fully elucidated. It is believed that MS has an autoimmune basis, with its development depending on the interaction of environmental and genetic factors. [1] Potential environmental factors include viral infections, particularly

those from the Herpesviridae family (e.g., EBV, HHV-6, HHV-7, HSV-1, HSV-2, VZV, CMV), which show higher seroprevalence in MS patients. Their presence may indicate a possible role in initiating the disease or be a consequence of immunological disturbances associated with MS. [19] Other potential risk factors include fever, injuries, stress, smoking, vitamin D deficiency (which explains the higher incidence in regions with limited sunlight exposure), obesity during adolescence, shift work at night, alcohol abuse, and excessive coffee consumption. [1,14] Genetic predispositions also play a significant role. The presence of HLA class II alleles, such as DRB1*1501, DRB1*0301, and DRB1*1303, increases the risk of developing MS, whereas the A2 allele of the HLA class I system has a protective effect. [10] The risk of developing MS is higher among relatives of affected individuals - it is approximately 4% for siblings, 30% for monozygotic twins, and 5% for dizygotic twins. If one parent has the disease, the risk for the child is 2.5%, while if both parents are affected, the risk increases tenfold. [15] Increasing attention is also being paid to the relationship between the gut microbiota and the development of MS. An altered bacterial flora composition can lead to disruption of the gut barrier, bacterial translocation, and immune imbalance, which may promote the development of autoimmune diseases, including MS. Therefore, interventions such as probiotic therapy, fecal microbiota transplantation, or dietary changes may help alleviate inflammation and disease symptoms. [20]

The development of inflammatory-demyelinating lesions in the central nervous system (CNS) results from the disruption of the blood-brain barrier. This enables the migration of T lymphocytes and macrophages into the CNS, leading to the formation of multiple inflammatory foci (demyelinating plaques). Activation of microglia occurs, and pro-inflammatory cytokines such as TNF-α, leukotrienes, interleukins, and proteolytic enzymes are released, which results in myelin damage, as well as the loss of axons and oligodendrocytes. In some cases, the damage may also be primarily degenerative, associated with the activation of B lymphocytes and plasma cells that produce antibodies against myelin and oligodendrocyte proteins. Oligoclonal bands are frequently observed in the cerebrospinal fluid of patients, reflecting the excessive production of these antibodies. [1]

In MS, remyelination occurs, which is the partial reconstruction of myelin after a disease relapse. Remyelination enables the temporary restoration of neurological functions, particularly in the early stages of the disease. This process relies on the activity of oligodendrocyte precursor cells (OPCs), which migrate to the sites of damage and differentiate into mature cells capable of rebuilding the myelin sheaths. [21]

Diagnosis of MS

In the diagnosis of multiple sclerosis (MS), demonstrating dissemination of the disease process in both time and space is of critical importance. This means that neurological symptoms must result from lesions located in anatomically distinct regions of the central nervous system (dissemination in space), and additionally, there must be evidence of at least two clinical relapses and/or the appearance of new or enlarging demyelinating lesions on magnetic resonance imaging (dissemination in time). [14] Evidence of dissemination in time can also be provided by the detection of oligoclonal bands in the cerebrospinal fluid**.** However, it is important to note that the presence of oligoclonal bands is not specific to MS - they may also be found in other neurological disorders such as neuroborreliosis, neurological complications of AIDS, neurosarcoidosis, neurosyphilis, systemic lupus erythematosus with central nervous system involvement, or paraneoplastic syndromes. Conversely, the absence of oligoclonal bands does not exclude the diagnosis of MS. [14,16] The diagnosis of MS is based on the McDonald criteria, which rely on clinical and imaging features. A definitive diagnosis can only be established after excluding other conditions that may present with symptoms similar to those of MS. [16]

In addition, a condition known as the radiologically isolated syndrome (RIS) can be distinguished. RIS refers to a situation in which magnetic resonance imaging (MRI) reveals inflammatory-demyelinating lesions within the central nervous system (CNS), but no clinical symptoms typical of multiple sclerosis are present. RIS alone is not sufficient to establish a diagnosis of MS. [1]

In patients with RIS, the risk of developing clinical symptoms of MS within five years is approximately 30%. It is important to note that this risk is higher in the presence of contrast-enhancing lesions, spinal cord involvement, younger patient age, abnormal visual evoked potentials, the presence of oligoclonal bands in cerebrospinal fluid (CSF), as well as elevated levels of interleukin-8, neurofilaments, and an increased IgG index. [16]

Relapse

A relapse in multiple sclerosis (MS) refers to the sudden onset of new neurological symptoms or the worsening of existing symptoms, which persist for at least 24 hours. These symptoms are not associated with fever or infection. If symptoms last for a few seconds or minutes but recur after more than 24 hours, they may also be considered a relapse of the disease. [9] Two relapse episodes are considered distinct if there is a symptom-free period lasting at least four weeks between them. [16]

In the treatment of MS relapses, corticosteroids, such as methylprednisolone and prednisone, are used to reduce the inflammatory process in the body. These drugs work by reducing the release of pro-inflammatory cytokines, decreasing intracellular IgG production, and stabilizing the permeability of the blood-brain barrier. [9]

In contrast, a so-called pseudorelapse is a phenomenon in which the worsening of MS symptoms (e.g., the intensification or onset of new symptoms) is triggered by external factors, such as high temperatures or infections. [16]

Forms of Multiple Sclerosis

The forms of multiple sclerosis (MS) are classified based on the clinical course of the disease. Four main types are distinguished: relapsing-remitting, secondary progressive, primary progressive, and progressive-relapsing. Additionally, based on the severity of the disease, a benign and a malignant form are recognized. [11]

In the relapsing-remitting form of MS, periodic relapses occur, followed by remission periods. During remission, symptoms may completely resolve or leave only minimal neurological deficits. Between relapses, the disease remains stable. Relapses occur on average 0.4 to 1.2 times per year and may be triggered by, for example, infections. Initially, symptoms fully resolve after each relapse, but over time, after multiple relapses, permanent neurological deficits may develop. [11]

Secondary progressive MS initially presents as the relapsing-remitting form, but over time, as the patient's condition worsens between relapses, the disease transitions into a progressive form. Symptoms do not resolve after a relapse, leading to a gradual loss of function and progressive disability. [11]

Primary progressive multiple sclerosis is a form of MS that causes a gradual decline in neurological function from the onset, without accompanying relapses. [16] Periods of stability or brief remissions of symptoms may occur. This form is typical of older adults. [11]

Progressive-relapsing MS is characterized by continuous disease progression accompanied by relapses. After each relapse, symptoms may partially resolve or persist permanently. [11]

The benign form of multiple sclerosis (MS) is characterized by the absence of significant disability for at least 15 years from the onset of the disease. It primarily affects individuals with the relapsing-remitting form of MS, is more common in women and younger patients, and often presents with monosymptomatic manifestations. In contrast, the malignant form of MS progresses rapidly, leading to the swift development of symptoms and significant disability in a short period of time. This includes forms such as Marburg variant, Baló's concentric sclerosis, Schilder's disease. [11]

Additionally, MS can be classified based on the age of onset. The pediatric form develops before the age of 16, while late-onset MS occurs after the age of 50 and is generally associated with a poorer prognosis. [11]

Pregnancy and Multiple Sclerosis

During pregnancy, the frequency of MS relapses tends to decrease; however, three months postpartum, the relapse rate increases and subsequently returns to pre-pregnancy levels. [11]

Symptoms in Patients with Multiple Sclerosis

Multiple sclerosis often begins asymptomatically. Patients typically seek medical attention only after the onset of initial symptoms, such as vision disturbances, numbness, paresthesia, or aphasia. [1] Clinical symptoms in patients with multiple sclerosis are heterogeneous, as they depend on the location of inflammatory-demyelinating lesions within the brain and spinal cord. [3] A phenomenon known as Uhthoff's phenomenon is observed, where neurological symptoms worsen with an increase in body temperature. [2]

First Isolated Symptom Complex

The first isolated symptom complex refers to the first episode of distinct neurological symptoms lasting longer than 24 hours, not accompanied by fever, infection, or signs of encephalopathy. An acute or subacute episode can present with diverse symptoms, as demyelinating lesions may localize in various parts of the central nervous system. [14] Among the most common symptoms of CIS are unilateral optic neuritis, cerebellar syndrome, spinal cord syndrome, and focal supratentorial syndrome. Atypical symptoms include bilateral optic neuritis, encephalopathy, complete ophthalmoplegia, complete transverse myelitis, disorders of consciousness, and meningeal signs. [16] Early diagnosis of CIS is crucial, as prompt initiation of multiple sclerosis treatment has a positive effect on prognosis. [3] In contrast, poorer prognosis is associated with the presence of MRI

lesions at the time of CIS onset (which may indicate an earlier disease onset), the presence of oligoclonal IgG bands in cerebrospinal fluid, the presence of IgM antibodies against myelin proteins and oligodendrocytes, as well as abnormal visual evoked potentials. [1]

Clinically Isolated Syndrome (CIS) precedes the development of multiple sclerosis in approximately 85% of patients. The average time to the onset of a second relapse after CIS is about 1.9 years and depends on the type of symptoms associated with the first episode. The clinical course following CIS can vary - some patients experience further relapses, while others show a gradual decline in neurological function. It is important to note that MRI changes may appear more frequently than clinical symptoms, which may be related to the so-called silent location of demyelinating lesions or their small size, which is insufficient to trigger noticeable neurological symptoms. [11]

In patients suspected of having multiple sclerosis, but MRI does not confirm the presence of demyelinating lesions indicative of dissemination in time and space, it is recommended to repeat MRI of the brain and spinal cord 3 to 6 months after the first clinical episode. If characteristic changes are not observed on MRI after this period, subsequent imaging should be performed at intervals of 6 to 12 months from the previous examination. [16]

Spasticity

Spasticity is one of the primary symptoms in patients with multiple sclerosis, characterized by increased muscle tone resulting from damage to the upper motor neuron. Damage to the central nervous system (CNS) leads to an imbalance between the excitatory and inhibitory mechanisms of alpha and gamma motor neurons in the spinal cord. [8] Spasticity can present as muscle spasms (phasic) or continuous increased muscle tone (tonic). In ambulatory patients, spasticity impairs movement, while in bedridden individuals, it poses a significant challenge during caregiving tasks and may contribute to the development of pressure ulcers. A characteristic feature is the reduction in tone at the end of passive movement, which is referred to as the "clasp-knife" phenomenon. Factors that may exacerbate spasticity include urinary tract infections, bladder retention, pressure ulcers, and the use of serotonin reuptake inhibitors. [6] Pharmacological treatment of spasticity requires gradual dose escalation of muscle relaxants. Therapeutic effects should be monitored individually, as the response to treatment varies among patients. [8] Medications used in pharmacological therapy include baclofen, tizanidine, tolperisone, tetrazepam, and dantrolene. An alternative to oral therapy is intramuscular botulinum toxin injections, as well as intrathecal baclofen administration using a specialized pump in cases where patients are immobilized. This method carries risks of side effects, such as meningitis, disseminated intravascular coagulation (DIC), or rhabdomyolysis. [6] Physical exercises also play a crucial role in the management of spasticity, helping to improve the range of motion. [6] In patients with MS, muscle tone abnormalities can occur early in the disease, especially in muscles responsible for postural control, which may lead to falls. Therefore, it is important for pharmacological treatment and physical therapy to be applied concurrently. [8]

Tremor

Tremor is a common symptom in individuals with multiple sclerosis, occurring in approximately one-third of patients. It is associated with demyelination in the cerebellum and its connections with the brainstem and subcortical structures. Tremor typically manifests as shaking of the upper limbs, head (which can lead to speech difficulties), and torso, making it difficult to maintain a seated position. Treatment of tremor is challenging, but possible therapies include the use of benzodiazepines (e.g., clonazepam), propranolol, primidone, carbamazepine, isoniazid, and gabapentin. In cases of pharmacological treatment failure, procedures such as stereotactic thalamotomy or electrostimulation of the thalamus may be considered. For head tremor, botulinum toxin injections into the neck muscles causing the tremor can be effective. If upper limb tremor significantly interferes with daily functioning, wrist weights may help reduce tremor severity and stabilize the limb. [6]

Sphincter Dysfunction in Multiple Sclerosis

In patients with multiple sclerosis, disorders related to sphincter function include urinary urgency, frequent urination, urinary incontinence, difficulties with urination, as well as defecation issues such as constipation and fecal incontinence [6]

Bladder dysfunction in MS, resulting from a neurogenic spastic bladder, causes difficulties in urine storage. Atonic bladder may also occur, which is characterized by an inability to empty the bladder and urine retention. Another cause of dysfunction may be impaired coordination between the detrusor muscle and the external sphincter, leading to ineffective micturition and an increased risk of urine retention, which predisposes to urinary tract infections. [6,8]

Micturition disorders can change throughout the course of the disease. In cases of overactive detrusor (urinary urgency, urinary incontinence), anticholinergic drugs such as oxybutynin, tolterodine, and tricyclic antidepressants are commonly used. For nocturia, desmopressin is indicated. In cases of bladder atony, α-adrenoceptor antagonists and baclofen, which is used to reduce increased external sphincter tone, can be helpful α-adrenoceptor antagonists and baclofen, which is used to reduce increased external sphincter tone, can be helpful. Additionally, procedures such as sterile self-catheterization, suprapubic compression, or the Valsalva maneuver may prove useful. In cases of detrusor-sphincter dyssynergy, oxybutynin combined with baclofen, tizanidine, or α1-receptor blockers such as doxazosin, terazosin, and tamsulosin, as well as intermittent self-catheterization, are recommended. In advanced cases, suprapubic catheterization may be necessary. Disorders related to bowel function, such as constipation, are most often caused by delayed colonic motility and contraction of the puborectal muscle. Treatment includes a high-fiber diet, the use of laxatives, and enemas. For fecal incontinence, paraffin suppositories, oxybutynin, and tricyclic antidepressants may be used. [6]

Sexual Dysfunction in Patients with Multiple Sclerosis

Sexual dysfunction occurs in 30-80% of patients with multiple sclerosis, This issue is more observed in men than in women. In men, the most common sexual problems include difficulty achieving and maintaining an erection, decreased libido, premature ejaculation, and reduced penile sensation. In women, symptoms include decreased libido, difficulty achieving orgasm, dyspareunia (pain during intercourse), vaginal dryness, and diminished vaginal sensitivity. Erectile dysfunction in men can result from demyelinating damage in the motor and sensory pathways connecting the brain to spinal cord centers, which affects the erectile center. Psychological factors such as fear of rejection, low self-esteem, and issues related to spasticity, weakness, or urinary incontinence may also exacerbate the condition. During the diagnostic evaluation of erectile dysfunction, it is important to assess whether the patient experiences nocturnal and morning erections. The presence of these erections suggests a psychological cause, while their absence may indicate a neurogenic or vascular origin. In cases where vascular problems are suspected, patients may undergo duplex Doppler ultrasonography to assess the status of the corpora cavernosa, the presence of calcifications, fibrosis, and arterial flow in the penis. Sexual dysfunction in MS may also be exacerbated by coexisting conditions such as diabetes, cardiovascular diseases, hyperlipidemia, hypertension, obesity, and metabolic disorders. Additionally, certain medications, such as selective serotonin reuptake inhibitors, β-blockers, and diuretics, may contribute to erectile dysfunction. Treatment of sexual dysfunction should begin with lifestyle changes, including smoking cessation, a low-fat diet, physical activity, and treatment of neuropathic or visceral pain and spasticity, as well as weight reduction in cases of obesity. Proper management of comorbid conditions is also essential. Pharmacotherapy includes the use of phosphodiesterase type 5 inhibitors (sildenafil, tadalafil, vardenafil, avanafil) and alprostadil in the form of a cream applied locally to the urethra. Furthermore, vacuum erection devices (VEDs), penile prostheses, and psychotherapy may also be utilized. [5]

Dizziness

Dizziness, both vertigo and non-vertigo types, is a common symptom in patients with multiple sclerosis. It can occur suddenly or take on a chronic form. Demyelinating lesions, especially in areas near the entrance of the VII cranial nerve root and the medial vestibular nucleus, are the most frequent causes of these symptoms. In cases where dizziness is severe, treatment with methylprednisolone is used. For chronic dizziness, therapy may include the use of medications that reduce vestibular excitability - such as betahistine, or drugs that improve cerebral blood flow. [6]

Cognitive Impairments

Cognitive impairments occur in 43-72% of patients with multiple sclerosis and tend to worsen as the disease progresses. The most common impairments involve episodic memory, attention, and verbal fluency. Neuropsychological rehabilitation, as well as pharmacotherapy with medications such as amantadine, pemoline, or donepezil, is recommended for the treatment of these disorders. [6]

Pain in Multiple Sclerosis

Pain is one of the most common symptoms associated with multiple sclerosis (MS) and can significantly impact the daily functioning of patients. It can be classified as primary pain, resulting from direct damage to the nervous system, or as secondary pain, associated with other symptoms of the disease. [6] Primary pain includes conditions such as trigeminal neuralgia, optic neuritis, and Lhermitte's sign. [7]

Trigeminal neuralgia is characterized by sudden, sharp pain lasting from a few seconds to 2 minutes in the area innervated by the second and third branches of the trigeminal nerve (V). This pain is often accompanied by localized skin hypersensitivity. It can be triggered by touch on specific trigger points, with

the frequency of attacks ranging from several to dozens per day. The pain typically occurs unilaterally. After a period of remission, it may also appear on the opposite side. The treatment of trigeminal neuralgia primarily involves carbamazepine. In case of treatment failure, other medications, such as oxcarbazepine, gabapentin, pregabalin, or lamotrigine, may be considered. If pharmacological treatment is ineffective, procedures such as thermolesion of the Gasser ganglion or surgical intervention in cases of neurovascular conflict may be considered. [7]

Optic neuritis is one of the early symptoms of MS, presenting as unilateral retrobulbar pain, exacerbated by eye movements, and unilateral visual disturbances. [7]

Lhermitte's sign is a pain triggered by bending the head forward, which results in a sensation of an electric shock traveling along the spine. This phenomenon is related to ectopic discharges in the spinal cord, particularly in the cervical segment, where demyelinating lesions are present. [7]

Secondary pain in MS occurs, among others, as spastic limb pain, painful muscle spasms, back pain, and headaches. [7]

Peripheral pain in the limbs is also frequently reported, characterized by a pulsating, burning pain accompanied by temperature sensation disturbances. This pain is associated with demyelinating lesions in the cervical and thoracic regions of the spinal cord and degeneration of central nervous system structures. [7]

Musculoskeletal pain, which arises from muscle weakness and increased spasticity, is also common. As a result, patients may experience reduced mobility, which can contribute to the development of osteoporosis and joint stiffness. [7]

Additionally, migraine may be a contributing factor to pain in MS patients. An increase in the intensity of migraine symptoms can indicate an impending relapse of the disease. MS patients with migraine often show demyelinating lesions in areas such as the periaqueductal gray matter, substantia nigra, and red nucleus. [7]

Chronic Fatigue Syndrome in Multiple Sclerosis

Chronic fatigue syndrome (CFS) is one of the most common symptoms in patients with multiple sclerosis, affecting 80% to 97% of individuals. [4,6] It is characterized by a feeling of energy depletion and exhaustion that is not related to depression or muscle weakness. [4] The pathogenesis of this syndrome is still not fully understood, but it is believed to result from damage to central motor pathways, reduced metabolic activity in specific areas of the brain, such as the prefrontal cortex, premotor cortex, and putamen, as well as the influence of cytokines such as TNFα and IL-1. [6]

Patients often complain of apathy, daytime sleepiness, difficulty concentrating, rapid fatigue, memory problems, and a lack of energy for everyday activities. [4] Fatigue is especially common in patients with primary or secondary progressive forms of MS. [6] Unlike physiological fatigue, it does not improve with rest. It may intensify under the influence of heat (Uhthoff's phenomenon), coexisting depression, sleep disturbances, pain, and the use of medications that reduce muscle tone, such as benzodiazepines, anticonvulsants, and tricyclic antidepressants. It is important to differentiate pathological fatigue from depression, which is characterized by low self-esteem, lack of motivation, mood disturbances, and feelings of guilt. [4]

Treatment for fatigue includes performing aerobic exercises, eliminating factors that exacerbate fatigue, and pharmacotherapy, such as amantadine or pemoline. [6]

Depression in Multiple Sclerosis

Depression co-occurring with multiple sclerosis (MS) affects 42% to 54% of patients. Additionally, individuals with MS are at an increased risk of suicide. It is believed that the occurrence of depression is primarily linked to brain damage caused by the disease, as patients with primary involvement of the spinal cord and cerebellum experience depression less frequently.

Treatment for depression typically involves medications from the selective serotonin reuptake inhibitors (SSRIs) group, such as fluoxetine and paroxetine, as well as tricyclic antidepressants and tianeptine. [6]

Differential Diagnosis of Multiple Sclerosis

In the diagnostic process of multiple sclerosis (MS), it is crucial to exclude other conditions that may present symptoms resembling those of MS. [16] The diagnostic process should begin with a thorough medical history, analysis of clinical symptoms, and general examinations. [18] It is not uncommon for patients to be prescribed immunomodulatory therapy based on an incorrect diagnosis, which can expose them to potential side effects of the medications used. [17]

The most common conditions that have been mistakenly identified as multiple sclerosis (MS) include: migraine, nonspecific white matter changes in the brain, neuromyelitis optica (NMO) and other disorders from the so-called NMO spectrum, as well as autoimmune rheumatic diseases. The differential diagnosis of MS should also consider: acute disseminated encephalomyelitis (ADEM), optic and spinal cord neuritis with the

presence of anti-myelin oligodendrocyte glycoprotein (anti-MOG) antibodies, neuroborreliosis, systemic lupus erythematosus (SLE), Sjögren's syndrome, neurosarcoidosis, vitamin B12 deficiency, degenerative spinal changes (spondylosis), adrenomyeloneuropathy, MELAS syndrome (mitochondrial encephalopathy with lactic acidosis and stroke-like episodes), antiphospholipid syndrome, Susac syndrome, hereditary spinocerebellar ataxias, progressive multifocal leukoencephalopathy (PML), CADASIL (cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy), and toxoplasmosis. [16,17]

Management of Multiple Sclerosis

The treatment of multiple sclerosis (MS) is an individualized process, dependent on various factors such as the form of the disease and the effectiveness of previous treatments. Therapy includes both relapse management and disease-modifying treatment, as well as symptomatic therapy and rehabilitation. For MS relapses, corticosteroids such as methylprednisolone and prednisone are commonly used. In severe cases, where standard treatment is ineffective, plasmapheresis or the administration of immunoglobulins may be considered. For chronic treatment, first-line drugs are used, including beta interferons, glatiramer acetate, dimethyl fumarate, and teriflunomide. If these are ineffective after at least one year of use, second-line drugs such as natalizumab, fingolimod, or mitoxantrone are used. Second-line drugs are also used when there is high clinical or radiological activity of MS from the outset of the disease. [9]

An important aspect of treatment for MS patients is rehabilitation. Although it does not directly affect the cessation of disease progression or the reduction in relapse frequency, it plays a crucial role in improving the patients' quality of life. Rehabilitation should be tailored to the individual needs and capabilities of the patient. The main goal is to alleviate disease-related symptoms such as spasticity, ataxia, pain, neurogenic bladder dysfunction, and sexual problems. [12]

Prognosis

From the time of diagnosis, people with MS live on average 6-7 years shorter than the healthy population. The average life expectancy from the time of diagnosis is 35-40 years, with women generally living longer than men. [11] The disease impacts patients' functioning in all aspects of their lives. The deterioration in the quality of life is closely related to the duration of the disease, the number of hospitalizations, the frequency of relapses, and the degree of progression of motor disability. [22]

Conclusions

Multiple sclerosis (MS) is a chronic disease of the central nervous system and represents one of the most common causes of disability among young adults. It is characterized by inflammatory and demyelinating lesions within the CNS, which disrupt the proper functioning of the nervous system. Although most frequently diagnosed in individuals between the ages of 20 and 40, MS can also occur in both younger and older patients. Thanks to modern pharmacological and rehabilitative therapies, individuals with MS are often able to effectively manage their symptoms and significantly improve their quality of life. While a complete cure for MS is not currently available, appropriately selected therapy can slow disease progression, reduce symptom severity, and support patients in daily functioning. Early diagnosis and a comprehensive treatment approach play a key role in managing the disease process.

Disclosure Author's contribution:
Conceptualization: Anna Rakoczy, Patrycja Walkiewicz, Gabriela Godek
Methodology: Patrycja Walkiewicz, Martyna Bukała, Jowita Frydrych
Software: Karolina Ryba, Karolina Ochyra, Katarzyna Znamirowska
Check: Kornelia Pudło, Jowita Frydrych, Klaudia Zacher
Formal analysis: Patrycja Walkiewicz, Karolina Ryba, Gabriela Godek
Investigation: Klaudia Zacher, Kornelia Pudło, Karolina Ochyra
Resources: Patrycja Walkiewicz, Anna Rakoczy, Martyna Bukała
Data curation: Katarzyna Znamirowska, Jowita Frydrych, Martyna Bukała
Writing- rough preparation: Patrycja Walkiewicz, Kornelia Pudło, Karolina Ryba
Writing review and editing: Anna Rakoczy, Klaudia Zacher, Jowita Frydrych
Visualization: Patrycja Walkiewicz, Martyna Bukała, Karolina Ochyra
Supervision: Patrycja Walkiewicz, Katarzyna Znamirowska, Kornelia Pudło
Project administration: Gabriela Godek, Anna Rakoczy, Patrycja Walkiewicz

All authors have read and agreed with the published version of the manuscript.
Funding statement: The study did not receive special funding.
Institutional Review Board Statement: Not applicable
Informed Consent Statement: Not applicable
Data availability statement: Not applicable
Conflict of Interest Statement: The authors report no conflicts of interest.

REFERENCES

1. Kamińska, J., Koper, O. M., Piechal, K., & Kemona, H. (2017). Stwardnienie rozsiane – etiopatogeneza i możliwości diagnostyczne. *Postępy Higieny i Medycyny Doświadczalnej, 71*, 551–563. https://doi.org/10.5604/01.3001.0010.3836
2. Kazibutowska, Z. (2008). Diagnostyka, rokowanie i leczenie w stwardnieniu rozsianym w kontekście zagadnień rehabilitacji. *Polski Przegląd Neurologiczny, 4*, 46–47.
3. Selmaj, K. (2005). Stwardnienie rozsiane – kryteria diagnostyczne i naturalny przebieg choroby. *Polski Przegląd Neurologiczny, 1*(3), 99–105.
4. Krajewski, S., Dobek, A., Zawadka-Kunikowska, M., Kowalewski, M., Jakimiec, R., & Kunikowski, K. (2014). Zespół przewlekłego zmęczenia – problem osób chorych na stwardnienie rozsiane. *Hygeia Public Health, 49*(3), 519–525.
5. Lipowski, M., & Brola, W. (2024). Zaburzenia erekcji u chorych na stwardnienie rozsiane. *Aktualności Neurologiczne, 24*(1), 35–39. https://doi.org/10.15557/AN.2024.0005
6. Berkowicz, T., & Selmaj, K. (2005). Leczenie objawowe stwardnienia rozsianego. *Polski Przegląd Neurologiczny, 1*(3), 124–129.
7. Malec-Milewska, M. (2014). Ból u chorych na stwardnienie rozsiane. *Medycyna Paliatywna w Praktyce, 8*(1), 29–40.
8. Bartosik-Psujek, H., Malec-Milewska, M., Berkowicz, T., Jędrzejewski, B., Radziszewski, P., & Selmaj, K. (2013). Nowoczesne leczenie objawowe w stwardnieniu rozsianym. *Polski Przegląd Neurologiczny, 9*(4), 160–171.
9. Losy, J., Bartosik-Psujek, H., Członkowska, A., Kurowska, K., Maciejek, Z., Mirowska-Guzel, D., Potemkowski, A., Ryglewicz, D., & Stępień, A. (2016). Leczenie stwardnienia rozsianego – zalecenia Polskiego Towarzystwa Neurologicznego. *Polski Przegląd Neurologiczny, 12*(2), 80–95.
10. Rzepiński, Ł., & Maciejek, Z. (2018). Heterogenność etiopatogenezy stwardnienia rozsianego w kontekście danych klinicznych, immunohistochemicznych, autopsyjnych oraz aktualnych możliwości terapeutycznych. *Polski Przegląd Neurologiczny, 14*(1), 1–9.
11. Bonek, R., & Maciejek, Z. (2009). Naturalny przebieg stwardnienia rozsianego. *Aktualności Neurologiczne, 9*(2), 116–125.
12. Potemkowski, A., & Opara, J. (2015). Potrzeby i możliwości rehabilitacji chorych na stwardnienie rozsiane w Polsce. *Aktualności Neurologiczne, 15*(2), 74–79. https://doi.org/10.15557/AN.2015.0010
13. Potemkowski, A. (2009). Stwardnienie rozsiane w świecie i w Polsce – ocena epidemiologiczna. *Aktualności Neurologiczne, 9*(2), 91–97.
14. Kaczmarczyk, A. (2022). Choroby demielinizacyjne. W A. Brzęk, E. Krzystanek, & J. Siuda (Red.), *Fizjoterapia i leczenie w wybranych jednostkach chorobowych w obrębie ośrodkowego układu nerwowego: Rozważania teoretyczne i zalecenia praktyczne. Podręcznik dla studentów kierunków medycznych, w tym fizjoterapii i lekarskiego* (ss. 23–31). Śląski Uniwersytet Medyczny w Katowicach.
15. Guzik, A., & Kwolek, A. (2015). Częstość występowania i rozmieszczenie stwardnienia rozsianego w Polsce i na świecie. *Przegląd Medyczny Uniwersytetu Rzeszowskiego i Narodowego Instytutu Leków w Warszawie, 1*, 55–62.
16. Adamczyk-Sowa, M., Kalinowska, A., Siger, M., Kułakowska, A., Rejdak, K., Potemkowski, A., Losy, J., Mirowska-Guzel, D., Zakrzewska-Pniewska, B., Stępień, A., Brola, W., Głąbiński, A., Sarzyńska-Długosz, I., Zaborski, J., & Bartosik-Psujek, H. (2021). Diagnostyka stwardnienia rozsianego. Rekomendacje Sekcji Stwardnienia Rozsianego i Neuroimmunologii Polskiego Towarzystwa Neurologicznego. *Polski Przegląd Neurologiczny, 17*(4), 149–164. https://doi.org/10.5603/PPN.2021.0028
17. Wawrzyniak, S., & Pietrzak, A. (2020). Stwardnienie rozsiane – wybrane aspekty dotyczące rozpoznania choroby. *MS Report, 9*(4), 12–16.
18. Bartosik-Psujek, H. (2012). Algorytmy diagnostyczne i kryteria kwalifikacji do leczenia immunomodulacyjnego w stwardnieniu rozsianym. *Polski Przegląd Neurologiczny, 8*(2), 76–83.
19. Zajkowska, A., & Kułakowska, A. (2018). Wirusy *Herpesviridae* a stwardnienie rozsiane – powiązania etiopatogenetyczno-terapeutyczne. *Polski Przegląd Neurologiczny, 14*(1), 10–17.
20. Szymczak, W., Pastusiak, K., & Bogdański, P. (2021). Rola mikrobioty jelitowej w rozwoju stwardnienia rozsianego. *Polski Przegląd Neurologiczny, 17*(3), 115–120. https://doi.org/10.5603/PPN.2021.0020
21. Stasiołek, M., Mycko, M., & Selmaj, K. (2005). Patogeneza stwardnienia rozsianego. *Polski Przegląd Neurologiczny, 1*(3), 92–98.
22. Snarska, K., Karwowska, M., Kapica-Topczewska, K., Drozdowski, W., & Bachórzewska-Gajewska, H. (2015). Jakość życia pacjentów ze stwardnieniem rozsianym. *Problemy Pielęgniarstwa, 23*(3), 349–356.