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Advances in Psychotherapy –
Evidence-Based Practice

Multiple Sclerosis

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Advances in Psychotherapy – Evidence-Based Practice

The basic objective of this series is to provide therapists with practical, evidence-based treatment guidance for the most common disorders seen in clinical practice – and to do so in a reader-friendly manner. Each book in the series is both a compact "how-to" reference on a particular disorder for use by professional clinicians in their daily work and an ideal educational resource for students as well as for practice-oriented continuing education.

The most important feature of the books is that they are practical and easy to use: All are structured similarly and all provide a compact and easy-to-follow guide to all aspects that are relevant in real-life practice. Tables, boxed clinical "pearls," marginal notes, and summary boxes assist orientation, while checklists provide tools for use in daily practice.

Multiple Sclerosis

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Preface

Multiple sclerosis (MS) is a complex, unpredictable, and chronic neurologic disorder that can affect numerous bodily systems. There is no known cause or cure. The disease process can result in minimal symptoms or significant disability. The cover photograph illustrates the precarious nature of MS; while at one point the disease can appear to be stable, at another point, symptoms and functioning can change and successful interventions can become less effective. The role of the mental health professional has been well recognized in evidenced-based treatment of individuals living with MS. Indeed, mental health providers interface with individuals living with MS across the course of the disorder.

There is no definitive medical or psychological MS theory or treatment. However, the trend in healthcare is toward integrative medicine, and the National MS Society and the Consortium of Multiple Sclerosis Centers both recognize the importance of comprehensive care for people living with MS. Numerous professionals may be part of an MS treatment team, and each team member may have its own perspective, research, and terminology. We will be drawing on research from many fields in an attempt to highlight both the challenges and the resources available for someone who is living with MS and those who provide support.

The following abbreviations are used frequently throughout the book:

CID	Chronic illness and disability
CNS	Central nervous system
DMTs	Disease-modifying treatments
DSM-5	*Diagnostic and Statistical Manual of Mental Disorders*, Fifth Edition
MS	Multiple sclerosis
NMSS	National Multiple Sclerosis Society
PPMS	Primary progressive multiple sclerosis
PRMS	Progressive–relapsing multiple sclerosis
RRMS	Relapsing–remitting multiple sclerosis
SPMS	Secondary progressive multiple sclerosis

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The authors have been blessed with the ability to join with colleagues whom we enjoy and respect, to grow together and create something that will help others. We are grateful to the editors for this rare opportunity, and we especially want to thank Dr. Danny Wedding for all of his support and encouragement. Many people have offered their expertise and encouragement during this project. We wish to thank Dr. Shelley Peery for consultation and editing; Sheila Kolenc for layout and technical assistance; Dr. John A. Schafer and Dr. Sabeen Lulu for contributing their knowledge on MS; Dr. Rhoda Olkin for consultation on disability; and Dr. Rosalind Kalb, Jaclyn Smoczynski, and Janelle Del Carlo of the NMSS for their assistance and encouragement.

Dedication

This book is dedicated to people who live with MS and those who help and support them. A portion of the proceeds of this book will be donated to the National Multiple Sclerosis Society.

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Description

1.1 Terminology

A working knowledge of terminology related to multiple sclerosis (MS) is important. Multiple domains of an individual's life can be touched by MS, and the disease poses various challenges. A comprehensive understanding of related terms facilitates effective communication with other healthcare providers, informs the education provided to individuals with MS, and aids the clinician's formulation of a comprehensive treatment plan. Tables 1, 2, 3, and 4 provide an overview of relevant terminology associated with biopsychosocial factors that may impact the life of a person with MS. In addition, more detailed and inclusive overviews of MS-related terminology and definitions are available from the National Multiple Sclerosis Society (NMSS; http://www.nationalmssociety.org) and the Consortium of Multiple Sclerosis Centers (http://www.mscare.org).

Table 1
MS-Specific Terminology

Term	Definition
Multiple sclerosis	An unpredictable disease of the central nervous system (CNS) that disrupts the flow of information within the brain, and between the brain and body (NMSS; http://www.nationalmssociety.org/what-is-MS); four disease courses have been identified (Lublin & Reingold, 1996).
Relapsing–remitting course	Episodes of acute worsening of neurologic function, with some amount of recovery and no progression in between.
Secondary progressive course	Following an initial relapsing–remitting course, the disease transitions in many people to a steadily progressive form with increased loss of function.
Primary progressive course	Continuing worsening of disease from onset, without distinct relapses.
Progressive relapsing course	Progressive disease from onset, with occasional acute relapses and continuing disease progression.

Table 1 (continued)

Term	Definition
Clinically isolated syndrome	A temporary diagnosis that may initially be given if insufficient brain magnetic resonance imaging (MRI) evidence is present at first clinical presentation. Implies increased risk for future confirmed MS, given the need for subsequent evidence of further clinical relapses or new MRI lesions.
Radiologically isolated syndrome (RIS)	MRI abnormalities typical of CNS demyelination in the absence of clinical symptoms; treatment/diagnosis made on a case-by-case basis or after exam findings suggestive of demyelinating events.

Table 2
Relevant Biological and Neurological Terminology

Term	Definition
Antigen	Any substance that causes your immune system to produce antibodies against it. An antigen may be a foreign substance from the environment (e.g., chemicals, bacteria, viruses, or pollen) or formed within the body (e.g., bacterial toxins or tissue cells).
Autoimmunity; autoimmune disease; immune-mediated disease	The prefix *auto* means *self* — that is, the immune system is reacting against normally occurring antigens in the body, as if these antigens were foreign (NMSS).
Axon	Also known as nerve fiber; the extension of the cell body that carries messages (NMSS).
Axonal (also, dendritic) sprouting	A phenomenon in which injured axons regenerate or "sprout" new terminal connections (Loring, 1999).
Blood–brain barrier (BBB)	A semi-permeable barrier that excludes many chemicals in the blood from entering the cerebrospinal fluid (CSF) and brain. This barrier is not absolute. The probable functions of the BBB include exclusion of blood-borne toxic substances and protection from systemic neurotransmitters and hormones (Loring, 1999).
CNS	Brain and spinal cord.
Cerebral spinal fluid (CSF)	Fluid produced in the choroid plexus that serves as a protective hydraulic system to cushion the brain and spinal cord from jarring injury. CSF may be examined as part of a neurological work-up because many CSF alterations may reflect nervous system impairment. Samples of CSF are obtained by lumbar puncture (Loring, 1999), and analysis of CSF is helpful in the diagnosis of MS.

Table 2 (continued)

Term	Definition
Cortex, cerebral	Outer layer of the brain consisting of gray matter. Its surface area is greatly increased by being folded into convolutions called *gyri*, which are separated by furrows, or grooves, called *sulci* (Loring, 1999).
Cranial nerves	Twelve paired nerves arising from the brain stem that innervate muscles of the head and receive sensory information, primarily from the head (Loring, 1999).
Demyelination	Destruction of the myelin sheath surrounding a nerve fiber that disrupts neural conduction. The most common demyelinating disease is MS (Loring, 1999).
Disease-modifying treatments	Medications prescribed to modify the disease course.
Gadolinium	A chemical compound given during MRI scans that helps distinguish new lesions from old lesions.
Immunoglobulin G (IgG)	An antibody-containing substance produced by human plasma cells in diseased CNS plaques. Levels of IgG are often increased in the CSF in patients with MS.
Lhermitte's sign	The radiation of tingling or electric-like paresthesias into the limbs or trunk on flexion of the neck.
Myelin sheath	The fatty insulating substance surrounding nerve fibers in the white matter of the brain and spinal cord (NMSS).
Neurodegenerative	Disease process that reflects the progressive loss of structure or function of neurons, including death of neurons.
Oligodendrocytes	Cells that make and maintain myelin.
Optic neuritis	An inflammatory disorder of the optic nerve that commonly occurs in only one eye and causes visual loss and sometimes blindness; it is usually temporary.
Paresthesias	Abnormal sensations such as numbness, prickling, or "pins and needles."
Peripheral nervous system (PNS)	Nerves and axons that connect the CNS to muscles, sensory organs, and glands
Plaques (lesions)	Scarring (also called lesions).
Relapses	Random attacks of inflammation. Also known as exacerbations or flare-ups.
Spasticity	Involuntary muscle contractions leading to spasms and stiffness or rigidity (primarily affecting the lower limbs in MS).
T cells	T cells, which are one type of white blood cell in the immune system, somehow become sensitized to proteins

Table 2 (continued)

Term	Definition
	in the CNS. When T cells become activated, they enter the CNS through blood vessels and produce damaging inflammation. Once in the CNS, these T cells not only injure myelin, but also secrete chemicals that damage nerve fibers (axons) and recruit more damaging immune cells to the site of inflammation.
Transverse myelitis	An acute spinal cord disorder causing sudden low back pain as well as muscle weakness and abnormal sensory sensations in the lower extremities.
White matter	A component of the CNS in the brain and superficial spinal cord. White matter consists mostly of glial cells (i.e., cells that form myelin, and provide support and protection for neurons) and myelinated axons that transmit signals from one region to another. While *gray matter* is primarily associated with processing and cognition, white matter modulates the distribution of action potentials, acting as a relay and coordinating communication between different brain regions.

Table 3
Cognitive and Neuropsychological Terminology

Term	Definition
Cognition	Mental processes associated with attention, perception, thinking, learning, and memory (Loring, 1999).
Delirium	A temporary and usually reversible confusional state involving alterations in level of arousal, disturbances of attention, and impairment in the logical stream of thought. Onset is rapid, with a fluctuating course (Loring, 1999).
Dementia	An umbrella term used to reflect the fact that cognitive dysfunction has resulted in impairment in independent living.
Neuropsychiatric; neurobehavioral	Describes mental disorders, as well as affective and behavioral symptoms, that can be attributed to diseases of the nervous system.

Table 4
Rehabilitation Terminology

Term	Definition
Rehabilitation	Neurorehabilitation aims to aid recovery from a nervous system injury/disease and to minimize and/or compensate for any functional disturbances (e.g., activities of daily living, communication, mobility). Rehabilitation specialists include an interdisciplinary team of speech, physical, and occupational therapists, as well as psychologists and physicians.
Impairments	Refers to the symptoms and limitations caused directly by CNS damage (e.g., decreased vision, decreased strength, spasticity, tremor, etc.)
Disability	Refers to the reduction in function in the performance of tasks (e.g., walking, bathing, etc.).
Handicap	Refers to the reduced ability to participate in various life situations (e.g., driving, employment, etc.) and the environmental restrictions that the patient suffers.
Remediation	Correcting the problem. This restorative approach consists of reinforcing previously learned patterns of behavior (Loring, 1999).
Compensation	An alternative means of task performance because the preferred approach has become more difficult or impossible secondary to impairment or disability. Also, modifying the environment or use of assistive devices to accommodate changes.

1.1.1 Psychiatric Disorders and Psychosocial Problems Associated With MS

Mental health professionals often find it useful to distinguish between psychosocial problems encountered by many individual living with MS and comorbid psychiatric disorders. Such a distinction can aid in the comprehensive conceptualization of the individual and treatment formulation. Psychosocial problems, which reflect psychological, interpersonal, and social adjustment difficulties, may be faced by individuals prior to definitive diagnosis of MS, as well as throughout various stages of the course of MS. Psychiatric disorders are defined by the classification system within the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association, 2013) and the *International Statistical Classification of Diseases and Related Health Problems* (ICD-10; World Health Organization, 2007) and can also appear prior to or subsequent to the diagnosis of MS.

1.1.2 Psychiatric Diagnoses Associated With MS

Mental health professionals have an important place in the management of MS. Common symptoms associated with MS that are amenable to psychological intervention include mood disorders, cognitive disorders, adjustment disorders, interpersonal difficulties, and potential neurobehavioral symptoms associated with neurologic disease and medication effects.

Potentially relevant comorbid psychiatric diagnoses that mental health professionals may use to classify clinically significant problems are based on the DSM-5 (American Psychiatric Association, 2013). Table 5 shows diagnoses that may be encountered within a clinical setting while working with individuals with MS. Given the variability of diagnostic codes for select disorders listed in Table 5, the reader is referred to the DSM-5 for further detail.

Table 5
Psychiatric Diagnoses Associated With MS

Mood disorders	**DSM-5 (ICD-10)**
Major depressive disorder	296.99 (F34.8)
Adjustment disorder with depressed mood	309.0 (F43.21)
Persistent depressive disorder (dysthymia)	300.4 (F34.1)
Depressive disorder due to another medical condition	See DSM-5
Substance/medication-induced depressive disorder	See DSM-5
Bipolar (I or II) disorder (coding depends on severity and whether the most recent episode was manic or depressed)	296.89 (F31.81)
Pseudobulbar affect	F48.2
Cyclothymic disorder	301.13 (F34.0)
Disruptive mood dysregulation disorder	296.99 (F34.8)
Anxiety disorders	**DSM-5 (ICD-10)**
Generalized anxiety disorder	300.02 (F41.1)
Adjustment disorder with anxiety	309.24 (F43.22)
Unspecified anxiety disorder	300 (F41.9)
Anxiety disorder due to another medical condition	293.84 (F06.4)
Substance/medication-induced anxiety disorder	See DSM-5
Somatic symptom disorder or illness anxiety disorder	300.7 (F45.21)
Social anxiety disorder (social phobia)	300.23 (F40.10)
Agoraphobia; also see panic disorder	300.01 (F41.0)
Specific phobia (e.g., needle/injection phobia)	See DSM-5

Table 5 (continued)

Personality	DSM-5 (ICD-10)
Personality change due to another medical condition	310.1 (F07.0)
Personality disorders	301.83 (F60.3)
Personality change as an associated feature in delirium	See DSM-5
Personality change as an associated feature of major or mild neurocognitive disorder	See DSM-5
Personality change as a result of a substance use disorder	See DSM-5
Psychological factors affecting other medical conditions	316 (F54)
Cognitive disorders	DSM-5 (ICD-10)
Major or mild neurocognitive disorder due to another medical condition	See DSM-5

1.1.3 Psychosocial Problems Associated With MS

Corbin and Strauss (1988) wrote:

> When a severe chronic illness comes crashing into someone's life, it cannot help but separate the person of the present from the person of the past and affect or even shatter any images of self held for the future. Unless the illness is mild or its effects on activity are relatively negligible, who I was in the past and hope to be in the future are rendered discontinuous with who I am in the present. New conceptions of who and what I am – past, present, and future – must arise out of what remains. (p. 10)

Often, individuals are faced with adjusting their self-image from invulnerable or healthy to one that includes living with a chronic illness. Psychosocial consequences can influence numerous areas of life, with distress related to disruptions to life goals, employment, finances, independence, relationships, and activities of daily living (Mohr et al., 1999). A change in self-image may arise from any aspect of MS, such as incontinence, sexual dysfunction, reduced mobility, or cognitive problems. Therapists can explore why the changed and/or lost abilities were important and identify alternative methods to meet those needs.

While self-image refers to how one thinks about himself/herself, stigma reflects others' views of an individual. Reactions from others range from avoidance to being overly solicitous. However, stigma should be differentiated from difficulties clients have in their own self-image that are projected onto others; these assumptions of how others view or will treat them may derive from the client's own experiences and attitudes about disability, impairments, and disease prior to the diagnosis of MS. Still, individuals within one's support system may misattribute the root cause of a symptom; for instance, fatigue may be incorrectly identified as "laziness." Anger and frustration can develop

when the client is invalidated in his or her attempt to describe the impact of their symptoms to others. For instance, when explaining that they are not able participate in planned activities secondary to MS-related fatigue, others may say, "I had a busy day, too" or "I didn't sleep well last night, either." Similarly, clients may hear, "But you look so good," which gives an implicit message that they are not measuring up to expectation. To follow, some symptoms are referred to as "invisible" because they are not readily apparent to others. Some examples of "invisible symptoms" include vision disturbance, fatigue, weakness, pain, prickly or tingling sensations, heat sensitivity, dizziness, and cognitive difficulties. Alternatively, others may assume that limitations exist when there is actually no evidence to support such a conclusion. Moreover, despite legal protections, clients can be vulnerable to discrimination, such as in the work environment.

Covert symptoms (fatigue, pain, cognitive dysfunction) can be disabling but not visible to others

Identity issues may include self-doubt, self-criticism, and the loss of one's sense of current skills and future capabilities

Social role and relationship difficulties in MS are associated with lack of social support, isolation, and social withdrawal. In an effort to regain a sense of control over an unpredictable disease process and maintain independence, individuals can refuse help from others. Alternatively, dependency issues can develop in multiple facets of relationships, including emotional, physical, medical, and financial spheres. Within relationships, the client can experience fear of abandonment. Such fear can underlie isolation, or trigger other potential destructive behaviors that are detrimental to the relationship. For clients who are not in a relationship, uncertainty about dating and meeting a life partner is common.

Low levels of social support in MS have been shown to be associated with depression

Individuals may avoid talking to family and friends about their MS. Avoidance may stem from a fear of potentially burdening others, causing others to worry, or concern that they will be treated differently than they were prior to having MS. Relevant related psychosocial issues may include intimacy, communication, division of labor within the family, disclosure of diagnosis to others, community involvement, self-esteem, and independence. Maintaining social ties often requires new methods of approaching relationships wherein the client may learn to become more open with others about the effect of the disease and potential ways MS can affect a relationship. When faced with the prospect of having to cope with a long-term illness, the entire family system may find its usual way of functioning to be challenged.

A relevant dimension of psychosocial functioning is quality of life. Quality of life is a multidimensional concept related to individuals' perception of their general well-being and level of role fulfillment across a range of different psychosocial, physical, and symptom-related phenomena. Individuals diagnosed with MS assess their quality of life as reduced compared with the general population and also lower than other chronic disease populations. Multiple challenges to both physical and psychological well-being are often present, as the person may encounter unpleasant and unpredictable symptoms, difficult treatment regimens and drug side effects, and increasing levels of physical disability. The quality of life of individuals with MS has been measured in terms of physical symptoms, mobility, emotional life, and social interaction. Further, these various areas warrant assessment and commensurate intervention over time. For instance, fatigue is a frequent, frustrating, and often disabling symptom in MS that has a major impact on quality of life. Similarly, quality of life in MS is often negatively affected by depression and cognitive dysfunction.

Fatigue, depression, and cognitive dysfunction have been shown to be major determinants of quality of life in MS

Clinical Pearl
Asking Clients About Their Needs and Desires

Supportive others often feel lost when trying to figure out the "right" thing to say or do to help their loved one. Often, the question "What concerns you the most?" can facilitate a discussion based on the individual's needs and desires. Rather than assuming what the individual could benefit from and then acting on this (potentially well-intended but misguided) assumption, this question allows clients to obtain the support they truly desire.

Given the unpredictable course, many individuals face considerable uncertainty and anxiety, leaving them feeling overwhelmed. As a result, a variety of psychosocial-relevant questions and statements may be posed by individuals living with MS:

- "I feel lost. I am not sure of who I am anymore or what the future holds for me."
- "I am broken."
- "How long will this last?"
- "My emotions now are so raw and hard to control."
- "Should I tell my boss?"
- "I don't think I'll ever find somebody…who would want to sign up for this?"
- "I feel useless."
- "He thinks I'm lazy. He just does not understand what happens to me when fatigue hits."
- "Using the walker feels like I'm just giving up on myself."
- "My attention problems make it difficult to carry on a meaningful conversation."

1.2 Definition

MS is a chronic progressive neurologic disease that impacts the brain and spinal cord (also known as the CNS) as well as other select areas, such as the optic nerves. The CNS conducts electrical and chemical signals throughout the body to allow for thought, emotion, sensory perception, and muscle control. In MS, the flow of information within the brain, and communication between the brain and body, is disrupted.

MS is largely thought to be an immune-mediated disease

The precise cause of MS has yet to be established. MS is widely believed to be an immune-mediated disease (NMSS, http://www.nationalmssociety.org/What-is-MS/Definition-of-MS/Immune-mediated-disease). This implies that there is a dysregulation of the normal immune response to some infection or environmental trigger in an individual with genetic vulnerability. The specialized cells and organs that comprise the immune system work in concert to defend the body against attacks by foreign invaders, such as bacteria or viruses. In autoimmune diseases, such as MS, the immune system erroneously identifies self as foreign and assaults select areas of the body that it no longer recognizes. In MS, random attacks of inflammation occur in areas of the white matter and result in significant damage. Within the CNS, white matter acts as

Table 6
Nervous System Communication Disruption in MS

Motor signals

- Information from the CNS (brain and spinal cord) is transmitted to muscles and other organs through the peripheral nervous system (PNS; the nerves and axons that connect the CNS to muscles, sensory organs, and glands).
- These messages control movement, dexterity, strength, coordination, and other functions of the body.
- Increased muscle tone, resulting in stiffness and spasms, which is referred to as spasticity, is common.
- For example, an individual describes weakness or heaviness in a limb, or a tendency to trip or fall, or drags the affected leg.

Sensory signals

- Sensory organs that provide sensations of vision, hearing, temperature, and touch send messages back to the CNS about the environment.
- For example, an individual expresses concerns about vague and transient symptoms, and describes squeezing, burning, or pressure in a band-like distribution around the chest. Alternatively, the individual may report numbness, prickling, or tingling (also referred to as paresthesias); they may exhibit Lhermitte's sign (i.e., the radiation of tingling or electric-like paresthesias into the limbs or trunk after flexion of the neck).

Integrative signals

- Information is transmitted from nerve to nerve within the nervous system.
- For example, an individual expresses concerns about attention, memory, problem solving, and other cognitive functions.

Note. Adapted from Kalb, Holland, and Giesser (2007)

a relay and coordinates communication between different brain regions. These attacks are commonly referred to as relapses, exacerbations, or flare-ups. As a result of these attacks, nerve impulses slow or stop, and this disruption causes the symptoms experienced by individuals with MS (see Table 6).

The myelin sheath is the protective insulation that surrounds nerve fibers in the white matter of the brain and spinal cord. Myelin facilitates the rapid transmission of electrochemical impulses between the brain, spinal cord, and other body regions (NMSS, http://www.nationalmssociety.org/What-is-MS/Definition-of-MS/Myelin). Myelin is lost in *multiple* areas, leaving scarred or *sclerotic* (hardened) tissue, which gives the disease its name (see Figure 1). The target of destruction includes not only the myelin sheath but also axonal and neuronal degeneration. As such, gray matter can also be impacted early in the disease course. Involvement of gray matter, which implies that there has been destruction of the nerve fibers, has been implicated in irreversible disability (i.e., reduction in function).

The production of lesions and axonal loss results in potential sensory, motor, cognitive, and/or neuropsychiatric difficulties

The collective damage to white and gray matter results in a broad spectrum of clinical signs and symptoms. For instance, symptoms may include sensory problems (e.g., visual disturbances, reduced sensation), motor difficulties (e.g., walking, balance, and coordination problems), cognitive dysfunction (e.g., problems with attention, processing speed, and memory), and changes in

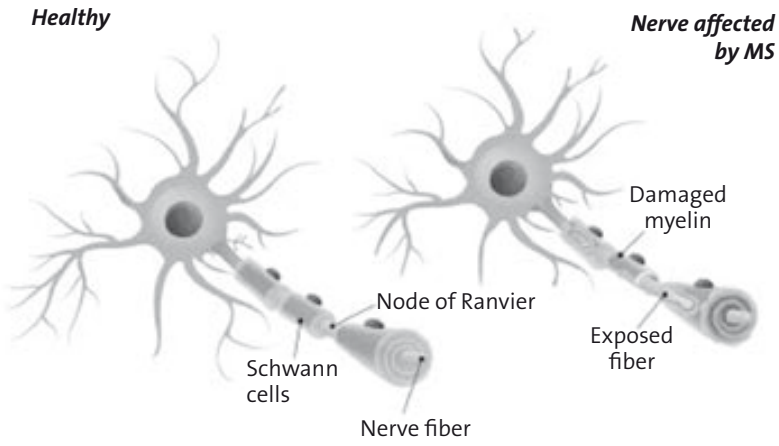

Figure 1. Damage to the Myelin Sheath in MS.
Source: Designua/shutterstock.com

mood and behavior. These symptoms may range from mild to severe. Regardless of the level of severity, symptoms can have a significant impact on functioning. Fatigue, for example, is considered by many to be their most disabling symptom. Often individuals describe much angst surrounding the impact of fatigue on their capacity to engage in meaningful activities, such as occupational and home responsibilities as well as hobbies and social events. Likewise, the client's participation in counseling may be challenged whether the disturbance in functioning is isolated or presents in conjunction with other changes. For instance, clients may present with concentration problems that affect discourse during a session, as they lose track of what they wanted to say or have difficulty holding in mind comments made by the therapist. Other clients may grapple with leg weakness and physical pain that makes it difficult to come to therapy to address the onset of emotional dysregulation that has also come about as a symptom of MS.

Particular symptoms also depend on the location of the plaques and can vary greatly. Disease innervating the brain stem, optic nerve, and spinal cord can have more impact on independence. Inflammatory problems of the optic nerve (i.e., optic neuritis) manifest in 55% of persons living with MS. Optic neuritis is often viewed as an early sign of MS, since it presents as the initial symptom in approximately 15% of individuals living with MS. The individual may express concerns about blurred or double vision, color distortion, or even blindness in one eye. Similarly, many describe muscle weakness in their extremities as well as balance and coordination problems at some time point in the disease course.

Someone with MS often faces uncertainty over the duration of MS-related symptoms, which may range from being brief to prolonged. Partial or complete remission of symptoms can occur, particularly in the early stages. Although remission of symptoms is associated with reduced inflammation, progressive structural changes often include volume loss (also known as *atrophy*). The progressive and accumulative nerve damage experienced by

individuals living with MS over time is referred to as *neurodegeneration.* The following list illustrates the significant aspects that define the mechanisms of this disease process:

- Inflammatory attacks destroy myelin and oligodendrocytes (the cells that make and maintain myelin).
- Produces damaged areas (lesions or scars) along the nerve.
- Damage and loss of the underlying nerve fiber (axonal damage and atrophy).
- Slows or stops nerve conduction, producing the neurologic signs and symptoms of MS.

1.3 Epidemiology

The exact cause of MS is yet to be determined. Immunologic, environmental, infectious, and genetic contributing factors continue to be explored (see Table 7).

1.3.1 Incidence and Prevalence

The incidence of a disease is the number of new cases occurring in a given period of time

Prevalence refers to the number of people with MS at a particular point in time in a particular place

Some estimates have suggested that there are more than 500,000 people living with MS in the United States and Canada, and more than 2.1 million worldwide (NMSS, 2012).

The prevalence rates for MS vary by continent and geographical latitude (NMSS, http:// www.nationalmssociety.org/What-is-MS/Who-Gets-MS). Studies indicate that MS varies greatly in frequency worldwide (Simpson, Blizzard, Otahal, Van der Mei, & Taylor, 2011). Epidemiological statistics on MS have inherent biases, however, which should be kept in mind (see Section 1.3.2 for further detail).

1.3.2 Underdiagnosis of MS

MS remains underdiagnosed, especially among populations of people who do not traditionally participate in biomedical or social science research

As information accumulates, biomedical and psychosocial research findings will uncover the actual incidence and prevalence of the disease, improve the time to an accurate diagnosis, and identify additional treatments that affect the course and severity of the disease.

Inherent Biases and Salient Factors

Epidemiological statistics regarding MS have inherent biases, and, therefore, the estimates of the incidence and prevalence of MS are only approximations.

- There is no single test for MS. The diagnosis can be missed, be delayed, or even be incorrect.
- Data from earlier epidemiological studies may not accurately represent the current MS population because the investigators used different methods for identifying and counting people with MS, as well as different strategies for analyzing their data.