Multiple Sclerosis
A Self-Care Guide to Wellness

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Multiple Sclerosis: 
A Self-Care Guide to Wellness

Second Edition

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Dedication

In memory of Labe C. Scheinberg, MD and Pamela F. Cavallo, MSW, ACSW.

Dr. Labe C. Scheinberg passed away on February 21, 2004. Dr. Scheinberg had a brilliant mind, quick wit, and a sensitivity to the needs of others. He was a pioneer in MS care and research, and was well known for his knowledge of science and literature. He led the fight against MS in symptomatic management including psychosocial and spiritual care. Dr. Scheinberg is missed today and will be missed by future generations of patients, families, and the MS team.

Pamela Cavallo (1947–2001) was the former Director of the Clinical Programs Department of the National Multiple Sclerosis Society. Her entire career focused on ways to help people with MS and their families have better quality of life. She implemented her vision with programs aimed at people with MS and their families to end the devastating effects of this disease.
Acknowledgments

We would like to thank many people for their encouragement and support in this project: Thomas E. Stripling, Elinor Tucker, and Jim Angelo of the Paralyzed Veterans of America for their dedication to the fight against MS; Dr. Vivian Beyda of the United Spinal Association for always seeking new ideas; the National Multiple Sclerosis Society, the Consortium of Multiple Sclerosis Centers, and all organizations seeking to help people with MS and their families; our own families for their patience and support; and last, but not least, Dr. Diana M. Schneider of Demos Medical Publishing, for her wit, wisdom, and sharp pencil that have helped make MS publications widely available during the past decade.
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Preface

MULTIPLE SCLEROSIS is a disease of the central nervous system that has a far-reaching and variable impact on young adults; it can have profound physical, social, and psychological consequences for patients and their families. MS is a disease that has evolved from the mysterious “crippler of young adults” to, more recently, one that has generated a great deal of public interest due to highly publicized treatments, both conventional and unconventional.

Impairments in MS are the result of demyelination in the brain or spinal cord or both, and manifest themselves in mild sensory symptoms, weakness, fatigue, bowel or bladder dysfunction, tremor, incoordination, or paralysis. These impairments and their many manifestations can result in social, emotional, vocational, educational, and sexual disruptions. This book is designed to empower those affected by multiple sclerosis with updated information about MS care, available resources, and other valuable tools to remain well despite chronic illness. It is the second edition of a book that has proven valuable to people with MS who are impacted by the disease on a day-to-day basis.

The philosophy of each chapter is consistent with a phrase coined by the National MS Society: “Knowledge is power,” and your authors and editors hope that each reader takes an active role in planning and implementing healthcare and self-care activities and acts as a consultant to his or her healthcare team. The goal of our work is to support the development of an MS Expert Person who is challenged by MS, but who can overcome problems with realistic and appropriate solutions.

Whether diagnosed for a few years or having lived with the disease for some time, the person with MS will find in this book many practical tips on self-care designed to promote maximum independence, well-being, and productivity. Despite the diagnosis, wellness can be achieved with knowledge and commitment.

This book was developed in partnership with and under the auspices of the Paralyzed Veterans of America, which has made a major and continuing commitment to multiple sclerosis care.
Foreword

Since 1998, when Paralyzed Veterans of America (PVA) first published *Multiple Sclerosis: A Guide to Wellness*, great strides have been made in research findings and treatment options. For this reason, PVA is proud to present this newly updated edition of the “MS Wellness Guide,” as it has come to be called.

Edited by Nancy J. Holland, RN, EdD, MSCN and June Halper, MSCN, ANP, FAAN, this second edition has been expanded to include new chapters on the promise of research, disease management, general health issues, managing financial resources, health insurance options, and community living options. Each of the other chapters has been updated and revised to reflect advances in the field and changing management strategies. The table of contents has been reorganized to facilitate finding information of special interest to the reader, and the appendix on “Helpful Resources” has been greatly expanded.

The new edition continues to focus on staying well in the presence of MS. Wellness is a concept that does not normally come to mind when we think about a disease. We usually think of diseases in terms of curable or incurable. But MS is a disease that—while incurable—can be managed and yields to many treatments and therapies. Although not cures, they can provide the patient with a great deal of control over his or her experience of well-being.

This book covers a broad spectrum of topics related to MS and its effects, focusing especially on the needs of those who have been living with the disease for some time. Practical tips on self-care are designed to promote maximum independence, well-being, and productivity. The objective is to emphasize that wellness can be achieved with knowledge and commitment.

PVA has been pleased to partner with Demos Medical Publishing in updating and producing this new edition. We are proud to see it take its place among the other books in the Demos catalog of reliable, practical guides on living with multiple sclerosis.

Randy Pleva
National President
Paralyzed Veterans of America
About the Paralyzed Veterans of America

Founded in 1946, PVA is the only congressionally chartered veterans service organization dedicated solely to individuals with spinal cord injury or diseases. PVA has 34 local chapters around the country and represents over 21,000 members. Approximately 20 percent of PVA members have MS. To serve them better, PVA has published a number of books on MS, promoted the development of MS Centers of Excellence within the Department of Veterans Affairs and engaged with other organizations in vigorous efforts to promote MS program building.

The first “Wellness Guide” has been one of PVA’s most popular publications. Through the partnership with Demos, PVA hopes to be able to reach an even wider audience.
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Chapter 1
An Overview of Multiple Sclerosis
Joseph B. Guarnaccia, MD and John Booss, MD

Multiple sclerosis (MS) is a disease of myelin, the insulating cover around the nerves of the central nervous system (CNS: brain, optic nerves, and spinal cord) (see Figure 1.1), that becomes damaged in MS. MS most commonly begins in young adulthood and affects about twice as many women as men. Although its initial symptoms vary greatly, certain patterns are typical: a previously healthy woman or less frequently, a man, 20 to 30 years old suddenly experiences neurologic symptoms. These symptoms may range from dimming of vision to numbness in the legs or body to dizziness or imbalance. Symptoms of this first attack (or exacerbation) usually remit (clear) or improve.

Four general patterns of disease course are diagnosed as MS (see Figure 1.2). Relapsing-remitting MS is a pattern of attacks (exacerbations) followed by partial or complete recovery from symptoms (remission). This relapsing/remitting pattern may give way to a pattern of progressive disability, called secondary progressive MS.

Some individuals rarely experience remission of symptoms. They have primary progressive MS, in which there is steady progression without remissions. A fourth pattern, recently defined, is progressive-relapsing MS. This is a chronic progressive course in which infrequent relapses occur.

The reasons for these differences in the course of MS are unknown. However, the relapsing-remitting pattern most typically affects young adults, especially women. Older individuals are more likely to have patterns of progressive MS. In these latter cases, onset is usually after age 40, and men and women are affected equally.

The multiple scars of MS (plaques) can be seen as pale, well-defined patches scat-
tered throughout the brain and spinal cord. They are located in the white matter, which contains a high percentage of myelin, an insulating material that covers sections of nerve cells that carry electrochemical messages from the nerve cells to “action” parts of the body, such as the eyes or the muscles in the hands or legs. Because many of these messages from the brain must travel relatively long distances, myelin is critical for impulse conduction (see Figure 1.3). In MS, myelin is the primary target of an attack by the body’s immune system, although damage to the underlying nerve is now known to occur. Multiple sclerosis is an autoimmune (self-immune) disease, because the body’s immune system mistakenly attacks healthy myelin.

Figure 1.3
Myelinated Axon

WHO GETS MULTIPLE SCLEROSIS?
For decades, medical scientists have sought clues to causes for the variable incidence of MS in different parts of the world. The disease is far more common in temperate zones than in the tropics. Zones with low, medium, and high risk for MS are roughly based on distances north and south of the equator. The north-south or south-north gradient occurs within countries as well. In the United States, for instance, MS is more common in northern states than in southern states. Possible reasons for these variations are discussed in the next section.

However, whatever factors in high-risk zones predispose the development of MS, exposure to them during childhood or adolescence seems to have the greatest effect. If an individual moves after that critical period from a high-risk zone to a lower risk zone, or vice versa, the risk level of the original habitat applies. For example, a person who moves after adolescence from a temperate, high-risk zone to a tropical, low-risk zone will continue to have a higher risk of developing MS than the population in the tropical zone. What makes this observation intriguing is that MS does not usually begin in individuals until they reach their twenties and thirties—years or even decades after the period when MS is thought to originate.

Location alone does not account for all the variability, however. Multiple sclerosis is also more common in people of certain ethnic or racial backgrounds. Parts of the British Isles have the highest concentration of MS in the world, affecting one out of every hundred. Immigrants of Northern European descent have colonized other high-incidence areas of the world, including the United States and Canada. By contrast, MS is rare to nonexistent among African natives, Native Americans, and Laplanders in Scandinavia.

IS MULTIPLE SCLEROSIS INHERITED?
Because people of similar ethnic or racial composition share certain inherited traits, genes may play an important role in MS. But MS is not a simple genetic disease; that is, it is not due to a defective gene that causes the disease on its own. However, some individuals may inherit a cluster of genes that increases their susceptibility to the disease.

Scientists are investigating genetic factors and how they contribute to the disease.
We know that certain genes control some aspects of immune system development and function. It is possible that those or other unidentified genes may predispose the immune system to attack CNS myelin.

In some families, more than one individual may have MS, although the chances of more than one family member developing the disease are still low, less than 5 percent. Even for identical twins, who have identical genes, the risk is still only about 30 percent that both twins will have MS.

WHAT ELSE MAY BE IMPORTANT IN CAUSING MULTIPLE SCLEROSIS?
The combination of unidentified genes, geographic location, and an abnormal immune response to myelin has led scientists to consider that MS may be caused by a virus. Some viruses can infect the CNS, including, in rare instances, viruses that cause common childhood diseases. Polio, a once-common scourge that has been virtually eradicated in industrialized nations, was, like MS, more common in temperate climates than in the tropics. One hypothesis is that paralytic polio does not develop in the less stringent sanitary conditions and close living arrangements that are common in warmer climates and favor the occurrence of infections earlier in childhood, when maternal antibodies are still present and paralysis is much less likely.

The notion of an infectious cause of MS gained support when the disease emerged in the Faroe Islands, off the coast of England, after occupation by British troops during World War II. It has been speculated that dogs kept as pets by the British brought canine distemper or another virus to the island, exposing the native human inhabitants. However, no links to the canine distemper virus have been demonstrated.

Scientists have also speculated that MS results from altered immune response to one or more common viral infections, and that this abnormal response is more likely to occur when infection is acquired later in childhood. Many other viruses have been implicated and continue to be studied by researchers as possible causes of MS. One large study found that the disease was seven times more common in people who have had infectious mononucleosis, which is caused by the Epstein-Barr virus. But, however appealing the idea, there is no direct proof that any one virus causes the disease.

Other pieces of the puzzle remain unsolved as well. During their reproductive years, women are more susceptible to MS than men. Female hormones, such as estrogen and progesterone, significantly influence immune function. During pregnancy, women with MS seem to be relatively protected from neurologic attacks. However, the disease has a greater tendency to flare within the first six months of the postpartum period. These observations, however, are not absolute. A great majority of women successfully manage both pregnancy and the postpartum period.

Emotional stress, common infections such as colds or sinusitis, and trauma to the CNS also have been studied as possible causes both of MS and of periodic exacerbations. Except for the observation that common viral infections often precede exacerbations, no cause-and-effect relationship has been validated in scientifically controlled studies.

WHAT IS UNLIKELY TO CAUSE MULTIPLE SCLEROSIS?
Some theories of the cause of MS are highly speculative. Many books and articles in the popular press have touted particular causes of MS and suggested inappropriate treatments based on unscientific theories. For example, exposure to mercury through
dental fillings has been cited as a possible cause of MS; as a result, many people have asked their dentists to perform costly and inconvenient replacement of fillings. There is no scientific evidence to suggest such an approach.

Likewise, some medical authors have tried to show that diets rich in animal fats are important in causing and sustaining the disease, but their findings are not based on sound scientific studies. The National Multiple Sclerosis Society (NMSS) recommends the dietary guidelines published by the American Heart Association, in the absence of any compelling evidence linking MS to animal fat in the diet.

**HOW DOES MULTIPLE SCLEROSIS CAUSE SYMPTOMS?**

The effects of MS occur because messages to and from the CNS fail to reach their targets properly. Why does this happen? As noted, myelin insulates nerves within the CNS. When myelin is lost, messages lose strength because they “leak out” at the places where myelin has been damaged or destroyed. Therefore, the messages either slow down or fail altogether. This accounts for the nerve’s loss of function. Also, the demyelinated nerve itself becomes unstable and begins to initiate spontaneous nerve impulses. These impulses are experienced as pain, the sensation of “pins and needles,” or abnormal movements (see Figure 1.4).

Physical symptoms may include loss of muscle strength, clumsiness, altered sensation, decreased sight, or reduced perception of the position of the body or limbs in space. More subtle symptoms include a mild decrease in mental acuity or memory, or mood swings. Plaques in the so-called “silent” areas of the brain do not cause outward symptoms. Remission of symptoms has been explained by reduced inflammation in the plaque and remyelination by the cells that make myelin, *oligodendrocytes*.

**COMMON SYMPTOMS OF MULTIPLE SCLEROSIS**

Virtually any aspect of neurologic function can be affected by MS, but some symptoms, such as *optic neuritis* in a young person, are characteristic. Optic neuritis usually results in partial loss of vision in one eye because of inflammatory demyelination of the optic nerve. Vision may be blurred, and colors may be difficult to distinguish. Eye movement may be uncomfortable.

Double vision, another common symptom, is caused by plaques in the brainstem, the part of the brain directly above the spinal cord. Brainstem plaques may also cause vertigo, a sensation of spinning, or dizziness.

*Trigeminal neuralgia*, or tic douloureux, also occurs, although this condition is also common in individuals who do not have MS. Tic douloureux causes sharp, shooting pains in the face, usually precipitated by chewing or speaking.

The *cerebellum* is the part of the brain that controls balance and the rhythm of muscle movement. Involvement of the cerebellum and its connections may cause gait...
instability, problems with hand coordination, or slurred speech.

The spinal cord is frequently affected by MS. Individuals sometimes experience a sharp, seemingly electrical sensation, called *Lhermitte’s sign*, when they flex their necks. Plaques in the spine can cause a variety of symptoms, including numbness, weakness, bowel or bladder difficulty, or gait imbalance. Plaques in the brainstem or higher levels of the brain can also cause these symptoms, but the hallmark of MS involvement in the spinal cord is simultaneous involvement of both the right and left sides of the body.

In addition to muscle weakness, *spasticity* may also occur. This results when communication from the brain to the motor cells that directly control muscle movement in the spinal cord is interrupted and primitive spinal cord reflexes take over. Spastic weakness may cause difficulty in walking because considerable effort is needed to overcome stiffness in order to raise and propel the leg forward. However, spasticity is a boon when it partially compensates for muscle weakness by acting as a “splint” in walking, standing, or transferring.

The concept of spasticity also applies to bladder function. Individuals may experience a sudden urge to urinate and inability to hold their urine, even in public places. Other problems are retention of urine or difficulty initiating urination. (Bladder problems are addressed in detail in Chapter 7, “Bladder and Bowel Management.”)

**HOW IS MULTIPLE SCLEROSIS DIAGNOSED?**

None of the symptoms described so far occurs only in MS. Strokes, tumors, or infections can cause the same disabilities when they affect the same areas of the brain and spinal cord. Therefore, the diagnosis of MS requires the exclusion of other neurologic diseases. Diagnosing MS was a greater problem in the past, before physicians could produce sophisticated images of the brain and spinal cord and test other aspects of neurologic function. In the past, the diagnosis of MS relied primarily on a patient’s medical history and a physical examination. Criteria for the diagnosis required at least two verified neurologic attacks, separated in time, and caused by damage in at least two different areas of the CNS. These criteria reflected the natural history of relapsing forms of MS. Progressive MS could be diagnosed, in the absence of another known neurologic condition, after a progressive worsening of neurologic symptoms over a six-month period.

These criteria have been modified in light of improved diagnostic tests. These tests include magnetic resonance imaging (MRI) of the brain, measuring nerve conduction through the CNS, and cerebrospinal fluid testing for abnormal proteins or cells. The earlier standard required evidence of multiple brain or spinal cord lesions by history and neurologic examination. Now these methods can be augmented with imaging and laboratory tests.

The diagnosis of MS should always be made or confirmed by a *neurologist*, a physician who specializes in diseases of the nervous system. It is wrong and potentially damaging to say that an individual has the disease in the absence of positive test results. However, positive test results should be corroborated by the patient’s medical history, symptoms, and abnormal findings on physical examination.

MRI scans and other test results must be carefully interpreted in light of each person’s history and examination. The plaques typical of MS have been found at autopsy in individuals who never reported symptoms of the disease during their lifetime. Furthermore, other neurologic diseases can mimic MS, and a skilled physician is
required to differentiate among them. Equally important, the possibility of MS should be recognized in patients who have atypical symptoms, so that costly, unnecessary, or even potentially hazardous treatments are not given for an erroneously diagnosed condition.

WHAT ARE THE TESTS FOR MULTIPLE SCLEROSIS?

MAGNETIC RESONANCE IMAGING (MRI)
The most revolutionary advance in diagnosis of MS, as well as other diseases of the CNS, is imaging the brain and spinal cord by magnetic resonance. The MRI has revolutionized the ability to diagnose MS, and it has emerged as a primary research tool as well (see Figure 1.5).

MRI scanning determines the progression of the disease by measuring the size and number of both “silent” and active plaques. The technique is especially useful in clinical studies of new therapies, because it allows unbiased investigators to compare disease activity and progression by comparing the MRI scans of treated and untreated individuals.

EVOKED POTENTIALS
Evoked potential tests measure electrical transmissions in the CNS from the point of origin, such as the eye or ear, to the place in the brain where the message is received. The tests can measure visual, auditory, and other sensory perceptions.

The tests may consist of a changing visual pattern placed in an individual’s field of sight, a series of clicks delivered to each ear, or a small electrical current delivered to the finger or toe. The diagnosis of MS is aided by these tests because demyelination in the CNS results in an increase in the amount of time needed to transmit electrical messages.

Evoked potentials are useful additions to other tests, particularly the MRI when the brain scan is normal. Although MRI scanning of the brain is very sensitive in detecting MS plaques, the technique is less precise in the spinal cord or optic nerve because they are smaller areas. Visual evoked potentials may be particularly helpful when demyelination in the optic nerve is not yet sufficient to cause visual complaints by individuals.

CEREBROSPINAL FLUID EXAMINATION
Cerebrospinal fluid surrounds the brain and spinal cord and often reflects disease conditions in the CNS. In MS, certain abnormalities in the spinal fluid reflect the inflammatory nature of the disease. These abnormal-
ities include the presence of white blood cells, which are involved in inflammation, and the protein products of these cells. (White blood cells differ from red blood cells, whose function is to transport oxygen to tissues.)

In MS, the number of white blood cells in the spinal fluid may be mildly elevated, but a more characteristic finding is the presence of inflammatory proteins, called antibodies or immunoglobulins. The presence of these substances in spinal fluid, and their absence in the blood, indicates that they are being produced within the CNS. Both the amount (IgG index) and properties (oligoclonal bands) of these proteins indicate CNS inflammation, which is characteristic of MS.

MULTIPLE SCLEROSIS AS A DISEASE OF THE IMMUNE SYSTEM

Normally, the immune system is able to distinguish between infectious organisms or foreign tissues (such as a transplanted organ), which are attacked or rejected, and the body's own organs or tissues, which are tolerated. How white blood cells perform these functions is a fascinating story. The process requires continual adaptation on the part of white blood cells to recognize—through receptors on their surfaces and in proteins they make—any disease-producing bacteria, virus, or fungus, and even the body's own cells that have become cancerous.

Scientists have learned to activate the immune system—through vaccination—to defend the body against potentially infectious challengers. The other side of immunity, however, is that these white blood cells sometimes misrecognize and cause damage to the body's own cells and proteins. White blood cells that act in this way must be destroyed or held in check. If the system breaks down, autoimmune disease may occur. The immune system is then said to have "lost tolerance" to a particular organ or tissue in the body. Restoration of this tolerance is the ultimate goal of any treatment for autoimmune disease.

In MS, tolerance is lost to myelin in the CNS. By a process that continues to be clarified at a rapid rate, white blood cells cross into the CNS and destroy myelin. Some white blood cells specifically misrecognize myelin, others make antibodies to myelin, and still others digest myelin. Moreover, in keeping with the natural system of checks and balances in immunity, other classes of white blood cells suppress the inflammatory attack.

The ability of scientists to produce an MS-like disease—called experimental allergic encephalomyelitis—in laboratory animals has been critical to understanding the immune process in general and MS in particular. This animal research has been instrumental in the development and testing of therapeutic interventions prior to clinical testing in humans with MS.

DRUGS USED TO TREAT MULTIPLE SCLEROSIS

All accepted medical therapies (see Chapter 3 and Appendix C) used to ease or prevent attacks of MS or to slow its progress have an effect—either a suppressive or modifying effect—on the immune system. A good example are the glucocorticosteroids. When given by intravenous infusion at high doses for short periods of time, glucocorticosteroids have many actions, including the suppression of white blood cell functions. In MS, glucocorticosteroids are commonly used to treat exacerbations. Individuals who receive intravenous corticosteroids for optic neuritis have had improved visual outcomes. These medications have definite—if uncommon—risks, however, which should be discussed with the treating physician. In general, the risks and side effects of short courses of intravenous corticosteroids are minimal.
when compared with those of daily oral steroids taken over a long period of time.

Traditionally, long-term treatments for MS have suppressed immune function. Those that have been tested and are still used include azathioprine, cyclophosphamide, and methotrexate. Their use may slow disease progression, but individuals taking these drugs must be carefully monitored by their physicians because of the medical risks.

It was not until the advent of the beta interferons in 1993 that a relatively safe, nontoxic, long-term treatment for MS became available. The first drug of this type was interferon beta-1b, Betaseron®. Testing in a large clinical trial showed that interferon beta-1b could produce a 33 percent decrease in the number and reduce their severity. Its clinical efficacy was further supported by findings on MRI scans that the rate of new plaque formation was significantly reduced. Interferon beta-1b is administered by injection just beneath the skin every other day.

In 1996, a second beta interferon, interferon beta-1a, Avonex®, was approved for distribution. It is administered by injection into a large muscle once a week. The beta interferons are natural products of cells that participate in immunity. They have a number of modulating effects that tip the balance away from an immune attack.

A third drug is glatiramer acetate, Copaxone®. Glatiramer acetate is a mixture of four amino acids—the building blocks of protein—that have been shown to reduce neurologic exacerbations in individuals with relapsing/remitting disease. It is hypothesized to work either by binding receptors on T-lymphocytes that would otherwise bind myelin basic protein or by stimulating other subsets of T-lymphocytes that suppress activated cells.

In 2001, a second interferon beta-1a, Rebif®, was approved in the United States after being available for several years in Europe and Canada.

Beta interferons and glatiramer acetate offer two distinct advantages over general immune suppressants. First, they do not disturb general immunity to infections. Second, they have fewer side effects on other organ systems. They therefore appear to be safer to use over long periods of time. Disadvantages of the interferons are their frequent side effects, which include fever, chills, muscle aches, depression, and skin reactions at injection sites, particularly common at the beginning of treatment.

Glatiramer acetate is relatively free of these side effects. However, some individuals suffer occasional brief reactions immediately after an injection. These reactions, which consist of flushing, sensations of a rapid heartbeat, and shortness of breath, usually resolve within 5 or 10 minutes and are of no known threat to health.

Some individuals with rapidly progressive disease benefit from cytotoxic therapies. Mitoxantrone, one such chemotherapy, was FDA approved in 2000 for individuals with rapidly progressive MS. Presently under study is the effect of these drugs on preventing long-term disability in individuals who have relapsing/remitting and progressive MS, because the underlying immune process is not significantly changed in individuals with these types of the disease.

In 2005, Tysabri® (natalizumab) was approved by the FDA for relapsing forms of MS. Although encouraging early data resulted in “fast track” approval, one death and other related concerns led to the suspension of Tysabri®. This was a very disappointing event, and there is hope that analysis of the problems may one day lead to re-introduction of natelizumab.

THE FUTURE OF MULTIPLE SCLEROSIS TREATMENTS

Restoring normal immune tolerance to myelin without disturbing other functions of the immune system is the ultimate goal of
therapy. As more is understood about the natural mechanisms for establishing and maintaining this tolerance, new drugs will be designed to treat MS. Our knowledge of immune regulation is built partly on the tremendous strides made in this century in augmenting with vaccines the immune system’s ability to fight infectious diseases that once were uniformly fatal or disabling. Strategies for treating MS and other autoimmune diseases, and for tolerating transplanted organs, may include vaccines to train the immune system not to react.

For individuals who are disabled from MS, there is hope that some day demyelination will be reversible or that myelin can be regenerated in the CNS. Scientists are investigating chemical substances that stimulate myelin growth and nerve repair, as well as the transplantation of myelin-producing cells to sites of damage. So far, most of this work is confined to animals, but it is anticipated that clinical trials will be performed on humans in the not-so-distant future.

The horizon for individuals with MS is brighter now than at any other time. The revolution in biotechnology has made modern treatments for MS possible and will continue to provide novel strategies for the development of newer and better therapies. People with MS, their families, and their care partners can look to the future with great optimism.