Original Research

Novel therapies in Multiple Sclerosis Treatment

Dhata Harris,[1]

[1]The Enitiative Group Inc, Atlanta GA

Correspondence to
Dhata Harris;
dhata.harris@enitiative.org

ABSTRACT

Background MS patients are two times more likely to have periodontal disease[1], 65% of periodontitis patients tested positive for H. Pylori in the dental plaque[2], and at least one study found that 86.4% of MS patients had H. Pylori infection[3]. This study aims to form a hypothesis of how an MS patient with periodontal disease and H. Pylori infection, went from having at least one relapse every 2-3 months to zero relapses in an 8-year period after surgical intervention.

Methods A patient directed research (PDR) study was performed between March 2005 and July 2025 including inputs from 6 participants (2 MS patients and 4 without.) The study sought to provide empirical evidence to validate present theories on the cause of MS which include factors that are genetic **(GEN)**, environmental **(ENV)**, infectious **(INF)**, and related to immune system dysfunction **(ISD)**.[4]

Results The study identified 10 diagnosed risk factors among the 6 study participants including **GEN** | familial MS (83%), predisposition to fungal infections (83%), cardiomegaly (17%); **ENV** | mold exposure (33%); **INF** | Malassezia furfur fungi (17%), h. pylori bacteria (33%), venomous spider bite (17%); **ISD** Tinea Versicolor (17%), BBB dysfunction (17%), MTHFR C677T fungal anergy (17%)

Conclusions The study identified how the risk factors for MS, shared in some way by each of the study participants, did not result in MS without being acted upon by a trigger and an environmental exposure.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Existing research on MS suggests genetic, environmental, infectious pathogens, and immune dysfunction risk factors are key contributors in disease development, while the exact cause of MS remains unknown.

WHAT THIS STUDY ADDS

This original research provides a 20 - year PDR dataset capturing the exact onset of the disease, 10 diagnosed and associated risk factors, and a hypothesis on the subsequent 8-year remission of MS symptoms following dental implant surgery, remediation of the h. pylori bacterial infection, and sleeve gastrectomy surgery.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

These findings may assist in establishing a profile to aid in the prevention of disease development and novel treatment options for those already diagnosed with MS.

INTRODUCTION

Multiple Sclerosis (MS) impacts an estimated 2.8 million people worldwide as of 2020.[5] While the disease was discovered 157 years ago, by Jean Martin Charcot, little progress has been made in understanding the pathogenesis.[6] A series of unrelated medical and surgical events, without intention to improve or reduce MS symptoms, may have resulted in a novel application for identifying the etiology and pausing relapses for a multiyear period.

Multiple Sclerosis

Multiple sclerosis (MS) presents with varied symptoms linked to the disease. In this study, patient x experienced notable symptom improvement after three medical interventions over five years. This paper proposes a hypothesis, based on data and recent research, to explain the subsequent eight-year remission.

METHODS

Study design

This study employs a reversed Six-Sigma DMAIC framework to clarify problem definition.[7] Patient-focused and modeled as a self-audit, it aims to establish with 95% confidence the absence of clinically significant misstatements. The main goal is to identify factors behind patient X's eight-year remission after treatment. Data are analyzed to pinpoint key variables and root causes, which, once defined, may inform discussions on replicating such outcomes for similar patients.

Study population and parameters

The study includes six closely related individuals, five by blood and one by marriage. Researchers aim to identify previously unknown genetic, environmental, infectious, and immune factors linked to patient x's multiple sclerosis. The "Control" phase of DMAIC evaluates how dental implants, daclizumab, H. pylori eradication, and sleeve gastrectomy together managed symptoms and supported an eight-year remission.

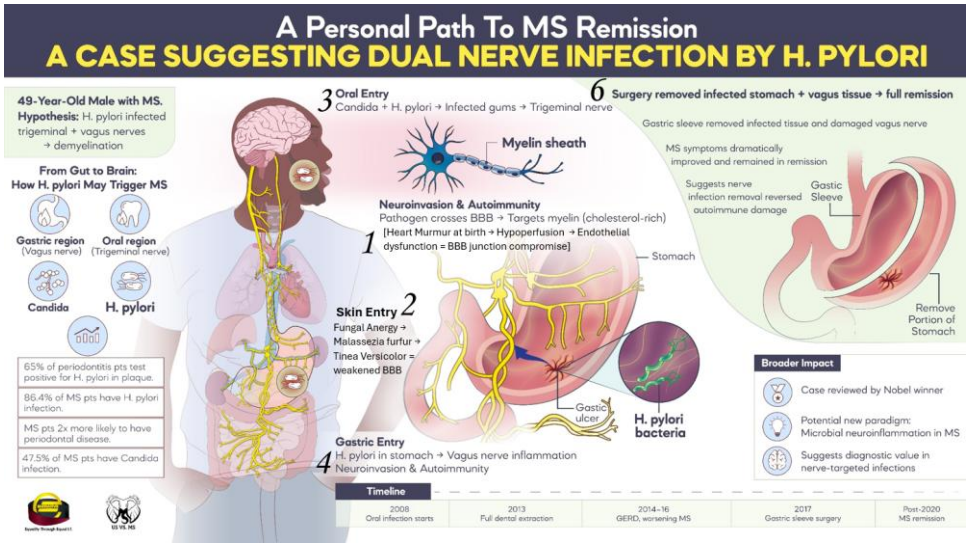


Figure 1 The figure shows the proposed pathogenesis and possible reason for extended remission in Multiple Sclerosis for patient x. Although MS has no established cause or cure, the analysis relies on peer-reviewed literature applied to patient x and other participants.

Systematic review of genetic factors in the onset of MS

Although this category highlights genetic factors linked to patient x's MS, there is overlap with immune system dysfunction. A 2018 study found up to a 20% chance that MS patients have a family member with MS; patient x's maternal aunt, included in the study, also has MS.[8]

Among five genetically related study participants, 83% showed susceptibility to fungal infections, possibly linked to the inherited MTHFR C677T mutation, found in about 20–40% of people.[9] Patient x inherited this mutation from his mother. Two maternal first cousins have both scoliosis and Crohn's disease. [10,11] Research indicates that MS, scoliosis, and Crohn's disease are loosely linked with the MTHFR C677T mutation, which can reduce enzyme

production by 30-65% and contribute to autoimmune risk. [12,13] These conditions share a similar mean age of onset (around 22), with MS historically averaging 23.79 years between 1970 and 1979—suggesting that MTHFR mutations may be underreported. [14, 15] While scoliosis and Crohn's disease often appear in the mid-to-late teens, this aligns with onset patterns for MS and MTHFR-related conditions. [16,17] Additionally, patient x was born with a heart murmur and later diagnosed with cardiomegaly and inverted t-waves; studies associate the MTHFR C677T polymorphism with increased risk for congenital heart defects, including these conditions. [18]

Systematic review of environmental factors in the onset of MS

Environmental exposure is a potential risk factor for multiple sclerosis (MS), though its mechanisms remain unclear. Patient x, a military member stationed briefly in Egypt in 2001, noted mold in his barracks' bathroom. Recent research suggests this exposure may have played a role in his MS development. [19]

Patient x developed multiple sclerosis (MS) symptoms in 2005, including leg weakness during the second mile of the Army Physical Fitness Test, four years after documented mold exposure. Mold produces mycotoxins over time; some are carcinogenic and linked to about half of reported illnesses. [20] In numerous instances, symptoms may not manifest until several years following the initial exposure to mold. [21] Patient x did not undergo mold or mycotoxin testing following travel to Egypt; however, subsequent exposures occurred in 2020 due to basement flooding and during travel to Bermuda for his father-in-law's funeral.

Although patient X did not exhibit MS symptoms following subsequent exposures, he noted a change in his condition one year later, in 2021. It took an additional four years for him to determine the underlying cause of these changes. Despite undergoing an extensive array of personal medical tests, he had not completed an assessment for potential effects related to mold exposure. The relatively high cost of this particular test had previously deterred him from pursuing it.

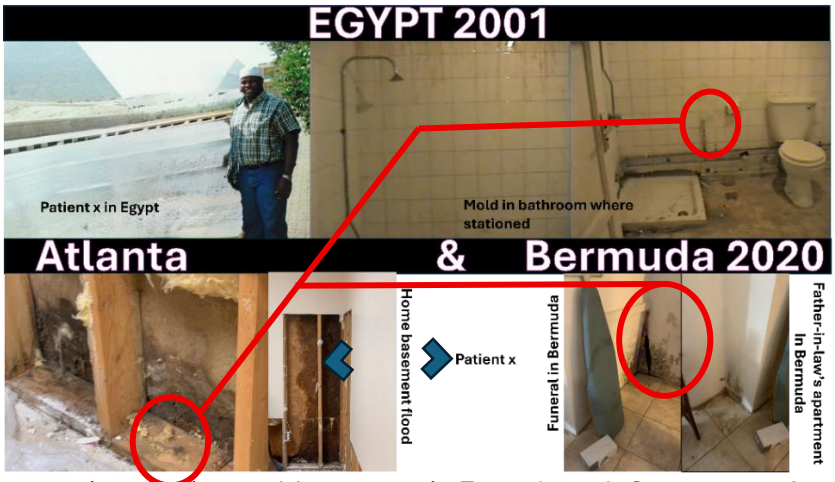


Figure 2 The graphic shows patient x's first mold exposure in Egypt (2001). Symptoms of mold toxicity appeared in 2021, about a year after two separate exposures in 2020, as shown in the lower part of the graphic.

Systematic review of infectious factors in the onset of MS

In this paper, infections will be examined through the framework of molecular mimicry, which is posited in this study to be equivalent to autoimmunity. [22] The concept of molecular mimicry requires further investigation; it is comparable to the phenomenon of "friendly fire," wherein the immune system fails to distinguish between foreign antigens that resemble T or B cells and self-antigens. In 1992, Patient x was diagnosed with Tinea Versicolor, a condition attributed to the yeast Malassezia furfur. Malassezia furfur, one of the predominant fungi in the human gut microbiome, is recognized for its potential to facilitate molecular mimicry. [23] Although molecular mimicry has

been implicated in the etiology of Multiple Sclerosis, the identification of the specific infectious agent frequently remains uncertain.[24] In addition, patient x was found to have both Helicobacter pylori in his gut and Chlamydia pneumoniae infection in his Cerebrospinal Fluid (CSF), detected via lumbar puncture, which are also known to possess molecular mimicry capabilities. Furthermore, a documented bite from a venomous spider in 2005—the same year as the onset of his multiple sclerosis—may have served as a potential trigger in the demyelinating process.[25]

Systematic review of immune system dysfunction factors in the onset of MS

Immune system dysfunction is characterized by either a weakened immune response or an inability to distinguish between foreign and native antigens. Patient x was diagnosed with Tinea Versicolor in 1991; although this condition results from the overgrowth of a common skin yeast, it may indicate compromised immune function.[26] The preceding section provided a systematic review of infectious agents potentially implicated in the etiology of multiple sclerosis (MS), as well as a spider bite experienced by Patient x. The MTHFR C677T gene mutation—also referred to as Single Nucleotide Polymorphism (SNP) rs1801133—has been shown to cause elevated homocysteine levels, an amino acid strongly linked to chronic inflammation. [27]

Antagonism of N-methyl-D-aspartate (NMDA) receptors may occur in conjunction with high homocysteine concentrations and exposure to certain spider venoms, leading to neurotoxicity and an increased risk of cognitive decline. [28,29] Another risk factor identified in Patient x is blood-brain barrier (BBB) dysfunction, also called hypoperfusion, which arises due to congenital heart and vascular defects associated with the MTHFR C677T mutation. Elevated homocysteine further contributes to vascular oxidative stress, a process that can promote the development of Cerebral Small Vessel Disease (CSVD).[30] In a study involving 330 CSVD patients, 56.1% exhibited cognitive impairment, and 71.5% presented with White Matter Hyperintensities (WMH) analogous to MS-related plaques.[31] Notably, distinguishing between CSVD and MS using magnetic resonance imaging (MRI) alone is challenging, and current literature suggests that differentiation is only possible through pathology: CSVD is associated with vascular lesions, whereas MS results from demyelination. [32]

In the context of the MTHFR C677T mutation, the etiologies of CSVD and MS may be more closely related than previously understood. Vascular abnormalities are well established in cases of dysfunctional methylation (MTHFR), yet the influence of methylation on myelin stability and Oligodendrocyte Progenitor Cell (OPC) renewal—which is essential for myelin sheath formation—merits further investigation.[33] Furthermore, a study of 411 participants (180 with MS, 231 healthy controls) found that individuals carrying the MTHFR C677T variant had a 2.9-fold increased risk of developing MS.[34]

CONCLUSION

Reverse Engineering the MS Disability Process for Patient X

Patient x has remained free of MS symptoms following four medical interventions. The Six Sigma DMAIC process improvement framework will be applied in reverse to develop a plausible theory regarding the cause of this prolonged remission.[35]

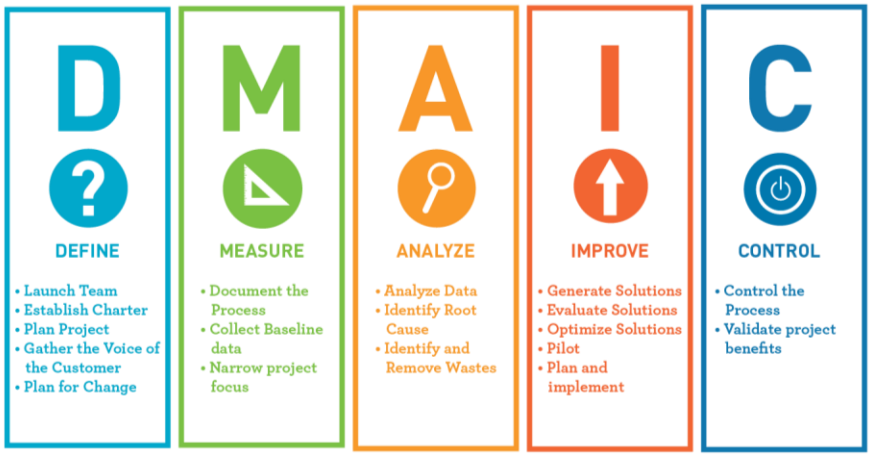


Figure 3 This illustration presents the Six Sigma DMAIC frameworks employed in process improvement initiatives. Reversing the sequence of process steps can help clarify underlying causes that were successfully managed. While the etiology and cure for MS remain unidentified, further reviews of this research journal may provide insights addressing both aspects, particularly in relation to patient x.

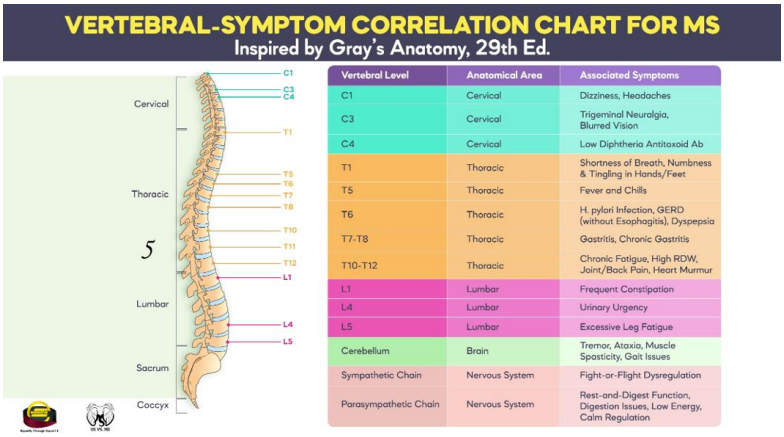
Control – Develop and sustain an effective solution that reduces or prevents relapses beyond the typical 12-to-18-month interval observed in Relapsing Remitting Multiple Sclerosis (RRMS).

Patient x has remained free of MS symptoms for eight years, with no adverse effects from heat or other external factors that previously contributed to relapse.

Improve – Identify the causes of nervous system dysfunction and devise strategies to regulate the immune response to stop self-harm.

Autonomic Nervous System Imbalance

The following locations were identified as being under immune stress. When exposed to such stress, individuals with dysregulated methylation may have difficulty converting norepinephrine to epinephrine (adrenaline). This challenge can hinder effective regulation of adrenaline levels in the sympathetic nervous system, resulting in a sustained "fight or flight" response.[36] Conversely, the parasympathetic nervous system facilitates a "rest and digest" state. Achieving equilibrium within the autonomic nervous system is the optimal therapeutic goal.



Multiple Sclerosis

Figure 4 This illustration provides a detailed account of the multiple sclerosis symptoms observed in patient x and indicates the corresponding areas within the brain and spinal cord from which these symptoms originate, as referenced in Gray's Anatomy, 29th Edition.

Analyze – Assess the factors present at the onset of disability in conjunction with relevant medical literature and personal or family history to establish a credible underlying cause.

"The Suspect List"

In 2001, Patient x encountered mold exposure while stationed in Egypt. Mold produces mycotoxins, many of which are carcinogenic. Gliotoxin, a specific mycotoxin, has been associated with the pathogenesis of multiple sclerosis due to its cytotoxic effects on microglial cells, which play critical roles in the development, maintenance, and repair of myelin.[37]

Before Binders & Probiotics

US BioTek LABORATORIES — Mycotoxin Panel

Company: [redacted] MD
Patient:
Sex: M
Date of Birth: [redacted]
Accession #:
Collected: 04/16/2025
Received: 04/21/2025
Completed: 04/25/2025

Procedure Type: Semi-Quantitative ELISA (Enzyme-Linked Immunosorbent Assay)

Code	Test - Urine	Result	Value (ppb)	Reference Range
OCHRA	Ochratoxin A	Present	9.765	<1.8 Not Present 1.8 to <2 Equivocal >=2 Present
AFLA	Aflatoxin Group: (B1, B2, G1, G2)	Present	2.084	<0.8 Not Present 0.8 to <1 Equivocal >=1 Present
TRICHO	Trichothecene Group (Macrocyclic): Roridin A, Roridin E, Roridin H, Roridin L-2, Verrucarin A, Verrucarin J, Satratoxin G, Satratoxin H, Isosatratoxin F	Present	0.172	<0.07 Not Present 0.07 to <0.09 Equivocal >=0.09 Present
GLIO	Gliotoxin Derivative	Present	4.723	<0.5 Not Present 0.5 to <1 Equivocal >=1 Present
ZEA	Zearalenone	Equivocal	0.632	<0.5 Not Present 0.5 to <0.7 Equivocal >=0.7 Present

After Binders & Probiotics

US BioTek LABORATORIES — Mycotoxin Panel

Company: [redacted] MD
Patient:
Sex: M
Date of Birth: [redacted]
Accession #:
Collected: 07/14/2025
Received: 07/15/2025
Completed: 07/17/2025

Procedure Type: Semi-Quantitative ELISA (Enzyme-Linked Immunosorbent Assay)

Code	Test - Urine	Result	Value (ppb)	Reference Range
OCHRA	Ochratoxin A	Not Present	1.527	<1.8 Not Present 1.8 to <2 Equivocal >=2 Present
AFLA	Aflatoxin Group: (B1, B2, G1, G2)	Present	1.038	<0.8 Not Present 0.8 to <1 Equivocal >=1 Present
TRICHO	Trichothecene Group (Macrocyclic): Roridin A, Roridin E, Roridin H, Roridin L-2, Verrucarin A, Verrucarin J, Satratoxin G, Satratoxin H, Isosatratoxin F	Present	0.134	<0.07 Not Present 0.07 to <0.09 Equivocal >=0.09 Present
GLIO	Gliotoxin Derivative	Equivocal	0.810	<0.5 Not Present 0.5 to <1 Equivocal >=1 Present
ZEA	Zearalenone	Present	0.715	<0.5 Not Present 0.5 to <0.7 Equivocal >=0.7 Present

Figure 5 The graphic above demonstrates that patient x exhibited elevated levels of gliotoxin for an estimated five years following mold exposure in 2020. Utilizing binders, as indicated in the subsequent graphic, patient x was able to reduce mycotoxin concentrations to normal levels within approximately three months. Individuals with typical MTHFR detoxification functionality would likely eliminate these toxins more rapidly.

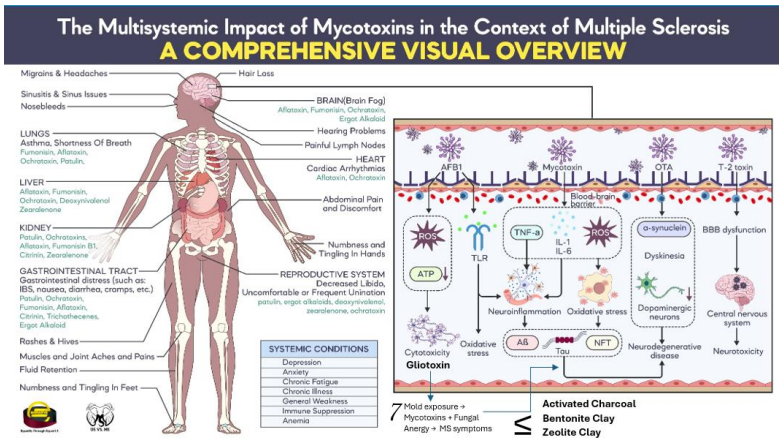
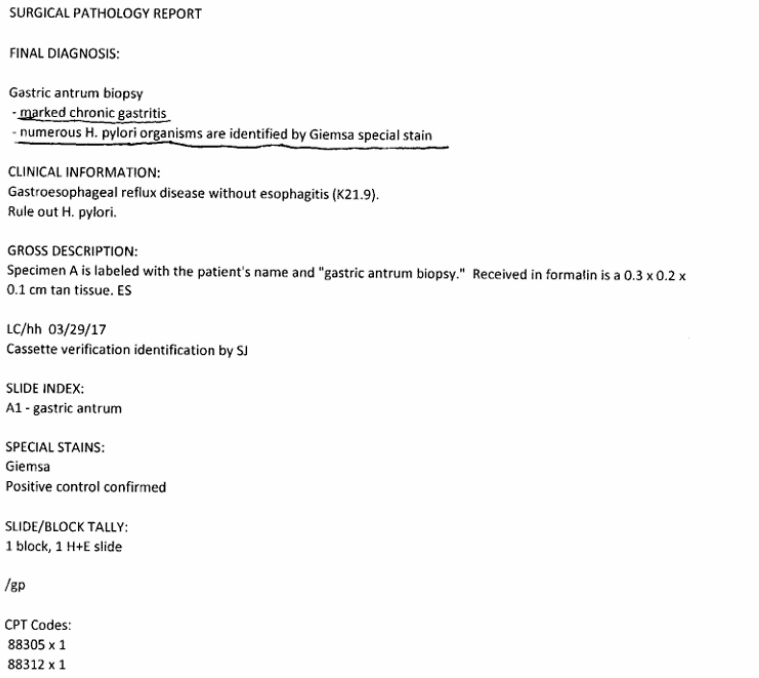


Figure 6 This diagram illustrates the systemic effects of mycotoxins on patient x and demonstrates the correlation between associated symptoms and multiple sclerosis (MS).

During preoperative evaluation for sleeve gastrectomy, Helicobacter pylori (h. pylori) was identified upon gastric antrum biopsy. This bacterium is known to induce DNA methylation, which may contribute to the development of gastric cancer.[38] Patient x was diagnosed with periodontal disease in 2004. Studies indicate that individuals with

multiple sclerosis are twice as likely to develop periodontal disease, and approximately 65% of patients with periodontal disease exhibit H. pylori in their dental plaques. H. pylori has been linked to various neurodegenerative conditions and may have contributed to damage to both the trigeminal and vagus nerves in patient x.[39]



SURGICAL PATHOLOGY REPORT

FINAL DIAGNOSIS:

Gastric antrum biopsy
- marked chronic gastritis
- numerous H. pylori organisms are identified by Giemsa special stain

CLINICAL INFORMATION:
Gastroesophageal reflux disease without esophagitis (K21.9).
Rule out H. pylori.

GROSS DESCRIPTION:
Specimen A is labeled with the patient's name and "gastric antrum biopsy." Received in formalin is a 0.3 x 0.2 x 0.1 cm tan tissue. ES

LC/hh 03/29/17
Cassette verification identification by SJ

SLIDE INDEX:
A1 - gastric antrum

SPECIAL STAINS:
Giemsa
Positive control confirmed

SLIDE/BLOCK TALLY:
1 block, 1 H+E slide

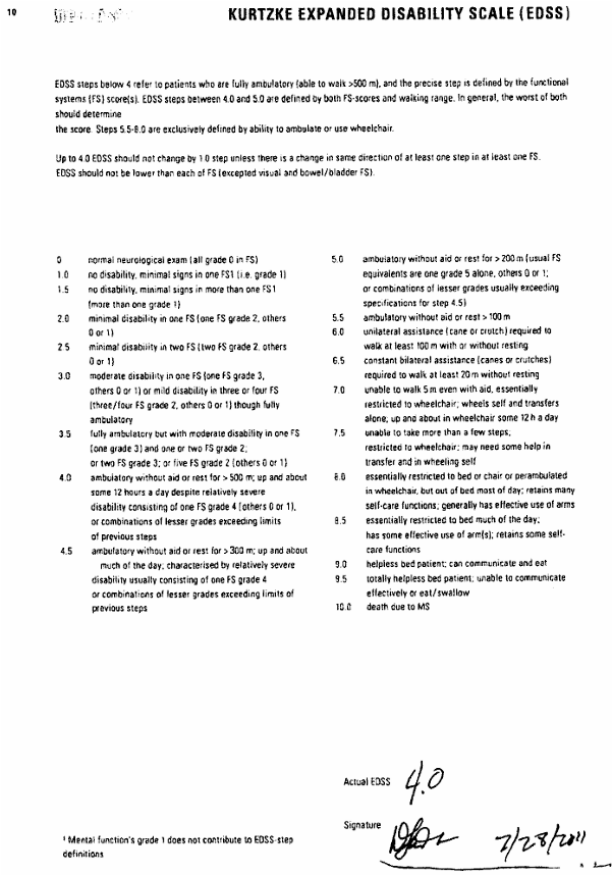
/gp

CPT Codes:
88305 x 1
88312 x 1

Figure 7 This graphic shows that chronic gastritis, GERD, and h. pylori were found during the preoperative endoscopy.

Measure – Record the established disability process to provide an initial benchmark of the progression prior to effective disability management.

Patient x was diagnosed with multiple sclerosis (MS) in 2008 following three years of intermittent symptoms that became increasingly persistent after a spider bite on his left thigh, which resulted in a nickel-sized area of necrotic tissue. After the formal diagnosis, his condition progressed significantly, leading to his application for disability retirement in February 2011, for which he received a fully favorable decision. At the time of retirement, his Expanded Disability Status Scale (EDSS) score was documented at 4.0.



10

KURTZKE EXPANDED DISABILITY SCALE (EDSS)

EDSS steps below 4 refer to patients who are fully ambulatory (able to walk >500 m), and the precise step is defined by the functional systems (FS) score(s). EDSS steps between 4.0 and 5.0 are defined by both FS-scores and walking range. In general, the worst of both should determine
the score. Steps 5.5-8.0 are exclusively defined by ability to ambulate or use wheelchair.

Up to 4.0 EDSS should not change by 1.0 step unless there is a change in same direction of at least one step in at least one FS.
EDSS should not be lower than each of FS (excepted visual and bowel/bladder FS).

0 normal neurological exam (all grade 0 in FS)
1.0 no disability, minimal signs in one FS1 (i.e. grade 1)
1.5 no disability, minimal signs in more than one FS1 (more than one grade 1)
2.0 minimal disability in one FS (one FS grade 2, others 0 or 1)
2.5 minimal disability in two FS (two FS grade 2, others 0 or 1)
3.0 moderate disability in one FS (one FS grade 3, others 0 or 1) or mild disability in three or four FS (three/four FS grade 2, others 0 or 1) though fully ambulatory
3.5 fully ambulatory but with moderate disability in one FS (one grade 3) and one or two FS grade 2; or two FS grade 3; or five FS grade 2 (others 0 or 1)
4.0 ambulatory without aid or rest for > 500 m; up and about some 12 hours a day despite relatively severe disability consisting of one FS grade 4 (others 0 or 1), or combinations of lesser grades exceeding limits of previous steps
4.5 ambulatory without aid or rest for > 300 m; up and about much of the day; characterised by relatively severe disability usually consisting of one FS grade 4 or combinations of lesser grades exceeding limits of previous steps
5.0 ambulatory without aid or rest for > 200 m (usual FS equivalents are one grade 5 alone, others 0 or 1; or combinations of lesser grades usually exceeding specifications for step 4.5)
5.5 ambulatory without aid or rest > 100 m
6.0 unilateral assistance (cane or crutch) required to walk at least 100 m with or without resting
6.5 constant bilateral assistance (canes or crutches) required to walk at least 20 m without resting
7.0 unable to walk 5 m even with aid, essentially restricted to wheelchair; wheels self and transfers alone; up and about in wheelchair some 12 h a day
7.5 unable to take more than a few steps; restricted to wheelchair; may need some help in transfer and in wheeling self
8.0 essentially restricted to bed or chair or perambulated in wheelchair, but out of bed most of day; retains many self-care functions; generally has effective use of arms
8.5 essentially restricted to bed much of the day; has some effective use of arm(s); retains some self-care functions
9.0 helpless bed patient; can communicate and eat
9.5 totally helpless bed patient; unable to communicate effectively or eat/swallow
10.0 death due to MS

[1] Mental function's grade 1 does not contribute to EDSS step definitions

Actual EDSS 4.0

Signature 7/28/2011

Figure 8 These findings indicate that patient x exhibited a relatively severe degree of disability at retirement and was progressing toward complete loss of ambulation.

Define – Did a shared problem or solution act as a nexus for each of the four medical interventions?

Patient x led a healthy lifestyle, including semi-professional football from 2002 to 2003, worked in corporate roles, and served in the Army Reserve until 2007. After MS symptoms appeared in 2005, he quickly became morbidly obese, which may have contributed to H. pylori infection, trigeminal and vagus nerve issues, and GERD. His MTHFR C677T mutation could have impaired detoxification, with reduced physical activity limiting toxin elimination. Studies show that morbidly obese MS patients experienced improved walking ability after bariatric surgery compared to those without surgery.[40] This journal documenting the onset of multiple sclerosis in patient x through an extended period of remission may serve as an empirical basis for the future development of tools aimed at enabling individuals to modify risk factors associated with multiple sclerosis.

REFERENCES

1. Tsimpiris, Athanasios, *et al*. Association of chronic periodontitis with multiple sclerosis: A systematic review and meta-analysis. *Multiple Sclerosis and Related Disorders* 2023: Volume 77, 104874
2. Asqah, Al, Hamoudi, Al, *et al*. Is the presence of Helicobacter pylori in the dental plaque of patients with chronic periodontitis a risk factor for gastric infection? *Can J Gastroenterol* 2009;23(3):177-179
3. Gavalas E, Kountouras J, *et al*. Relationship between Helicobacter pylori infection and multiple sclerosis. *Ann Gastroenterol* 2015 Jul-Sep;28(3):353-356
4. Ghasemi N, Razavi S, *et al*. Multiple Sclerosis: Pathogenesis, Symptoms, Diagnoses and Cell-Based Therapy. *Cell J* 2017 Apr-Jun;19(1):1-10
5. Walton C, King R, *et al*. Rising prevalence of multiple sclerosis worldwide: Insights from the Atlas of MS, third edition. *Mult Scler* 2020 Dec;26(14):1816-1821
6. Zalc B. One hundred and fifty years ago Charcot reported multiple sclerosis as a new neurological disease. *Brain* 2018 Dec 1;141(12):3482-3488
7. Ilin M, Bohlen J. Six Sigma Method. [Updated 2023 Jan 9]. In: *StatPearls [Internet]* Treasure Island (FL): StatPearls Publishing; 2025 Jan-.
8. Patsopoulos NA. Genetics of Multiple Sclerosis: An Overview and New Directions. *Cold Spring Harb Perspect Med* 2018 Jul 2;8(7):a028951.
9. Graydon JS, Claudio K, *et al*. Ethnogeographic prevalence and implications of the 677C>T and 1298A>C MTHFR polymorphisms in US primary care populations. *Biomark Med* 2019 Jun;13(8):649-661.
10. Morningstar, Mark, Strauchman, Megan, *et al*. Methylenetetrahydrofolate Reductase (MTHFR) Gene Mutations in Patients with Idiopathic Scoliosis: A Clinical Chart Review. *Open Journal of Genetics* 2017 Vol.7 No.1
11. Karban A, Feldman T, *et al*. The association of the MTHFR C677T polymorphism with inflammatory bowel diseases in the Israeli Jewish population: An example of genetic heterogeneity. *Medicine* (Baltimore). 2016 Dec;95(51):e5611.
12. Ribeiro, Claudia Mara *et al*. The effects of the MTHFR 677C>T (rs1801133) genetic variant on susceptibility and disability worsening in multiple sclerosis patients are mediated by homocysteine. *Multiple Sclerosis and Related Disorders* 2024 Volume 91, 105883
13. Moll, Stephan, Varga, Elizabeth, Homocysteine and MTHFR Mutations. *Circulation* 2015 July 7 Volume 132 Number 1: e6 - e9
14. Gales A, Masingue M, *et al*. Adolescence/adult onset MTHFR deficiency may manifest as isolated and treatable distinct neuro-psychiatric syndromes. *Orphanet J Rare Dis* 2018 Feb 1;13(1):29.
15. Romero-Pinel, Lucía, Bau Laura, *et al*. The age at onset of relapsing-remitting multiple sclerosis has increased over the last five decades, *Multiple Sclerosis and Related Disorders* Volume 68, 2022 104103
16. Menger RP, Sin AH. Adolescent Idiopathic Scoliosis. [Updated 2023 Apr 3]. In: *StatPearls* [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-.
17. Cantoro L, Lenti MV, *et al*. Early-onset versus late-onset Crohn's disease: An Italian cohort study. *United European Gastroenterol J* 2020 Feb;8(1):52-58
18. Wang W, Wang Y, *et al*. MTHFR C677T polymorphism and risk of congenital heart defects: evidence from 29 case-control and TDT studies. *PLoS One* 2013; 8(3):e58041.
19. Pizzorno J, Shippy A. Is Mold Toxicity Really a Problem for Our Patients? Part 2-Nonrespiratory Conditions. *Integr Med (Encinitas)* 2016 Jun;15(3):8-14
20. Hope J. A review of the mechanism of injury and treatment approaches for illness resulting from exposure to water-damaged buildings, mold, and mycotoxins. *ScientificWorldJournal* 2013 Apr 18;2013:767482.
21. Brewer JH, Thrasher JD, Hooper D. Chronic illness associated with mold and mycotoxins: Is Naso-sinus fungal biofilm the culprit? *Toxins (Basel)* 2013 Dec 24;6(1):66-80.
22. Suliman BA. Potential clinical implications of molecular mimicry-induced autoimmunity. *Immun Inflamm Dis* 2024 Feb;12(2):e1178
23. Nash AK, Auchtung TA, *et al*. The gut mycobiome of the Human Microbiome Project healthy cohort. *Microbiome* 2017;5:153.
24. Westall FC. Molecular mimicry revisited: gut bacteria and multiple sclerosis. *J Clin Microbiol* 2006 Jun;44(6):2099-104
25. Madill, Evan, Lee Shawn, *et al*. Transverse Myelitis Secondary to Insect Bite: A Case Series and Proposed Pathophysiologic Mechanism (P10-1.003) *Neurology* May 3, 2022 issue 98 (18_supplement)
26. InformedHealth.org [Internet]. Cologne, Germany: Institute for Quality and Efficiency in Health Care (*IQWiG*); 2006-. Overview: Tinea versicolor. [Updated 2025 Apr 16].
27. Liew SC, Gupta ED. Methylenetetrahydrofolate reductase (MTHFR) C677T polymorphism: epidemiology, metabolism and the associated diseases. *Eur J Med Genet* 2015 Jan;58(1):1-10
28. Parks TN, Mueller AL, *et al*. Arylamine toxins from funnel-web spider (Agelenopsis aperta) venom antagonize N-methyl-D-aspartate receptor function in mammalian brain. *J Biol Chem* 1991 Nov 15;266(32):21523-9
29. Lipton SA, Kim WK, *et al*. Neurotoxicity associated with dual actions of homocysteine at the N-methyl-D-aspartate receptor. *Proc Natl Acad Sci U S A.* 1997 May 27;94(11):5923-8
30. Papatheodorou L, Weiss N. Vascular oxidant stress and inflammation in hyperhomocysteinemia. *Antioxid Redox Signal* 2007 Nov;9(11):1941-58
31. Wang Q, Yuan C, *et al*. Association between MTHFR C677T polymorphism and cognitive impairment in patients with cerebral small vessel disease: a cross-sectional study. *Front Aging Neurosci* 2024 Feb 19;16:1334011
32. Wang B, Li X, *et al*. Radiological and Pathological Characteristics Between Cerebral Small Vessel Disease and Multiple Sclerosis: A Review. *Front Neurol* 2022 Jun 24;13:841521
33. Webb LM, Guerau-de-Arellano M. Emerging Role for Methylation in Multiple Sclerosis: Beyond DNA. *Trends Mol Med* 2017 Jun;23(6):546-562

REFERENCES - Continued

34. Naghibalhossaini F, Ehyakonandeh H, *et al*. Association Between MTHFR Genetic Variants and Multiple Sclerosis in a Southern Iranian Population. *Int J Mol Cell Med* 2015 Spring;4(2):87-93
35. Monday LM. Define, Measure, Analyze, Improve, Control (DMAIC) Methodology as a Roadmap in Quality Improvement. *Glob J Qual Saf Healthc* 2022 Jun 2;5(2):44-46
36. Mahmoodi N, Minnow YVT, *et al*. Cell-Effective Transition-State Analogue of Phenylethanolamine N-Methyltransferase. *Biochemistry* 2023 Aug 1;62(15):2257-2268
37. Matsusaka K, Funata S, Fukayama M, Kaneda A. DNA methylation in gastric cancer, related to Helicobacter pylori and Epstein-Barr virus. *World J Gastroenterol* 2014 Apr 14;20(14):3916-26
38. Kalafatakis I, Karagogeos D. Oligodendrocytes and Microglia: Key Players in Myelin Development, Damage and Repair. *Biomolecules* 2021 Jul 20;11(7):1058
39. VanElzakker MB. Chronic fatigue syndrome from vagus nerve infection: a psychoneuroimmunological hypothesis. *Med Hypotheses* 2013 Sep;81(3):414-23
40. Kalman Bencsath, Adham Jammoul *et al*. Outcomes of Bariatric Surgery in Morbidly Obese Patients with Multiple Sclerosis. *Journal of Obesity* 2017 February 19