Review Article

A narrative review of clinical practice guidelines for the application of physical therapy and rehabilitation procedures in the management of multiple sclerosis

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ABSTRACT

التصلب المتعدد (MS) هو اضطراب مناعي ذاتي مزمن يتميز بالتهاب عصبي وتنكس عصبي تدريجي، مما يؤدي إلى إعاقات جسدية ومعرفية كبيرة. وقد أصبحت إعادة التأهيل، لا سيما العلاج الطبيعي، مكونًا أساسيًا في إدارة الإعاقة المرتبطة بالتصلب المتعدد، من خلال تحسين القدرة على الحركة، وتقليل الإرهاق، وتعزيز جودة الحياة بشكل عام. تستعرض هذه المراجعة السردية الإرشادات الدولية الحالية المتعلقة بالعلاج الطبيعي وإعادة التأهيل في حالات التصلب المتعدد. أسفر البحث في قواعد البيانات (من عام ٢٠١٠ حتى أغسطس ٢٠٢٥) عن ثلاث إرشادات استوفت معايير الاشتمال. وتشير الأدلة إلى أن برامج التدريب الهوائي والمقاومة المنظمة، إلى جانب تمارين التوازن والمرونة، تساهم بشكل كبير في الحفاظ على الاستقلال الوظيفي. بالإضافة إلى ذلك، تقدم التقنيات المساعدة تطورات واعدة في الرعاية المرتكزة على المريض. ومع ذلك، تُعد التحديات مثل محدودية الوصول إلى خدمات التأهيل، وتفاوت مظاهر المرض، والالتزام ببرامج التأهيل، عوائق كبيرة. وتسلط هذه المراجعة السردية الضوء على الحاجة إلى إرشادات سريرية شاملة ومتعددة التخصصات لتحسين تدخلات العلاج الطبيعي وتعزيز رفاهية مرضى التصلب المتعدد على المدى الطويل.

Multiple sclerosis (MS) is a chronic autoimmune disorder characterized by neuroinflammation and progressive neurodegeneration, leading to significant physical and cognitive impairments. Rehabilitation, particularly physical therapy, has emerged as a crucial component in managing MS-related disability by improving mobility, reducing fatigue, and enhancing overall quality of life. This narrative review investigates current international guidelines on physical therapy and rehabilitation for MS. Literature search in databases (January 2010 until August 2025) resulted in three guidelines that met the inclusion criteria. Evidence suggests that structured aerobic and resistance training programmes, combined with balance and flexibility exercises, contribute significantly to maintaining functional independence. Additionally, assistive technologies offer promising advances in patient-centred care. However, challenges such as limited accessibility, variability in disease presentation, and adherence to rehabilitation programmes pose significant barriers. This narrative review highlights the need for comprehensive and multidisciplinary clinical guidelines to optimize physical therapy interventions and improve the long-term well-being of MS patients.

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Multiple sclerosis (MS) is a chronic, immune-mediated neurological disorder that affects the central nervous system (CNS), leading to demyelination, neurodegeneration, and significant disability.[1] The disease manifests with a wide range of symptoms, including fatigue, muscle weakness, spasticity, impaired coordination, pain, and cognitive dysfunction.[2] The development of MS results from a combination of genetic susceptibility and environmental factors. Genome-wide association studies have identified over 100 genetic variants linked to the disease.[3] However, each variant contributes only a small increase in risk, indicating that MS arises from the complex interplay of multiple genetic factors, rather than a few rare, strongly associated variants.[4] Several environmental factors have also been linked to MS, including Epstein-Barr virus (EBV) infection, smoking, childhood obesity, and low vitamin D levels.[5,6]

Among the various therapeutic strategies, rehabilitation and physical therapy play a critical role in improving functional independence, mobility, and quality of life for MS patients.[7] Given the progressive nature of the disease, evidence-based guidelines for rehabilitation and physical therapy are essential to ensure standardized and effective care. Over the past decade, there has been increasing recognition

of the importance of structured rehabilitation programmes in MS, with numerous studies evaluating their efficacy in symptoms management and disease progression mitigation.[8] Rehabilitation in MS encompasses a broad spectrum of interventions, including physical therapy, occupational therapy, speech therapy, and cognitive rehabilitation.[9] Physical therapy, in particular, aims to enhance motor function, balance, coordination, and endurance, ultimately helping patients to maintain their autonomy and reduce the risk of secondary complications such as falls and muscle atrophy.[10] The concept of rehabilitation and physical therapy's critical role would further benefit from incorporating contemporary biomechanical perspectives, which emphasize advanced assessment tools and personalized intervention strategies to optimize functional outcomes.[11] Furthermore, rehabilitation strategies must be tailored to disease stage, symptom burden, and individual patient needs, necessitating clear and up-to-date clinical guidelines. Based on the National MS Society, a progressive target of engaging in at least 150 minutes per week of exercise or lifestyle physical activity is recommended for MS patients, with adjustments based on individual capacity, symptom status, and comorbidities.[12]

Individuals with MS experience a range of impairments, functional limitations, and activity restrictions, as categorized by the World Health Organization (WHO) in their International Classification of Functioning, Disability, and Health (ICF). The essential elements of a multidisciplinary MS care unit have been highlighted, emphasizing that lifelong, comprehensive medical management should be integrated with rehabilitation strategies to enhance treatment outcomes.[13,14] Despite this recommendation, the implementation of multidisciplinary rehabilitation for MS patients varies significantly across the globe. For example, a Europe-wide survey of 72 rehabilitation facilities across 23 countries found that 86% of centres in Western Europe used an interdisciplinary model, whereas Eastern European centres more commonly employed a multidisciplinary model and physiotherapists comprised nearly 50% of the team compared to around 30% in Western facilities.[15] Even within Europe, there are stark contrasts, with some countries providing well-structured, multidisciplinary care for individuals with MS, while others lack such services entirely.[16,17] These disparities highlight the need for a standardized approach to MS rehabilitation, ensuring equitable access to specialized care regardless of geographic location.

Despite the growing body of research, guidelines on physical therapy and rehabilitation in MS vary across countries and professional organizations. A review of existing recommendations can help to bridge knowledge gaps, standardize best practices, and identify areas for further research. This narrative review aims to synthesize recent guidelines published from 2010 onwards, providing a comprehensive overview of recommended rehabilitation strategies for MS patients. As the efficacy, feasibility, and clinical applicability of these guidelines are evaluated, we intend to inform healthcare providers, researchers, and policymakers about the current landscape and future direction of rehabilitation in MS. In the following sections, we will explore the latest evidence-based recommendations for rehabilitation and physical therapy in MS, discussing key interventions, their clinical impact, and potential challenges in implementation. We will also highlight areas where further research is needed to optimize rehabilitation strategies and improve long-term outcomes for MS patients.

Identification of guidelines evaluating physical therapy in MS. This is a narrative review attempting to provide a qualitative synthesis of rehabilitation principles drawn from leading guidelines. Basically, we conducted a qualitative synthesis of rehabilitation principles drawn from leading international guidelines, summarizing each guideline's scope, evidence-grading system, and core recommendations without undertaking any statistical appraisal. In August 2025, a comprehensive literature search was conducted within the PubMed/Medline, Scopus, ISI Web of Science, and ProQuest database to identify reviews and overviews that examined clinical guidelines related to MS from 2010 onwards. To ensure no eligible guideline was omitted, the results were cross-checked against the published reviews of MS rehabilitation guidelines. The search strategy incorporated a combination of controlled vocabulary and free-text terms, including "multiple sclerosis" OR "MS" in conjunction with "guidelines" AND "review" OR "overview" AND "physical therapy" OR "rehabilitation". The primary objective was to retrieve and analyze guidelines that addressed rehabilitation and physical therapy interventions for individuals with MS.

To ensure a rigorous and transparent selection of high-quality recommendations, the following predefined eligibility criteria were applied: included only full-text clinical practice guidelines or consensus statements on MS rehabilitation, published in peer-reviewed journals or by recognized professional bodies in English from January 2010 onward (August 2025), with no restrictions on geographic origin. To ensure the inclusion of high-quality guidelines, we restricted our selection to those published in peer-reviewed journals, which guarantees external scrutiny, or those by recognized professional bodies that are customarily disseminated in peer-reviewed outlets [such as the National Institute for Health and Care Excellence (NICE)]. This endorsed methodological rigor while capturing authoritative guidelines without excluding major high-quality sources.

Each guideline had to (1) employ a formal development framework (such as GRADE or AGREE II) and achieve a minimum AGREE II Rigour of Development score of 60 % (a threshold commonly adopted in guideline appraisal studies to distinguish between moderate- to high-quality versus low-quality development processes;[18] (2) provide explicit, evidence-based recommendations for rehabilitation strategies

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or physical therapy protocols in MS; and (3) be cited in at least one of the identified systematic reviews. This approach ensured that only methodologically sound, up-to-date guidance with clear scope and quality thresholds informed our analysis.

Aspects of physical therapy and rehabilitation in MS.

Guidelines. Three guidelines were identified that fulfilled our selection criteria[19,20,21] (**Figure 1**). The Appraisal of Guidelines for Research and Evaluation II (AGREE II) tool is widely recognized for its robust framework in evaluating guideline rigour, transparency, and applicability across various healthcare domains. In this study, the author (AIA) systematically applied the AGREE II instrument to each guideline, rating all 6 domains, including Scope and Purpose, Stakeholder Involvement, Rigour of Development, Clarity of Presentation, Applicability, and Editorial Independence, using the standard 7-point scale. Then, the domain percentage scores and an overall quality rating for each guideline were calculated: Guideline A[19] scored 5/7 overall (rigour of development 65%), Guideline B[20] scored 5/7 (rigour 62%), and Guideline C[21] scored 6/7 (rigour 78%).

General principles of physical therapy in MS. Physical therapy in MS is fundamentally patient-centred and highly individualized, recognizing that disease progression, symptoms severity, and functional abilities vary widely among patients.[22] The core principle in all the reviewed guidelines is the necessity to personalize rehabilitation programmes to the specific needs of each individual.[19,20,21] A key component of MS rehabilitation is a multidisciplinary approach, which involves the collaboration of physiotherapists, neurologists, occupational therapists, and other healthcare professionals to provide holistic and comprehensive care.[23] These teams work together to formulate a structured rehabilitation plan that adapts over time in response to the patient's evolving condition through addressing various aspects of mobility, coordination, and overall physical function of MS patients. Echoing recent shifts in rehabilitation philosophy, emerging models [like the joint-by-joint training approach (JBJA)] move beyond static, impairment-focused exercises to a dynamic, whole-chain strategy that restores mobility and stability across linked regions (such as thoracic spine and shoulder girdle), while embedding patient education, technology-assisted reminders, and movement-based interventions to empower long-term self-management.[24]

Among the identified guidelines, the NICE guidelines emphasize enhancing quality of life in MS through effective symptoms management, comprehensive reviews, and relapse treatment. Rehabilitation is goal-directed, focusing on mobility and fatigue, while involving a coordinated multidisciplinary approach.[20] The 2022 NICE MS guideline (NG220) provides a broadly comprehensive framework, spanning from diagnosis and symptom management to rehabilitation and long-term care. It highlights the importance of individualized care planning, timely access to specialist input, and the integration of rehabilitation strategies into routine management. Notably, in areas where randomized trial data are limited (particularly in progressive MS) the guideline incorporates expert consensus to support practical recommendations for clinical decision-making.[20]

The European Society for Blood and Marrow Transplantation (EBMT) guidelines highlight the importance of optimizing functional recovery and QoL, particularly following autologous hematopoietic stem cell transplantation (AHSCT), which is increasingly used for highly active RRMS.[21] Rehabilitation in this context is structured into four distinct phases (pre-habilitation, acute, sub-acute, and community) each tailored to the patient's stage-specific needs, promoting neuroplasticity and self-management. Meanwhile, the Malaysian Clinical Practice Guidelines (CPG) also advocate for a multidisciplinary approach to managing MS-related symptoms and disabilities,[19] though they make fewer specific physical therapy recommendations compared to NICE and EBMT. Instead, the emphasis is on individualized treatment to address the diverse symptoms experienced by MS patients (**Table 1**).

Exercise recommendations and modalities. Exercise therapy is a cornerstone of MS rehabilitation, with strong evidence supporting its role in enhancing mobility, muscle strength, and cardiovascular fitness, while also helping to mitigate disease-related fatigue.[25] The reviewed guidelines universally support the inclusion of exercise in MS management but vary in the specifics of recommended exercise modalities.

The implementation of structured aerobic and resistance training programmes is recommended to improve cardiovascular fitness, muscle strength, and overall physical function. In addition, moderate-intensity aerobic exercise and moderate-to-high-intensity resistance training have been shown to safely and effectively improve cognitive function, mood, and overall well-being in older adults.[26] Aerobic exercises, such as walking, cycling, and swimming, have been shown to enhance cardiorespiratory fitness and reduce MS-related fatigue,[27] a common and debilitating symptom of the disease. Studies suggest that moderate-intensity aerobic exercise, performed for approximately 20–40 minutes at least three times per week, can significantly enhance functional capacity without exacerbating MS symptoms. Resistance training, which includes weightlifting, resistance bands, and bodyweight exercises, is essential for maintaining muscle strength and reducing the risk of falls. Training programmes typically involve exercises targeting major muscle groups, with 2–3 sets of 8–12 repetitions performed at least twice per week 20. Flexibility and stretching exercises are particularly emphasized in managing spasticity, a common symptom in MS.[28] Regular stretching can help to maintain joint mobility, reduce muscle stiffness, and improve overall movement efficiency.

Neurorehabilitation strategies. Neurorehabilitation in MS focuses on facilitating neuroplasticity, improving functional independence, and compensating for neurological deficits.[29] Recently, neurorehabilitation has emerged as a viable intervention for MS and is primarily utilized either to alleviate symptoms or to counteract the detrimental effects of physical inactivity. Research indicates that MS

Table 1 - Key recommendations of the physical therapy rehabilitations across the 2022 NICE MS guideline (NG220) 20 and the Malaysian Clinical Practice Guidelines (CPG) 19 for management of MS.

Aspects	Key recommendations	References
Exercise Therapy	Moderate-intensity aerobic exercise (such as walking, cycling, swimming) 20-40 minutes, 3 times per week. Resistance training twice per week targeting major muscle groups. Flexibility exercises to alleviate stiffness and prevent contractures. Balance and coordination exercises to reduce fall risk.	19, 20
Gait and Mobility Training	Treadmill training, robotic-assisted gait therapy, and functional electrical stimulation to enhance walking ability. Hydrotherapy for joint mobility improvement. Use of assistive devices such as canes, walkers, and orthoses.	19, 20
Fatigue Management	Activity pacing, energy conservation techniques, and cooling strategies (such as cooling vests) to improve exercise tolerance. Psychological and behavioral interventions to address fatigue-related distress.	19, 20
Spasticity and Pain Management	Stretching, soft tissue mobilization, hydrotherapy, and transcutaneous electrical nerve stimulation (TENS). Pharmacological interventions as needed, combined with physical therapy.	19, 20
Multidisciplinary Rehabilitation	Collaboration between physical therapists, occupational therapists, speech therapists, neurologists, and psychologists. Cognitive rehabilitation and psychological support to manage cognitive impairment and depression. Speech and swallowing therapy for dysphagia and communication difficulties.	19, 20
Home-Based *vs*. Clinical Rehabilitation	Clinical settings offer structured, supervised therapy with professional guidance. Home-based rehabilitation facilitated by mobile applications, tele-rehabilitation, and virtual therapy for greater accessibility.	19, 20
Technological Innovations	Virtual reality-based therapy for balance and coordination improvement. Wearable sensors for activity tracking and real-time feedback. Robotic exoskeletons for mobility enhancement.	19, 20

patients participating in rehabilitation programmes generally experience notable enhancements in their quality of life and greater autonomy in performing daily activities.[30,31]

Moreover, various MS-related symptoms show improvement with structured exercise, including cardiovascular endurance, neuromuscular efficiency, mobility, mood disorders like depression, and cognitive function. In addition, advances in neuroimaging have provided compelling evidence that neurorehabilitation induces beneficial changes in brain structure and function, while also influencing inflammatory markers.[32,33] The reviewed guidelines emphasize the importance of task-oriented therapy, which involves engaging patients in meaningful and purposeful activities to regain lost function.

Motor learning-based rehabilitation is another widely endorsed strategy. This approach encourages the repeated practice of specific movements to retrain the nervous system and improve coordination. Drawing on the JBJA model, this dynamic approach emphasizes individualized assessment and interventions, prioritizing exercises that enhance movement quality (for example, hip and thoracic mobility) and educating patients on postural variability, to further bolster motor relearning and functional recovery in MS.[34] Neuroplasticity-based therapies, such as constraint-induced movement therapy and mirror therapy, are gaining recognition for their potential to enhance motor recovery in MS patients.[19] Furthermore, technological advances have paved the way for innovative rehabilitation methods. The use of robotic-assisted therapy, virtual reality training, and functional electrical stimulation is increasingly advocated in some guidelines to enhance motor function and provide additional support in movement recovery. Robot-assisted gait training appears to be a viable and promising therapeutic approach for subjects with MS who experience significant walking impairments. Research indicates that this advanced rehabilitation method may offer superior improvements in walking speed and knee-extensor strength compared to traditional walking exercises. Additionally, robot-assisted training could enhance movement coordination, reduce fatigue, and promote neuroplasticity, potentially leading to long-term functional gains.[35]

Special considerations in MS rehabilitation. The MS patients present with a range of symptoms that require specialized rehabilitation interventions. Fatigue management is a major concern, as fatigue is one of the most debilitating symptoms in MS. Energy conservation techniques, graded exercise programmes, and lifestyle modifications are commonly recommended strategies. Some guidelines also advocate for the use of cooling techniques and adaptive pacing to help patients manage exertion levels.[10] Spasticity is another significant challenge in MS rehabilitation.[20] Physical therapy interventions such as stretching, positioning, and hydrotherapy are frequently used to alleviate spasticity-related discomfort. Pharmacological treatments, including muscle relaxants, may be combined with physical therapy to optimize results. Similarly, balance and coordination deficits are commonly addressed through vestibular rehabilitation and targeted exercises that focus on postural stability and gait training. Cognitive impairment, another major concern in MS, requires personalized interventions that integrate

Table 2 - The consensus recommendations for best clinical practice in rehabilitation before and after autologous haematopoietic Stem Cell Transplantation (AHSCT) for patients with MS (Table reproduced from Roberts et al., 2020, Frontiers in Neurology, under the terms of the Creative Commons Attribution License (CC BY). © 2020 Roberts et al. 21).

• All patients with MS undergoing AHSCT should be considered for pre-habilitation before and rehabilitation following the procedure. Referrals should be made early so rehabilitation can be delivered at the optimal time.
• Care should be provided with a coordinated multidisciplinary team (MDT) approach with a core and an extended team, who facilitate referral, assessment, and delivery of rehabilitation throughout the four phases of the pathway.
• Rehabilitation should be goal directed and patient centered and underpinned by principles of self-management and self-care.
• Rehabilitation for patients with AHSCT should be delivered at 4 phases during the pathway as detailed.
• All individuals receiving AHSCT should be provided with appropriate advice and support about the process and the rehabilitation available to them. Advice leaflets are recommended to guide on exercise, nutrition, and any necessary lifestyle changes. If appropriate, careers and family members should also be provided with advice and education to assist the individual. Specialist consultation may be necessary in some cases.
• Prior to the transplant, baseline level of impairment, function and participation should be ascertained through a formal MDT assessment process. Risk factors for potential deterioration should be identified. Following the assessment, careers including nursing staff and family should be provided with manual handling advice to facilitate safe transfers and mobility whilst encouraging independence.
• A rehabilitation plan should be tailored to patients' symptoms and goals. Rehabilitation provided at each stage of the pathway will be dependent upon the clinical presentation. A series of validated outcome measures will be taken at key points throughout the patient's journey to monitor any change.
• Validated and reliable standardized assessment tools and outcome measures should be recorded routinely to monitor any change.
• Infection control measures and other precautions appropriate to the stage of AHSCT (such as thrombocytopenia) should be followed.
• All MS patients who have received AHSCT should have a comprehensive review of all aspects of their care at least once a year, carried out by healthcare professionals with expertise in MS working as part of the extended MDT. Therapists need to be aware of "late-effects" of AHSCT as well as the potential for relapse and progression of MS.

cognitive exercises into rehabilitation programmes.[36] Some guidelines recommend dual-task training,[37] where patients engage in cognitive tasks while performing physical exercises, to enhance both motor and cognitive functions simultaneously.

Rehabilitation before and after AHSCT. One of the guidelines included in this article specifically discusses rehabilitation in the context of AHSCT 21, a procedure used in highly active MS cases (**Table 2**). Pre-transplant rehabilitation focuses on conditioning the patient for the procedure by implementing strength and endurance exercises to build physical resilience. The guidelines recommend a gradual return to physical activity, with an emphasis on monitoring for complications such as deconditioning and muscle weakness. Long-term monitoring is also crucial in the modification and improvement of rehabilitation protocols based on the progress made by a given patient.

Discussion and concluding remarks. As many as approximately 80% of individuals diagnosed with MS have been shown to experience mobility impairments within 10–15 years of an initial diagnosis of MS.[38,39] Over the course of a decade of diagnosis, about 38% of MS patients require walking aids, and this figure rises significantly to 83% after three decades.[40,41] The disease itself, along with a proneness towards a sedentary lifestyle, contributes to reduced physical activity levels. As a result, MS subjects face an increased risk of developing co-morbidities, such as osteoporosis, depression, fatigue, diminished muscle strength, and cardiovascular-related mortality.[42] Rehabilitation in MS is a dynamic and evolving field that integrates principles of neuroplasticity, exercise physiology, and multidisciplinary care. As MS manifests heterogeneously across patients regarding clinical and physical demonstrations, rehabilitation protocols must be adaptive, evidence-based, and individualized.[43] The current guidelines make robust recommendations for optimizing rehabilitation strategies, yet variations exist in their emphasis on specific exercise modalities, neurorehabilitation approaches, and the role of assistive technologies. A thorough discussion and evaluation of these aspects allows for a deeper understanding of the strengths and limitations of current MS rehabilitation guidelines.

Exercise therapy is a foundational pillar of MS rehabilitation, playing a critical role in preserving functional mobility, reducing symptom severity, and enhancing overall well-being. According to the reviewed guidelines, a comprehensive physical therapy program for people with MS should include four key components. First, moderate-intensity aerobic exercise (such as walking, cycling, or swimming) should be performed for 20–40 minutes, three times per week to maintain cardiovascular fitness and enhance overall endurance. Second, resistance training targeting all major muscle groups is advised twice weekly to preserve muscle strength and functional capacity. Third, regular flexibility exercises are essential to alleviate joint stiffness and prevent the development of contractures. Finally, dedicated balance and coordination drills should be incorporated to reduce fall risk and improve postural control. Together, these interventions create a balanced, evidence-based framework aimed at optimizing mobility, strength, and safety in individuals with MS.

The effectiveness of these interventions is underpinned by biological mechanisms that are increasingly recognized in MS rehabilitation research. Exercise promotes neuroplasticity, enhances muscle strength, and modulates immune responses, which together support functional recovery.[44,45] Aerobic and resistance training, in particular, have been linked to

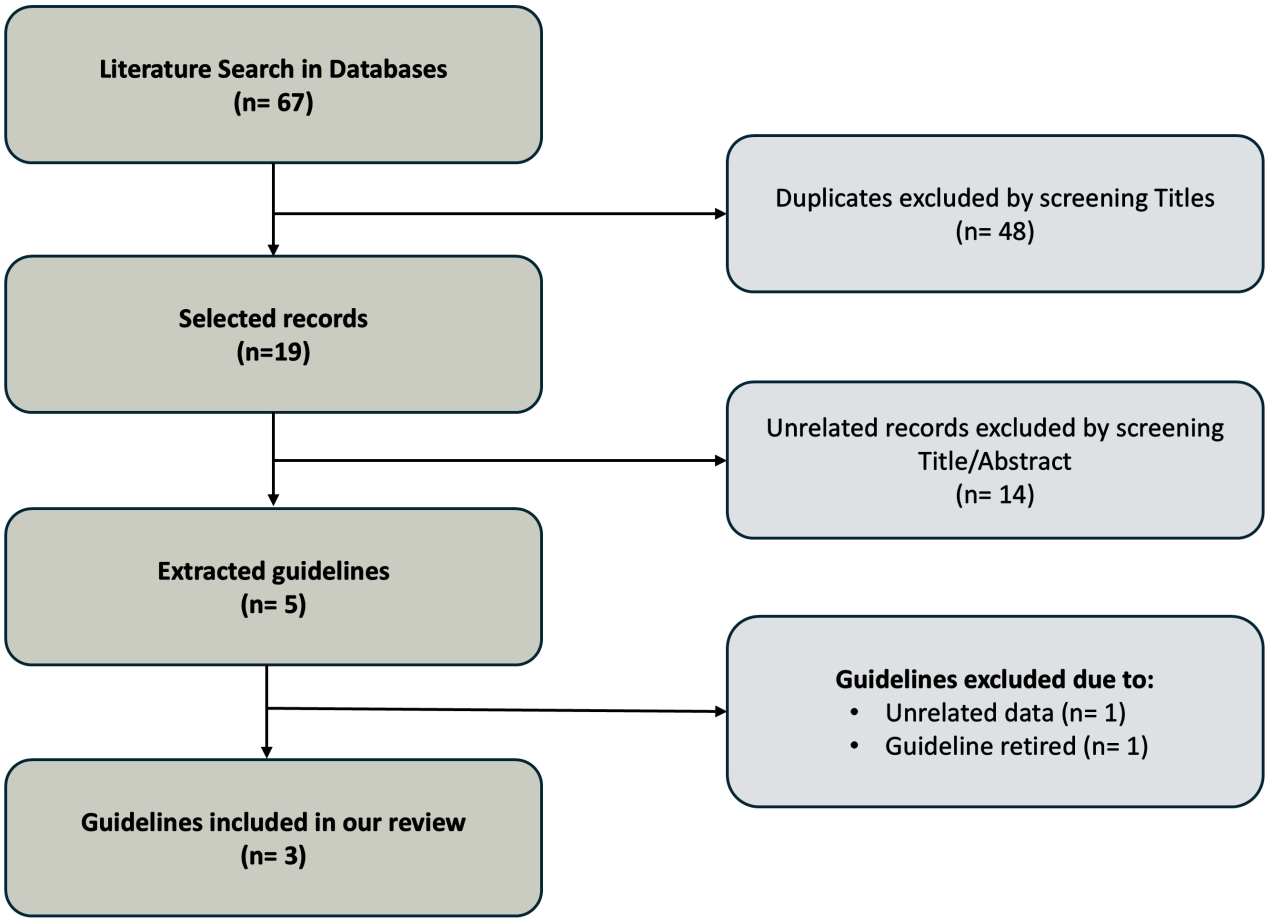

Figure 1 - Flow diagram of guideline selection.

increased levels of brain-derived neurotrophic factor (BDNF), a neurotrophin that facilitates synaptic plasticity, neural repair, and resilience against neurodegeneration.[46,47] These mechanistic insights provide a biological rationale for the guideline-endorsed integration of structured exercise into MS management, complementing clinical evidence on mobility, strength, and quality-of-life outcomes. Organizations such as the International Progressive MS Alliance emphasize the need for future research to focus on rehabilitation in progressive MS, particularly examining how physical activity influences disease progression.[48] Notably, sophisticated researchers in this field have developed a standardized framework to enhance the quality, consistency, and scope of MS rehabilitation studies, ultimately improving patients' quality of life.[49]

Despite the beneficial effects, MS-related symptoms such as fatigue, thermosensitivity, and spasticity pose challenges to exercise adherence. The reviewed guidelines recognize these barriers and recommend structured, supervised exercise programmes to minimize adverse effects. For instance, aerobic exercise is consistently recommended across guidelines, with moderate-intensity training being the most beneficial for improving cardiovascular fitness and mitigating fatigue. However, incongruous perspectives exist in the prescribed duration and intensity of aerobic exercise, with some guidelines suggesting short-duration, high-frequency sessions, while others support longer, moderate-intensity physical training sessions.[20] Modern resistance training and fall-prevention programs for MS now go beyond simple muscle-strengthening. They use evidence-based strategies that improve balance, body control, and everyday movement.[50] The 2022 NICE guideline (NG220)[20] underscores the importance of incorporating resistance training into a comprehensive rehabilitation program for people with MS, with the primary aim of maintaining independence in daily activities and reducing the risk of falls. The NICE recommends that strengthening exercises should be offered alongside aerobic and balance training, tailored to the individual's functional level and goals. Rather than prescribing resistance training as isolated muscle strengthening, the guideline frames it within task-oriented rehabilitation, emphasizing exercises that support transfers, gait stability, and safe mobility. For people with significant balance impairments, NICE

highlights the integration of resistance work with balance and postural control activities, delivered by a coordinated multidisciplinary team. Additionally, NICE notes that resistance training should be progressed gradually, adapted to fluctuations in fatigue, and reviewed regularly to ensure ongoing benefit and safety.[20] These recommendations reflect a pragmatic, clinically focused approach: strengthening is not treated as an end in itself but as a means to promote function, prevent complications, and support long-term quality of life in MS.

Neurorehabilitation and technological advances have also become a cornerstone across MS rehabilitation guidelines. Neurorehabilitation strategies are fundamental in MS rehabilitation, focusing on the restoration of lost motor functions and compensation for persistent deficits.[29] Modern frameworks such as the JBJA further enhance this by sequentially restoring mobility at the hips and ankles before emphasizing stability at the knee, trunk and feet, thereby normalizing gait mechanics and reducing maladaptive loading patterns.[51] In addition, interventions like neuromuscular electrical stimulation, virtual reality-based balance training and proprioceptive exercises augment sensorimotor control and dynamic postural stability, leading to better functional outcomes for people with MS.[29] The reviewed guidelines universally support task-oriented training, emphasizing repetitive and functional movements to facilitate motor learning and cortical reorganization. Constraint-induced movement therapy (CIMT) and mirror therapy have gained recognition for their role in upper limb rehabilitation,[52] though not all guidelines extensively discuss their implementation. Robotic-assisted rehabilitation and exoskeleton technology are emerging as promising adjuncts to conventional therapy.[53] Robotic gait training has shown efficacy in improving walking speed, endurance, and symmetry in MS patients with moderate to severe disability.[54] However, while some guidelines highlight the potential of robotic rehabilitation, others remain cautious due to limited accessibility, high costs, and insufficient long-term efficacy data. Similarly, functional electrical stimulation has been endorsed as a beneficial tool for improving foot drop and enhancing mobility;[55] however, its routine clinical integration varies across recommendations. Additionally, cognitive rehabilitation is another crucial yet often underemphasized aspect of MS therapy across guidelines. Cognitive impairment affects a significant proportion of MS patients, impacting on memory, attention, and executive function.[56] While some guidelines advocate for integrated cognitive-motor rehabilitation, incorporating cognitive training exercises within physical therapy sessions, others primarily focus on standalone cognitive training interventions. This divergence highlights the need for further research into optimal cognitive rehabilitation protocols tailored for MS populations.

Symptom management is considered a critical component of MS rehabilitation, with fatigue, spasticity, and thermosensitivity being major confining factors. Fatigue, which is a multifactorial and pervasive symptom, requires a multidimensional approach, combining pharmacological management, energy conservation strategies, and customized exercise interventions. The reviewed guidelines generally agree on the efficacy of graded exercise therapy and adaptive pacing techniques, though the integration of fatigue-specific rehabilitation programmes remains inconsistent across sources. Spasticity management involves a combination of stretching, positioning, and hydrotherapy,[57] with some guidelines advocating for adjunctive botulinum toxin injections or oral anti-spasticity agents.[20] Spasticity management is addressed differently across guidelines. The NICE MS guideline recommends pharmacological therapy, combined with individualized physiotherapy interventions such as stretching and positioning.[20] It further advises specialist referral for focal spasticity interfering with function, where botulinum toxin injections may be considered. In contrast, the Malaysian CPG places greater emphasis on hydrotherapy and includes tizanidine, diazepam, or dantrolene as pharmacological alternatives when first-line agents are insufficient, but it provides less detail on structured referral pathways for advanced interventions.[19] Therefore, while both guidelines stress stretching and physiotherapy as foundational, NICE prioritizes a clear stepwise pharmacological approach and specialist referral, whereas the Malaysian guideline broadens drug options and emphasizes aquatic therapy more strongly. Thermosensitivity, which leads to transient symptoms worsening in response to heat exposure, is another challenge during MS rehabilitation. Some guidelines recommend cooling techniques, such as pre-exercise cooling vests and air-conditioned environments, to mitigate exercise-induced exacerbations.[19] However, standardized protocols for managing thermosensitivity in rehabilitation settings are lacking, hence further evidence-based recommendations need to be addressed.

A particularly novel area of rehabilitation is its integration into AHSCT.[21] This procedure, primarily indicated for aggressive MS, requires pre- and post-transplant rehabilitation to optimize outcomes. The reviewed guidelines[21] that discuss AHSCT rehabilitation emphasize pre-transplant conditioning and gradual post-transplant recovery programmes. However, given the limited research on long-term rehabilitation outcomes post-AHSCT, more studies are needed to establish standardized rehabilitation protocols in this area.

Conclusion. As outlined in the NICE, EBMT (AHSCT), and Malaysian guidelines, physical therapy and rehabilitation in MS encompass exercise-based interventions, symptom-specific strategies, and multidisciplinary care. NICE provides a robust, general framework; EBMT offers a specialized, phased approach for AHSCT patients; and the Malaysian CPG emphasizes adaptability to local contexts. Integrating these insights (structured exercise, innovative technologies, and comprehensive assessments) can enhance MS management.

Building on the strengths of the NICE, EBMT, and Malaysian CPG guidelines, we propose a unified, tiered model for MS rehabilitation that begins with a structured, evidence-based exercise prescription (NICE), incorporates phase-specific protocols for complex cases such as AHSCT

(EBMT), and emphasizes adaptable, technology-assisted delivery tailored to local resources and patient preferences (Malaysian CPG). Routine multidisciplinary assessments (encompassing mobility, strength, cognition, and symptom burden) should inform individualized adjustments to exercise intensity and the addition of targeted interventions (like spasticity management, balance training, fatigue mitigation). Integrating home-based and tele-rehabilitation components ensures continuity of care, while scalable, low-cost assistive devices overcome geographic and economic barriers. Given that there is still a lack of exhaustive guidelines regarding physical therapy rehabilitations in MS patients, as research in this realm continues to evolve, future investigation should focus on refining rehabilitation protocols, integrating novel technologies, and exploring new strategies to maximize the long-term benefits of physical therapy for MS patients.

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