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Ocular Motor Rehabilitation Definition as Applied to the Defense Health Agency/Vision Center of Excellence Practice Recommendations

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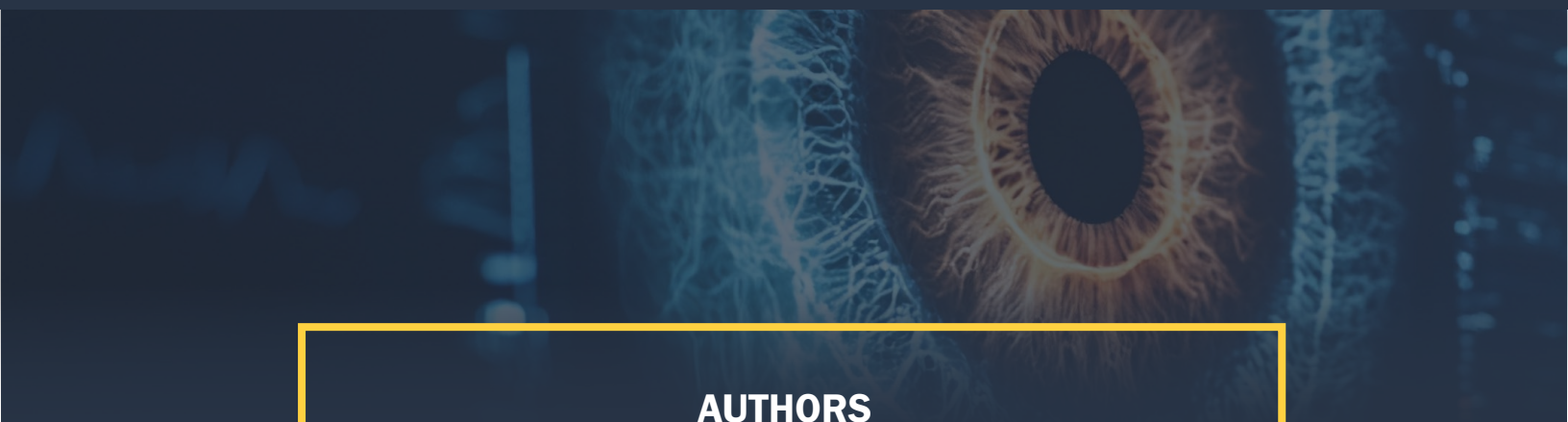

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PURPOSE

The purpose of this document is to develop a shared interprofessional definition of Ocular Motor Rehabilitation (OMR) as a strategy applied to interdisciplinary management of visual dysfunctions after mild traumatic brain injury (mTBI) within the Department of War (DOW) and Veterans Affairs (VA) systems of care. As OMR is not well defined, it is interpreted differently by individual disciplines. The newly developed definition of OMR in this document can be utilized to provide standard terminology for future research, Practice Recommendations (PRs), and Clinical Practice Guidelines (CPGs),[1] and education within the DOW and VA.

INTRODUCTION

Ocular motor function (OMF) refers to the tasks of the oculomotor (CNIII), trochlear (CNIV) and the abducent (CNVI) nerves, and pertains to the capacities of ocular focus and synchronization of ocular movements.[2] OMF is controlled by various parts and pathways of the brain. It encompasses ocular fixation, version, pursuit, saccade, accommodation, vergence, and response to the vestibulo-ocular reflex. OMF is crucial for activities such as reading, scanning, reacting to visual data, and maintaining balance.[3]

Ocular motor dysfunction (OMD) is a deficit of ocular motor function. It can result from systemic and neurological conditions such as diabetes, stroke, brain injuries including traumatic brain injuries (TBIs), and/or chronic use of certain medications.[4,5] Multiple ocular motor functions may be affected at the same time. Symptoms of OMD may include but are not limited to blurry vision, double vision, tracking issues, headaches, dizziness, photosensitivity, and imbalance. These symptoms can severely affect one's ability to perform daily activities and tasks.[3,6-9]

OMD is associated with TBI, the latter being a significant public health concern in the U.S. resulting in economic and social burdens. In 2020, there were approximately 214,110 TBI-related hospitalizations in the U.S. with falls being the leading cause.[10] Over 5.3 million Americans live with brain injury-related disabilities, impacting various aspects of life and independence.[11-14] TBI's include penetrating and non-penetrating head injuries. Non-penetrating TBIs can be classified as mild, moderate, severe, based on the Glascow Coma Scale, loss or alteration of consciousness, post-traumatic amnesia, and brain imaging.[15]

In military settings, TBI can result from, and is not limited to, blasts, blunt trauma, motor vehicle accidents, falls, combat/training activities such as parachute landings, and sports activities.[16] In addition, military personnel are at high risk for repeated impact and/or blast exposures which worsen symptoms and increase long-term impairments especially, if recurring within one year.[17-21] From 2000 to 2024, 82.2% of military TBIs were diagnosed

as mTBI.[22] mTBI, also known as concussion, is defined as brief loss or alteration in consciousness or memory and no abnormal brain imaging.[10,17,23] An estimated 1.93% to 2.32% of service members sustain multiple concussions annually.[10,17,24]

The impacts of mTBI on visual function are critical for military performance, causing delays in visual information processing and safety risks.[25,26] Symptoms affect daily activities, response time, safety, and performance, making the management of these symptoms essential.

Neurologic ophthalmic evaluations for diagnosing brain injuries include OMF assessment. Recent literature stresses the benefits of multisensory and interdisciplinary approaches for mTBI-related vision dysfunctions.[27-31] Key referrals include optometrists and ophthalmologists, with additional support from physiatrists, neuro-ophthalmologists, occupational and physical therapists, audiologists, speech pathologists, and neuropsychologists.[32-34] Rehabilitative plans that include an interdisciplinary approach for OMR, help service members regain necessary ocular function, visual processing, and readiness.

This document aims to define OMR and explain its role as an essential part of the interdisciplinary model in management of visual dysfunction after mTBI for the Defense Health Agency/Vision Center of Excellence (DHA/VCE) community. Consistent terminology and a common language for OMR are crucial for interdisciplinary assessment and rehabilitation collaboration in patient treatment, and to further standardization in research and clinical practice.

METHODS

Terminology used in current literature; descriptions of optometric residency and fellowship programs were reviewed. Clinical multidisciplinary and interagency Subject Matter Experts collaborated on the final document.

Literature Review of Terms and Definitions

To understand the evolution of the term “ocular motor rehabilitation”, two databases (PubMed and Google Scholar) were utilized to identify literature published from 2010 to 2025. The following Medical Subject Heading (MeSH) terms were used during the search to generate appropriate articles (Table 1):

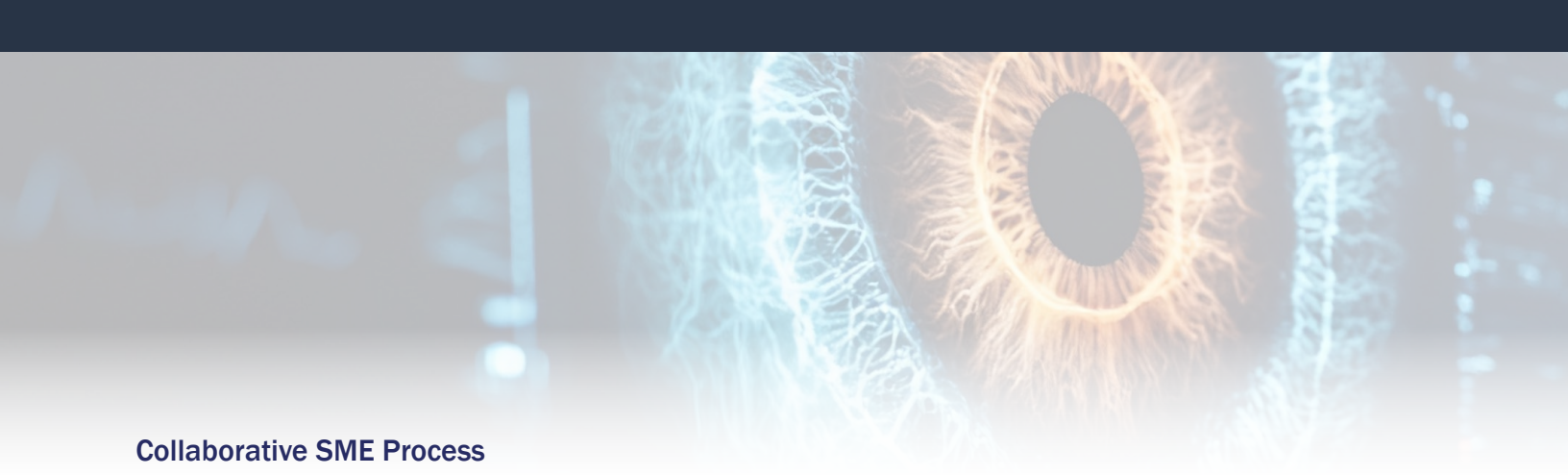
Table 1. MeSH terms used during literature search

Rehabilitation	Optometric Vision Therapy
Rehabilitative Interventions	Orthoptics
Rehabilitation Strategy	Orthoptic Therapy
Vision Impairment	Orthoptic Vision Therapy
Visual Function	Ocular Motor Rehabilitation
Functional Vision	Oculomotor Rehabilitation
Vision Rehabilitation	Neuro-optometric Rehabilitative Therapy
Vision Therapy	

The description, scope, and nature of the searched terms were compared. In addition, references from the articles identified during the search were manually screened to find additional relevant literature.

Residency and Fellowship Program Review of Terminology and Definitions

Association of Schools and Colleges of Optometry (ASCO)[35] website's residency and fellowship directory was used to identify programs with a focus on rehabilitation (e.g., "low vision rehabilitation", "vision rehabilitation"). Each residency and/or fellowship program, category title, area of emphasis, affiliated school, program description, and terminology were thoroughly reviewed. The terms searched were the same as in the literature review. Programs meeting the inclusion criteria (in which rehabilitation was a focus) were listed, and relevant details were recorded. One researcher identified and recorded the primary terminology used by each program, which was then reviewed by subject matter experts (SMEs) in optometry. Entries were then categorized by government and non-government sectors. In total, 66 residency programs and 4 fellowship programs focused on rehabilitation and/or vision therapy were identified across the U.S.



Collaborative SME Process

Clinical Subject Matter Experts (CSMEs) with expertise in vision dysfunction were recruited from federal (DOW and VA) and academic sectors, including optometrists, ophthalmologists, physiatrists, and physical and occupational therapists. Many had previously contributed to DHA/VCE CPRs and CPGs. These CSMEs reviewed and commented on drafts of the description, scope, and nature of multisensory interdisciplinary OMR related to vision dysfunction from mTBI. Through several revisions, they collaborated on the final definition of OMR.

RESULTS

Literature Terminology Overview: Terms in Current Literature Relating to "Rehabilitation"

Two leading organizations accepted the following definitions of rehabilitation:

The World Health Organization (WHO)[36] defines rehabilitation as a set of interventions optimizing functioning and reducing disability, aiming to maximize independence. Strategies involve addressing health conditions, modifying environments, using assistive products, educating for self-management, and adapting tasks to facilitate daily activities.[37]

In 2020, the Cochrane Rehabilitation Group refined the definition of rehabilitation for research purposes, emphasizing rehabilitation as a multi-modal process tailored to patients' needs and goals, involving a multidisciplinary team.[38-41] Their comprehensive definition addresses eight essential aspects: objectives, outcomes, target groups, interventions, professionals involved, locations, timing, and conditions.

The term "rehabilitation" was further described in clinical application.[41] The following four main intervention types within rehabilitative practices have been identified:

1. **Substitutive**: Using tools to work around impairments.
2. **Restitutive:** Supporting neural tissue restoration via neural plasticity.
3. **Compensatory:** Employing alternative strategies to bypass impairments.
4. **Pharmacological:** Using medications to alleviate dysfunction.

A strategic rehabilitation program includes diagnostic consideration, tailored interventions, and strategic planning. Clinical judgment is crucial in determining intervention types, delivery, and location, ensuring the strategy is individualized to the patient's condition and needs.[42] Clinical judgment must also ensure that selected interventions do not negatively affect other sensory or motor function comorbidities.

Another consideration when building a strategic rehabilitation program is to employ WHO's International Classification of Functioning, Disability and Health (ICF)[43] model. The ICF model provides a framework encompassing body functions, structures, activities, participation, environmental, and personal factors to comprehensively address health and disability. It offers a holistic view that is invaluable in rehabilitation contexts, facilitating an understanding of patients within their families and communities. The ICF model enhances communication among professionals and supports the development of interdisciplinary treatment plans where interdisciplinary teams build on each other's work to achieve shared goals.

Literature Terminology Overview: Terms in Current Literature Related to "Vision Rehabilitation"

Several key terms related to vision rehabilitation found in the literature included definitions that were specific. These included the following:

Vision Impairment (VI): Permanent or uncorrectable vision loss based on the best-corrected visual acuity in the better-seeing eye, involving loss of visual acuity or visual fields.[44,45]

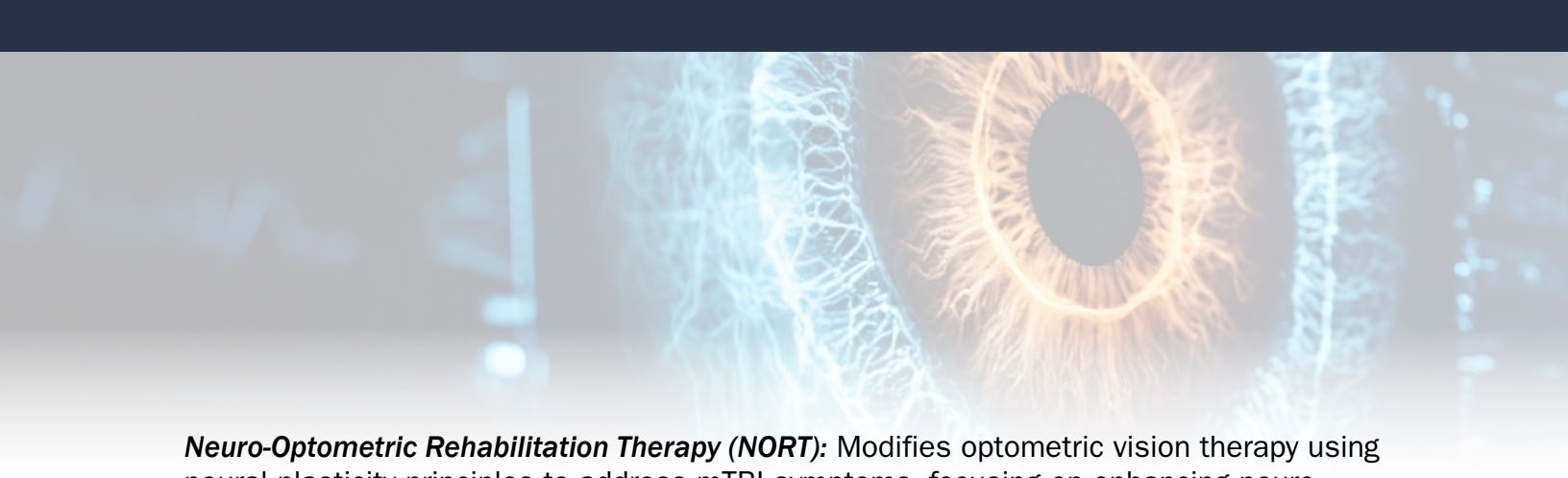
Visual Function: The functioning of the eye and lower-order cerebral mechanisms.[28,46]

Functional Vision: Daily life functioning, highlighting deficits in higher-order cerebral mechanisms such as visual perception.[28]

Vision Rehabilitation (VisR): An interdisciplinary approach to help those with vision impairment achieve safety, independence, and quality of life through various interventions.[47,48]

Orthoptics and Orthoptic Vision Therapy (OrthVT): Nonsurgical treatment for neuromuscular eye anomalies, involving eye exercises for issues like amblyopia and minor eye movement problems.[48,49]

Vision Therapy and Optometric Vision Therapy: Neurosensory and neuromuscular activities to develop and enhance visual skills, involving tools like lenses, prisms, and balance boards.[49,50]



Neuro-Optometric Rehabilitation Therapy (NORT): Modifies optometric vision therapy using neural plasticity principles to address mTBI symptoms, focusing on enhancing neuro-plastic changes through motivation, feedback, repetition, sensory-motor mismatch, and intermodal integration.[51]

The term "Ocular Motor Rehabilitation" was not well-defined as a protocol, but individual interventions for specific OMD and visually related tasks associated with mTBI were documented and have been accepted by the rehabilitative clinical community. Interventions for OMD have been systematically reviewed.[52-54] Substitutive interventions employing micro prism for correction of vertical ocular misalignments, and restitutive interventions for version, vergence, and gaze stabilization have been described.[54-60] Successful OMR collaboration between optometrists and occupational therapists to include several restitutive and compensatory interventions has been reported by several disciplines.[29-31,61]

Residency and Fellowship Terminology Overview

Sixty-six optometric residency programs with a focus on rehabilitation were identified: 18 federal (DOW and VA) and 48 non-federal. Additionally, four rehabilitation-focused fellowships were found: three federal and one non-federal. Descriptions of the programs did not include definitions of rehabilitation or specifically OMR. Program titles included Brain Injury Rehabilitation, Neuro-optometric Rehabilitation, Low Vision Rehabilitation, Pediatric Vision Therapy, Orthoptic Vision Therapy, Binocular Vision Therapy, and Sports Vision Training, with "Vision Therapy" and "Vision Rehabilitation" as general umbrella terms.

DISCUSSION

OMDs include dysfunction of ocular alignment (tropias and phorias), movement (pursuit and saccade) and binocular coordination (version and vergence). OMDs can also impact accommodation, resulting in insufficient, excessive, or inefficient reactions to stimuli. In mTBI, post-injury accommodative dysfunctions can alter monocular acuity. OMDs can also affect binocular acuity and binocularity. Uncorrected refractive errors can exacerbate these dysfunctions.[62] Common symptoms include blurry vision, diplopia, eye strain, headaches, depth perception issues, tracking problems, and balance issues. Frequent OMDs described in individuals with mTBI include accommodative insufficiency (42.8%), convergence insufficiency (36.3%), saccade dysfunctions (30%), pursuit dysfunctions (60%), and decompensated vertical phorias (24.4%).[5,63-65]

OMDs also impact non-visual senses such as balance, spatial orientation, proprioception, hearing, memory, behavioral health, and speech, as well as higher visual sensory modalities of visual perception and visual-motor coordination.[65] They affect attention, focus, auditory processing, and language skills, which are crucial for reading and comprehension. The vestibular and ocular systems stabilize gaze and acquire moving targets while the head or body is in motion. The vestibulo-ocular reflex (VOR) is part of the multisensory integration between ocular motor and vestibular systems. Ocular misalignment can disrupt the VOR compromising gaze stability, leading to poor posture, abnormal gait, dizziness and imbalance.[66] Dysfunction in saccades, pursuit, version, and vergence further contribute to imbalance. Given multi-sensory effects of OMDs, patients with these dysfunctions should receive OMR as interdisciplinary treatment including optometry and occupational and physical therapy. As a necessity for best practice, common language between disciplines is requisite for an interdisciplinary and ICF model of OMR.

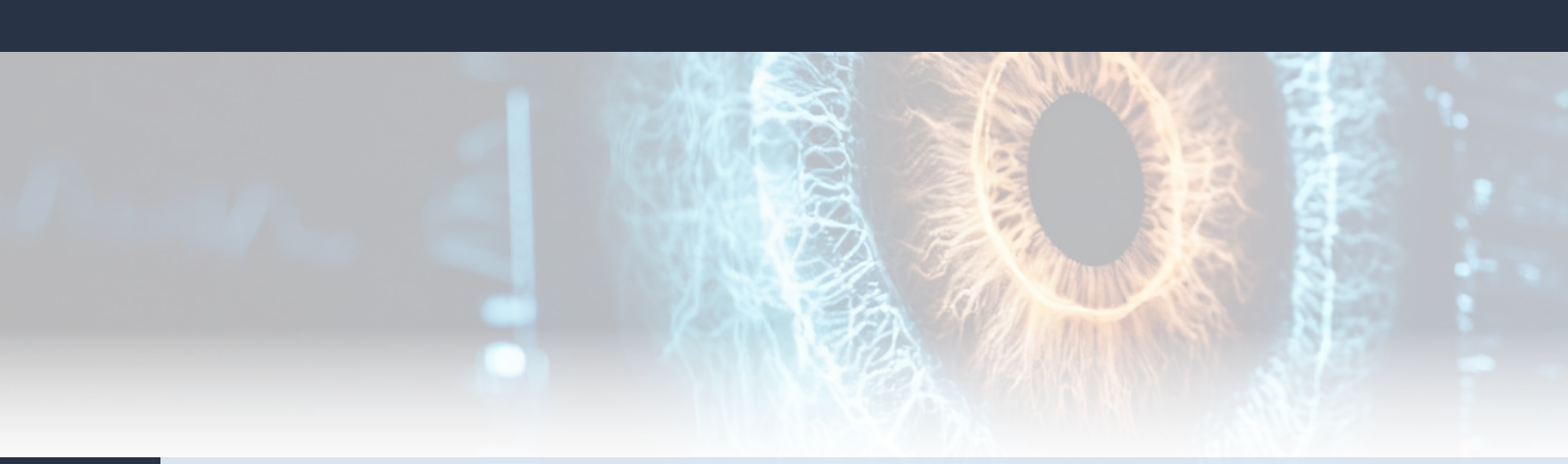
Application of OMR to General Rehabilitation Strategy and Intervention Terms and Definitions

Adequate OMF is crucial for reaction time, mobility, balance, binocular vision, depth perception, reading, information processing, language processing, and memory. Vision is important for postural stability. Such impairments, whether occurring in civilian or military settings, can profoundly affect cognitive function and motor control.[34,67] Sustained endurance to work demands, work efficiency, and productivity may be affected. Recent evidence suggests that OMR after mTBI may support recovery, complement other therapies, and improve outcomes.[55,68,69]

OMR strategies can include four types of interventions delivered by several disciplines sequentially or in concert, depending on the OMD and patient specifics:[34,41,53]

1. **Substitutive OMR Interventions:** Use spectacle or contact lenses (concave, convex, toric) and prisms to address refractive errors and ocular misalignments. They are provided by optometrists (ODs) and ophthalmologists (O-MDs). Ocular muscle surgeries, often considered substitutive interventions as they correct mechanical conditions and normalize ocular muscle positioning, are performed by O-MDs.[41]

2. **Restitutive OMR Interventions:** Restore functions via neural plasticity principles through orthoptic and optometric vision therapy, enhancing various ocular functions.[66] They are administered by ODs, O-MDs, OTs, orthoptists, and PTs.[29,70,71]



3

Compensatory OMR Interventions: Adaptation strategies like scanning and ergonomic adjustments, taught by ODs, OTs, PTs, orthoptists, and VA polytrauma and low vision Blind Rehabilitation Outpatient Service (BROS).[72]

4

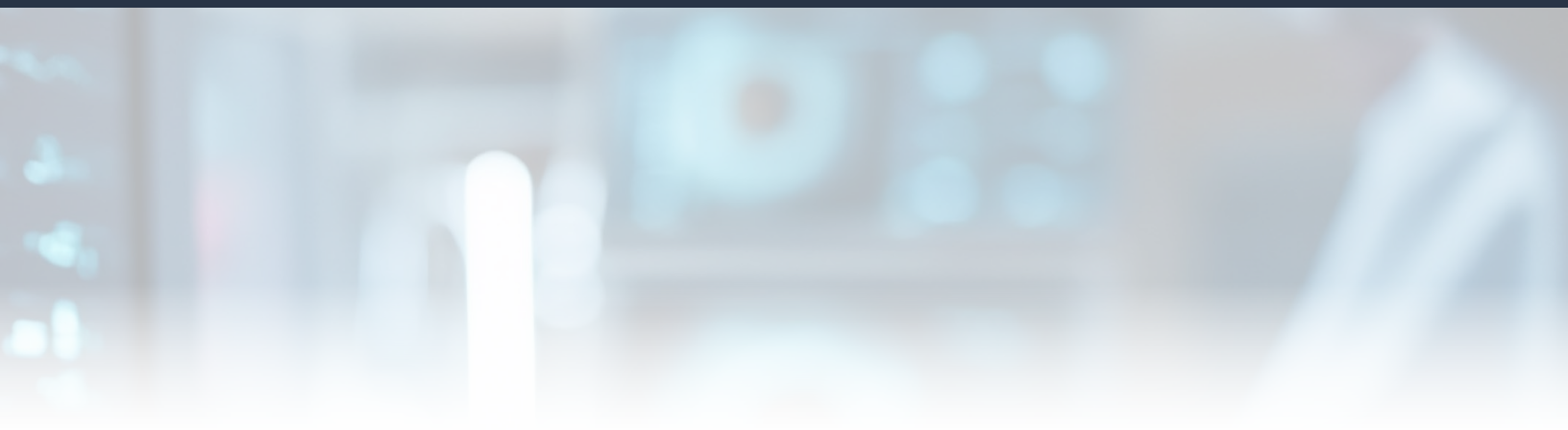
Pharmacological OMR Interventions: Medications prescribed by O-MDs and Neuro-O-MDs to manage symptoms like myokymia and ocular flutter.[41]

All OMR strategies should commence with accurate refractive error correction improving visual acuity to ensure optimal ocular motor control and gaze stability.[73] If problems persist after spectacle habituation, further strategic planning and interventions based on neural plasticity principles are needed. Restitutive interventions should progress from simple static monocular to complex dynamic binocular skills, integrating compensatory strategies as necessary.[74]

Several systematic and scoping reviews on "vision rehabilitation in mTBI" concluded that ocular motor-based rehabilitation demonstrates promising efficacy reducing OMD in individuals with mTBI.[50,59,64] Some authors also mentioned the absence of adverse events of OMR and several meta-analyses supported a positive trend toward efficacy.[54,56] A very recent randomized clinical trial, specifically the "CONCUSS randomized clinical trial of vergence/accommodative therapy for concussion-related symptomatic convergence insufficiency" addressed the question of effectiveness of immediate versus delayed office-based vergence/accommodative therapy with movement (OBVAM) for the treatment of convergence insufficiency (CI) in participants 11-25 years old with persistent post-concussive symptoms. The study found that watchful waiting resulted in a low recovery rate (6% after 6 weeks post-concussion), while both immediate and delayed OBVAM therapy resulted in successful or improved (up to 92%) normalization of clinical outcomes. The authors concluded that watchful waiting is very unlikely to produce a significant recovery in the assessed population, whereas OBVAM can successfully treat concussion-related CI in 6-8 weeks.[75]

Collaborative Statement: OMR Defined

An interdisciplinary, interagency team of CSMEs collaborated on defining OMR for vision dysfunction associated with mTBI. Many CSMEs and authors of this paper also contributed to DHA/VCE CRs and PRs. Based on their work and this document, the proposed definition has been accepted for use in DHA/VCE publications.



The recommended shared interprofessional definition of Ocular Motor Rehabilitation is a rehabilitative strategy to regain control over accommodative focus and eye movements, addressing dysfunctions in accommodation, ocular alignment, saccades, smooth pursuit, vergence, fixation, dynamic acuity, and gaze stabilization, often related, but not limited to traumatic brain injury. Interventions include substitutive, restitutive, compensatory, and pharmacological methods such as spectacles, prisms, surgery, vision therapy/orthoptics, occupational and physical therapy, adaptations, and medications. Individualization and clinical judgment are crucial.

Given the visual system's complexity and integration with cognitive, vestibular, motor, and autonomic functions, an interdisciplinary multimodal approach is essential. OMR spans various settings, including in-clinic offices and home environments, and involves tasks like reading, gaze stability, postural control, balance, gait, and sensory-motor coordination. It may apply to patients with TBI across their life span.

CONCLUSION

In summary, OMR for mTBI uses an interdisciplinary approach to enhance vision function and address eye movement dysfunctions. Ongoing research and evidence-based practices are vital for effective treatment. This document reviews vision rehabilitation terminology from literature and clinical programs, establishing a unified multidisciplinary and interagency (DOW, VA) collaborative statement defining OMR. Clear definitions and terminology foster better communication among disciplines, therefore improving treatment identification and outcomes for mTBI-associated ocular motor dysfunctions.

**VA Chat GPT was utilized to compress this manuscript.

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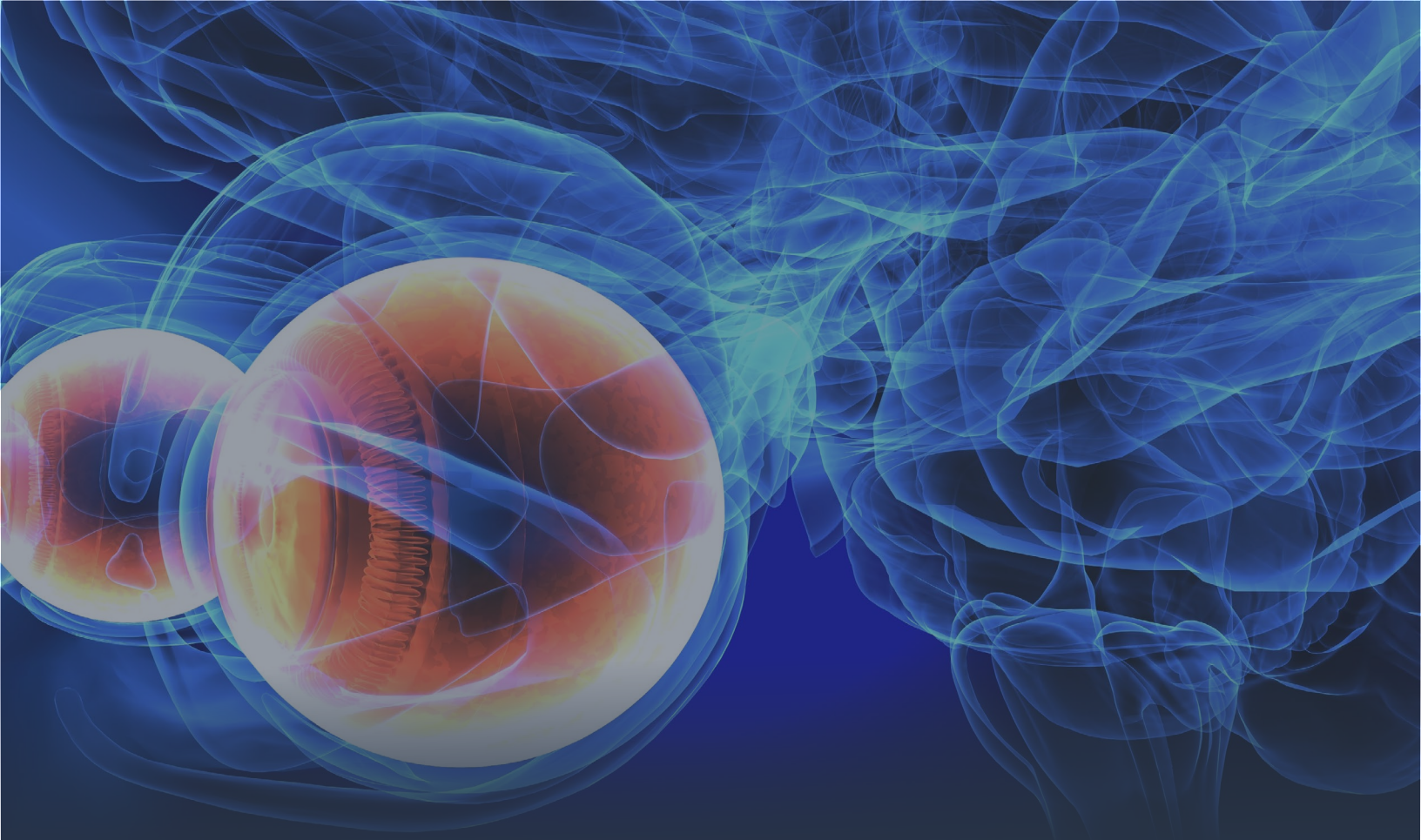

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