# Perspective: Conceptual Model Pyramid of Optometric Care in Mild Traumatic Brain Injury (mTBI): A Perspective

Kenneth J. Ciuffreda, OD, PhD, FCOVD-A

Diana P. Ludlam, BS, COVT

Naveen K. Yadav, BS Optom., MS, PhD

*SUNY College of Optometry, New York, New York*

Kenneth J. Ciuffreda, OD, PhD, FCOVD-A
New York City, New York

OD 1973, Massachusetts College of Optometry

PhD 1977, Physiological Optics University of California at Berkeley School of Optometry

Distinguished Teaching Professor
SUNY, State College of Optometry

Research Diplomate in Binocular Vision
American Academy of Optometry

The first two authors have developed and proposed a "conceptual model of optometric vision care in mild traumatic brain injury (mTBI)".[1] This comprehensive model allows one to "conceptualize", or "view", the manifold of vision care possibilities in mTBI very broadly. This is somewhat akin to looking at a landscape through a wide-angle lens versus a narrow-field telephoto lens. The model captures the entire scenario, and its essence, rather than only focusing on the smaller, and more segmented, detailed aspects. Hence, it allows for better integration of the various elements rather than looking at the individual components in relative isolation. In addition, the scope of the model minimizes the tendency of some practitioners to focus and dwell upon their "pet" areas and idiosyncratic ideas, in effect allocating less time and emphasis to the full-scope of conventional optometric vision care, that is to the full armamentarium that is available to the mTBI patient by the contemporary and well-trained neuro-optometrist. Lastly, the model acts to "demystify" the teachings of some in the field.

In our conceptual model, we have envisioned it as having four "tiers". Details of it have been presented elsewhere.[1,2] The model will be briefly discussed below within the conceptual framework of a "pyramid" (Fig. 1), along with examples of related cases we have examined, as well as some newer ideas.

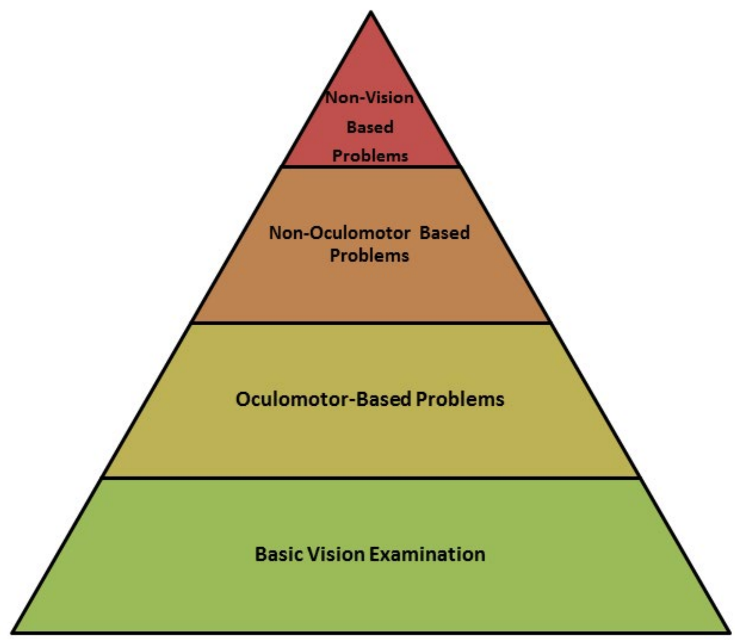


***Figure 1:*** Conceptual model pyramid showing the four tiers of optometric vision care in mTBI.

The first tier represents the comprehensive, three-part, basic optometric vision examination. This includes the refractive, binocular, and ocular health components. It serves as the "foundation" for the other 3 tiers. Just as when building a house, if the foundation is weak, the integrity of the remainder of the structure is called into question, and furthermore regarded as a bit precarious and tenuous in nature. This is especially true in mTBI, where there are some unique aspects to each of these three foundation areas. For example, if the refractive state is not properly corrected, the elderly individual with mTBI may still manifest visual deficits such as blurred retinal imagery, which in turn may increase the likelihood of a fall.[3]

The following is a sample case that highlights aspects of tier 1. The patient was a 31-year-old, emmetropic physician who sustained a head injury two years earlier in a motor vehicle accident. Her primary symptoms were constant diplopia and blur at near, which had an adverse effect on reading and other near tasks. Over the previous two years, she received a range of therapies (e.g., occupational therapy) and was examined by several medical consultants (e.g., neurologists) in an attempt to remediate these vision problems, all to no avail. Following our comprehensive optometric vision examination, she was diagnosed with near total paralysis of convergence and accommodation, which explained her near symptoms. Simple optics related to binocular vision was the solution: when we added +2.5 D lenses binocularly at near, she saw clearly but diplopically; when we added 16 pd base-in prisms (total) at near, she saw singly but not clearly; and when we added both the lenses and prisms together, she saw clearly and singly, with comfort and sustain. She exclaimed, "Why didn't someone do this before?"

The second tier represents the three oculomotor subsystems: version, vergence, and accommodation. Commonly found problems such as convergence and accommodative insufficiency, as well as saccadic dysmetria, make reading more difficult, thus resulting in asthenopia with attempts to sustain nearwork.[4] Presence of such signs and symptoms will have an adverse effect on one's vocational and avocational goals,[5] as well as other types of rehabilitation (e.g., cognitive therapy involving visual scanning). Fortunately, these oculomotor problems can be remediated to a considerable extent with a range of vision interventions, namely vision therapy, vergence prisms, near plus lenses, and sector occluders.[1,2,4]

The following is a sample case that highlights aspects of tier 2. The patient was a 21-year-old myopic student who was assaulted with a pipe and sustained head injury over the occipital region one year earlier. His primary symptoms were related to reading: rereading lines of text, intermittent blur, transient diplopia, and difficulty sustaining attention. As part of a pilot research study in our laboratory, he received 9.6 hours of oculomotor-based vision therapy over a six week period: version, vergence, and accommodation were trained on a one-on-one basis with considerable verbal feedback regarding accomplishing the specific tasks (e.g., "clear the blur") and his performance. Following this short period of oculomotor-based vision therapy, his symptoms were significantly reduced, and reading improved, with better comprehension and attentional sustain. In clinical practice, a longer period of vision therapy is typically required for optimal results with long term maintenance.

The third tier represents a wide range of non-oculomotor-based problems: abnormal egocentric spatial localization, photosensitivity, visual motion sensitivity, vestibular dysfunction, visual field defects, and visual information processing and perceptual problems. Again, and fortunately, these dysfunctions can be remediated to a considerable extent using a range of possible interventions: yoked prisms, grey or colored tints and brimmed hats, binasal occlusion, motion desensitization techniques, vestibular therapy, visual scanning, sector prisms, and perceptual therapy,[1,2] respectively.

The following is a sample case that highlights aspects of tier 3. The patient was a 55-year-old myopic homemaker and artist who had sustained eight head injuries over the past 6 years. She had persistent visual motion sensitivity (VMS) and photosensitivity (PS), which forced her to remain home-bound much of the time. She disliked large, busy shopping malls with their fluorescent lighting and long aisles. The patient was prescribed a 25% blue tint for constant wear by her optometrist for the PS, who then referred her to us for the objectively-based visual-evoked potential (VEP) and related testing, in particular for assessment of binasal occlusion (BNO) for the VMS.[6,7] The

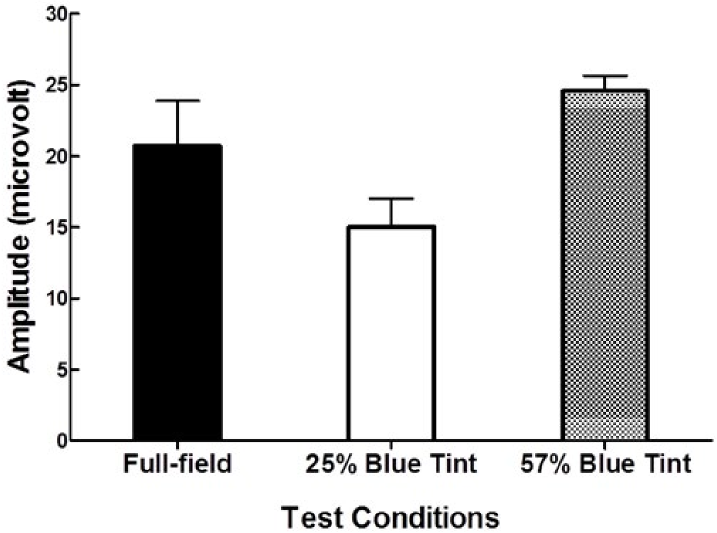


***Figure 2:*** VEP amplitude for the three test conditions. Mean +1 SD.

VEP test results for the tints are presented in Figure 2. The objective findings of increased amplitude suggested prescription of a 57% blue tint rather than the 25% one that she was wearing, mainly for the PS but also helpful for the VMS. The patient also preferred the darker blue tint. Similar increased VEP amplitudes were found with addition of the BNO. These findings suggested presence of magnocellular pathway deficits. Both the 57% blue tint and the BNO were incorporated into her refractive correction.

Lastly, the fourth tier represents a wide range of non-vision-based problems that, if present and left unattended, will impact adversely on one's optometric vision care. That is, the care will not be as effective. Presence of these problems typically requires referral to the appropriate health-care professional (e.g., neurologist, cognitive therapist). Such problems include depression, fatigue, cognitive impairment, behavioral issues, attentional deficits, and other medical/neurological conditions. They too can be helped with medications, counseling, exercise and various related therapies (e.g., pilates), yoked prisms, and/or cognitive/attentional therapy.

The following is a sample case that highlights aspects of tier 4. The patient was a 28-year-old myopic professional who had sustained head and body injuries in a motor vehicle accident three years earlier and was categorized as having moderate traumatic brain injury. She had a constellation of initial non-vision-based problems, such as impaired language and speech processing, cognitive deficits, and balance/gait problems, for which she obtained a considerable degree of appropriate therapies over this three year period, with relatively good results. These included speech therapy, neurocognitive therapy, and physical therapy. When she was subsequently examined by us, she had considerable residual vision problems, including blur, headaches, visual fatigue, and slow reading, all primarily at near, with poor sustain and marked visual discomfort. Following oculomotor-based vision therapy with us, and others at our college, over a period of two years and several hundred hours both in-office and at-home, along with appropriate refractive correction for distance and near, she could now read for at least thirty minutes with good comprehension and minimal visual fatigue. Vision therapy for her visual deficits, either prior to or concurrent with her other therapies, would have been the preferred sequence to optimize overall success.

In addition to the aforementioned standard clinical basic optometric and neuro-optometric tests as described in tiers 1-3 of our model, there are some other "specialty" tests that should be considered at times when deemed appropriate and informative. These can be categorized as sensory, motor, and electrophysiological in nature. Under sensory aspects, these might include testing of the coherent motion threshold (CMT) and the critical flicker fusion threshold (CFF) to ascertain visual motion sensitivity and temporal abilities, respectively. Under motor aspects, this might include the Visagraph to assess reading ability, dynamic posturography to assess balance for example with and without either BNO or yoked prisms, dynamic pupillometry to assess pupil responsivity to white and colored light, video oculography (VOG) to assess the vestibular system, and dynamic autorefraction to assess accommodative facility, all of which are both quantitative and objective by nature. Lastly, the electrophysiological aspects would include electoretinography (ERG) and the visual-evoked potential (VEP) to assess the retina and early visual cortex, respectively, again both quantitative and objective in nature.

In conclusion, in the context of our conceptual model, and beyond, we have outlined a broad approach to the diagnosis and treatment of the patient with mTBI. This model approach should provide guidance to the general optometrist desiring to learn more regarding providing optimal vision care for these patients, as well as to the more experienced practitioner in the area to expand their perspective. In addition, it should serve as an overview to others on the interdisciplinary team, such as the physiatrist and vestibular therapist, regarding the range of visual diagnostic tests and therapeutic options to be expected from the full-scope, contemporary neuro-optometrist.

## Acknowledgements

We thank Dr. Irwin Suchoff for his careful reading of the manuscript and insightful comments. We also thank DIOPSYS for use of the VEP system and Cerium for use of their Intuitive Colorimeter.

## References

1. Ciuffreda KJ, Ludlam DP. Conceptual model of optometric vision care in mild traumatic brain injury. J Behav Optom 2011; 22:10-12.
2. Ciuffreda KJ, Ludlam DP. Conceptual model of optometric care in mild traumatic brain injury. youtube April 10, 2015. https://youtu.be/A4ggoK-aQPk
3. Anand V, Buckley JG, Scally A, Elliott DB. Postural stability in the elderly during sensory pertubations and dual tasking: the influence of refractive blur. Invest Ophthalmol Vis Sci 2003; 44;2885-2891.
4. Ciuffreda KJ. The scientific basis and efficacy of optometric vision therapy in nonstrabismic accommodative and vergence disorders. Optometry 2002; 73:735-762.
5. Grosswasser Z, Cohen M, Blankstein E. Polytrauma associated with traumatic brain injury: incidence, nature, and impact on rehabilitation outcome. Brain Injury 1990; 4: 161-166.
6. Ciuffreda KJ, Yadav NK, Ludlam DP. Effect of binasal occlusion (BNO) on the visual-evoked potential in mild traumatic brain injury (mTBI). Brain Injury 2013; 27:41-47.
7. Yadav NK, Ciuffreda KJ. Effect of binasal occlusion (BNO) and base-in prisms on the visual-evoked potential (VEP) in mild traumatic brain injury (mTBI). Brain Injury 2014;28:1568-1580.

*https://doi.org/10.31707/VDR2015.1.2.p105*