

Summary of November 2017 Topic: Whiplash Associated Disorder (WAD)

The November Topic was Whiplash Associated Disorder (WAD). The five articles ranged in focus including oculomotor control, cervical spine proprioception, dizziness, and balance.

Common to all of the articles was that the subjects had a whiplash injury.

One systematic review examined oculomotor control after whiplash injury. Overall the results varied but a main finding was that compensatory eye movements were common, especially in smooth pursuits. Based on this finding, it was proposed that this could negatively affect head and eye coordination. (1)

Four articles looked at the efficacy of physical therapy on reducing symptoms from WAD. The first suggested that neck exercises including a behavioral approach could reduce pain, dizziness and improve balance compared to just performing neck exercises. However, this intervention did not resolve these impairments fully. The authors suggested that the effect of specific exercises for the neck, dizziness and balance should be studied. (2)

An article examined the effect of vestibular physical therapy on neck pain and cervical spine range of motion. Vestibular therapy did not decrease pain intensity nor improve range of motion but it clearly did not worsen either of these. (4) Another article examined the potential benefits of vestibular physical therapy on balance and self-perceived dizziness and balance handicap, using the Dizziness Handicap Inventory. Both of these measures improved after six weeks of vestibular PT. (5)

Finally, an article summarized that known mechanisms for dizziness, imbalance, impaired oculomotor control, cervical spine proprioception exist due to cervical afferent dysfunction following a whiplash injury. This article recommended the examination and targeted treatment of these impairments. (3)

Overall, these articles verify the association between dizziness, imbalance and visual disturbances following a whiplash injury and suggest that targeted assessment and treatment of these impairments is important in the rehabilitation of these patients.

1) Ischebeck BK, de Vries J, Van der Geest JN, Janssen M, Van Wingerden JP, Kleinrensink GJ, Frens MA. Eye movements in patients with Whiplash Associated Disorders: a systematic review. *Man Ther.* 2016 Apr;22:122-30. doi: 10.1016/j.math.2015.10.017.

2) Treleaven J, Peterson G, Ludvigsson ML, Kammerlind AS, Peolsson A. *J Orthop Sports Phys Ther.* Balance, dizziness and proprioception in patients with chronic whiplash associated disorders complaining of dizziness: A prospective randomized study comparing three exercise programs. 2017 Jul;47(7):492-502. doi: 10.2519/jospt.2017.7052.

3) Treleaven J. Dizziness, Unsteadiness, Visual Disturbances, and Sensorimotor Control in Traumatic Neck Pain. *J Orthop Sports Phys Ther* 2017;47(7):492-502. Epub 16 Jun 2017. doi:10.2519/jospt.2017.7052

4) Hansson EE, Persson L, Malmström EM. Influence of vestibular rehabilitation on neck pain and cervical range of motion among patients with whiplash-associated disorder: a randomized controlled trial. *J Rehabil Med.* 2013 Sep;45(9):906-10. doi: 10.2340/16501977-1197.

5) Ekvall Hansson E, Månsson NO, Ringsberg KA, Håkansson A. Dizziness among patients with whiplash-associated disorder: a randomized controlled trial. *J Rehabil Med.* 2006 Nov;38(6):387-90.

Summary of October 2017 Topic: Pain and the Vestibular System

These past month's abstracts looked at the link between the vestibular system and pain. In the first abstract a specific link between the two was discussed. There are remarkable parallel neurochemical phenotypes for inner ear and trigeminal ganglion cells and these afferent channels appear to converge in shared central pathways for vestibular and nociceptive information processing. These pathways share expression of receptors targeted by anti-migraine drugs (1). The second abstract assessed the incidence of vestibular dysfunction in patients receiving medication for chronic, noncancer pain or other underlying neurologic disorders and to determine associated follow-up therapeutic and diagnostic recommendations. It was found that patients being treated with medications for chronic, noncancer pain or other underlying neurologic disorders may have a higher-than-average incidence of vestibular dysfunction. Baseline assessment and monitoring of the vestibular apparatus may be indicated for these patients (2). Another study determined whether patients with fibromyalgia, compared to age-matched healthy controls, have differences in dynamic posturography, including sensory, motor, and limits of stability despite having a normal clinical neurological examination (3). A final study sought to determine if reduced head-on-trunk movement alters VOR suppression and gaze accuracy similar to experiments involving normal subjects and if intentionally increasing head and neck movement affects these dynamics. In patients with chronic neck pain, the internal commands issued for combined eye-head movements have large enough amplitudes to create accurate gaze saccades; however, because of increased neck stiffness and viscosity, the head movements produced are smaller, slower, longer, and more delayed than they should be. VOR suppression is disproportionate to the size of the actual gaze saccades because sensory feedback signals from neck proprioceptors are non-veridical, likely due to prolonged coactivation of cervical muscles. The outcome of these changes in eye-head kinematics is head-on-trunk stability at the expense of gaze accuracy. In the absence of vestibular loss, the practical consequences may be dizziness in the short term and imbalance and falls in the long term (4).

1. Balaban CD. Migraine, vertigo and migrainous vertigo: Links between vestibular and pain mechanisms. *J Vestib Res.* 2011;21(6):315-21. doi: 10.3233/VES-2011-0428.
2. Gilbert JW, Vogt M, Windsor RE, Mick GE, Richardson GB, Storey BB, Herder SL, Ledford S, Abrams DA, Theobald MK, Cunningham D, Kelly L, Herring KV, Maddox ML. Vestibular dysfunction in patients with chronic pain or underlying neurologic disorders. *J Am Osteopath Assoc.* 2014 Mar;114(3):172-8. doi: 10.7556/jaoa.2014.034.
3. Jones KD1, King LA, Mist SD, Bennett RM, Horak FB. Postural control deficits in people with fibromyalgia: a pilot study. *Arthritis Res Ther.* 2011 Aug 2;13(4):R127.
4. Johnston JL, Daye PM, Thomson GT. Inaccurate Saccades and Enhanced Vestibulo-Ocular Reflex Suppression during Combined Eye-Head Movements in Patients with Chronic Neck Pain: Possible Implications for Cervical Vertigo. *Front Neurol.* 2017 Jan 30;8:23. doi: 10.3389/fneur.2017.00023. eCollection 2017.

Summary of September 2017 Topic: Meniere's Disease

The September topic was Meniere's disease and the selected articles aimed to provide evidence to support clinical presentation of Meniere's disease.

One article assessed whether endolymphatic cavity enlargement could be detected in T2 weighted MRI and therefore used to indicate endolymphatic hydrops and confirm a diagnosis of Meniere's Disease. The study found that subjects with Meniere's Disease had a statistically significant increased endolymphatic cavity size compared to controls. Therefore, the current protocols using T2 MRI of the temporal bone can be used to help diagnose Meniere's Disease. (2)

Another article used MRI to measure endolymphatic hydrops in order to differentiate between Meniere's Disease and Vestibular Migraine diagnoses. Meniere's Disease showed significant endolymphatic hydrops via 3D-real-IR MRI but not in subjects with Vestibular Migraine. Therefore, this type of MRI can be helpful to rule in/rule out Meniere's Disease or Vestibular Migraine. This is especially useful because the clinical vestibular presentation of the two diagnoses can be similar. (1)

The final study aimed to examine the role of the vestibular system's influence on postural hemodynamics through examination of patients with Meniere's Disease who experience syncope. The study reinforced the function of the vestibular system on circulation regulation via the vestibular sympathetic reflex. (3)

These articles support proper diagnosis and therefore appropriate treatment of patients with Meniere's Disease.

1) Sun W, Guo P, Ren T, Wang W. Magnetic resonance imaging of intratympanic gadolinium helps differentiate vestibular migraine from Ménière disease. *Laryngoscope*. 2017 Feb 21.

2) Keller JH et al. Detection of endolymphatic hydrops using traditional MR imaging sequences. *Am J Otolaryngol*. 2017 Apr 6. pii: S0196-0709(16)30622-6.

3) Pyykkö I, Manchaiah V, Zou J, Levo H, Kentala E. Vestibular syncope: A disorder associated with drop attack in Ménière's disease. *Auris Nasus Larynx*. 2017 May 3. pii: S0385-8146(17)30088-3.

Summary of August 2017 Topic: Relaxation/meditation Strategies for Balance & Vestibular Treatment

Abstracts in August looked at possible relaxation and meditation strategies that could be useful in persons with vestibular disorders. While the research is more limited in these treatment options, the abstracts showed possible interventions that may be beneficial.

The first abstract confirmed that Interdisciplinary treatment improves patient coping, functionality, and satisfaction and decreases overall health care utilization in vestibular patients (1). Breathing techniques were shown to be beneficial in two of the abstracts provided. The results suggest that regulation of the breathing pattern may have an influence on disability related to chronic vestibular disease, while proprioception exercises may improve postural control (2). It was found that diaphragmatic breathing subjects, compared to those in the control group, displayed significantly greater heart rate variability and reported feeling less motion sickness during exposure to the virtual reality experience than those in the control group (5).

Yoga practice can significantly reduce cognitive motor interference, which improves balance, by improving allocation and utilization of attentional resources for both balance control and

executive cognitive functioning; thus resulting in better performance under dual task conditions (3).

Finally a study suggested mindfulness practice can promote effective heart rate regulation, and thereby promote effective recovery after a stressful event for individuals with headache conditions. Moreover, headache conditions may be associated with dysregulated stress recovery, thus more research is needed on the cardiovascular health and stress resilience of headache sufferers (4).

1. Naber CM, Water-Schmeder O, Bohrer PS, Matonak K, Bernstein AL, Merchant MA. Interdisciplinary treatment for vestibular dysfunction: the effectiveness of mindfulness, cognitive-behavioral techniques, and vestibular rehabilitation. *Otolaryngol Head Neck Surg.* 2011 Jul;145(1):117-24.
2. Jáuregui-Renaud K, Villanueva Padrón LA, Cruz Gómez NS. The effect of vestibular rehabilitation supplemented by training of the breathing rhythm or proprioception exercises, in patients with chronic peripheral vestibular disease. *J Vestib Res.* 2007;17(1):63-72.
3. Subramaniam S, Bhatt T. Effect of Yoga practice on reducing cognitive-motor interference for improving dynamic balance control in healthy adults. *Complement Ther Med.* 2017 Feb;30:30-35.
4. Azam MA, Katz J, Mohabir V, Ritvo P. Individuals with tension and migraine headaches exhibit increased heart rate variability during post-stress mindfulness meditation practice but a decrease during a post-stress control condition - A randomized, controlled experiment. *Int J Psychophysiol.* 2016 Dec;110:66-74.
5. Stromberg SE, Russell ME, Carlson CR. Diaphragmatic breathing and its effectiveness for the management of motion sickness. *Aerosp Med Hum Perform.* 2015 May;86(5):452-7.

Summary of July 2017 Topic: Vestibular Rehab in Concussion

Dizziness is a common symptom following concussion, according to one abstract occurrence rates are 67-77%. Imbalance, dizziness, visual and vestibular impairments were possible risk factors for prolonged recovery or worse outcomes following concussion.

The abstracts, including a systematic review, investigated whether vestibular therapy would reduce recovery time, improve outcomes, and is effective in the concussion population.

Overall, the research is limited in quality and breadth but suggest that vestibular therapy can be effective in treating this patient population.

The abstracts highlight that testing for vestibular impairments is warranted in the assessment of individuals with concussion. It is also recommended to treat those specific vestibular impairments. The abstracts also found that additional high quality research is needed to better determine the efficacy of vestibular intervention in concussion management.

Summary of June 2017 Topic: 3PD

Persistent postural-perceptual dizziness is the dizziness that lasts for over three months with no clinical explanation for its persistence. The patient's motor response pattern presents changes and most patients manifest significant anxiety. Clinical characteristics of patients with persistent postural and perceptual dizziness were looked at in one abstract. It was found that persistent

postural-perceptual dizziness affects more women than men, with a high associated prevalence of metabolic disorders and migraine. Questionnaires help to identify the predisposition to persistent postural-perceptual dizziness. The prognosis is good with adequate treatment (3). It has also been found that pre-existing anxiety-related personality traits may promote and sustain the initial etiopathogenetic mechanisms linked with the development of CSD. Targeting anxiety-related mechanisms in CSD may be therefore a promising way to reduce the disability associated with CSD (4).

The aim of another abstract was to investigate whether other sensory inputs such as pain stimuli might be altered in terms of a more widespread central perception dysfunction in this disorder. The results in this abstract support the hypothesis of the multisensory dimension of impaired sensory processing in patients with PPPD extends beyond vestibular/visual motion stimuli and reflexive postural/oculomotor control mechanisms to other sensory inputs such as pain perception in terms of a more generalized disturbed habituation pattern (2).

In general treatment plans that include patient education, vestibular rehabilitation, cognitive and behavioral therapies, and medications substantially reduce morbidity and offer the potential for sustained remission when applied systematically (1).

1. Dieterich M, Staab JP. Functional dizziness: from phobic postural vertigo and chronic subjective dizziness to persistent postural-perceptual dizziness. *Curr Opin Neurol*. 2017 Feb;30(1):107-113
2. Holle D, Schulte-Steinberg B, Wurthmann S, Naegel S, Ayzenberg I, Diener HC, Katsarava Z, Obermann M. Persistent Postural-Perceptual Dizziness: A Matter of Higher, Central Dysfunction? *PLoS One*. 2015 Nov 16;10(11):e0142468.
3. Bittar RS, Lins EM. Clinical characteristics of patients with persistent postural-perceptual dizziness. *Braz J Otorhinolaryngol*. 2015 May-Jun;81(3):276-82.
4. Chiarella G, Petrolo C, Riccelli R, Giofrè L, Olivadese G, Gioacchini FM, Scarpa A, Cassandro E, Passamonti L. Chronic subjective dizziness: Analysis of underlying personality factors. *J Vestib Res*. 2016 Nov 3;26(4):403-408.

Summary of May 2017 Topic: VEMPs

The VEMP can provide useful diagnostic information for many different conditions. One study looked to validate the VEMP score as a measure of brainstem dysfunction in patients with the first symptom of multiple sclerosis (MS) and to investigate the correlation between VEMP and brainstem MRI results. Significant correlations were found between clinical brainstem involvement and brainstem and pontine MRI lesions, and prolonged latencies and/or absent VEMP responses. The VEMP score is a valuable tool in evaluation of brainstem involvement in patients with early MS (1). The VEMP test could also be useful in the analysis of saccular function, and diagnosis of Meniere's disease. There was a significant relationship between the severity of hearing loss and a VEMP test without any recorded waves. Most of the cases with 'no wave recorded' VEMP test, were patients with severe hearing loss. However, there wasn't any relation between the pattern of hearing loss and 'no wave recorded' VEMP test. This showed VEMP test could be a valuable diagnostic clue especially in patients with definite Meniere's disease (2).

Another study compared VEMPs and video head impulse test (vHIT) results in patients presenting with vertigo and dizziness. They concluded VEMPs and vHIT data should be used complementarily and asymmetry on both tests strongly supports peripheral vestibular system involvement (3). VEMPs are also used in the diagnosis of superior semicircular canal dehiscence

(SCD). Data from this study suggest that both cVEMP thresholds and oVEMP amplitudes remain good diagnostic tests for identifying SCD, with each test dependent on a number of factors. The sensitivity and specificity of these individual tests may vary slightly between centers depending on testing parameters used (4). One last study looked at the emerging evidence that suggests children with attention deficit and hyperactivity disorder (ADHD) present more difficulties in standing and walking balance than typically developing children and aimed to evaluate vestibular otolith function in ADHD and matched control children. Their findings suggested that vestibular brainstem reflexes were altered in a subset of children with ADHD and proposed to include cVEMP reflexes in the clinical evaluation of ADHD patients (5).

1. Crnosija L et al. Vestibular evoked myogenic potentials and MRI in early multiple sclerosis: Validation of the VEMP score. *J Neurol Sci.* 2017 Jan 15;372:28-32.
2. Dabiri S et al. Analysis of Saccular Function With Vestibular Evoked Myogenic Potential Test in Meniere's Disease. *Acta Med Iran.* 2017 Feb;55(2):123-127.
3. Skorić MK et al. Vestibular evoked myogenic potentials and video head impulse test in patients with vertigo, dizziness and imbalance. *J Clin Neurosci.* 2017 May;39:216-220.
4. Hunter JB et al. Cervical and Ocular VEMP Testing in Diagnosing Superior Semicircular Canal Dehiscence. *Otolaryngol Head Neck Surg.* 2017 Feb 1:194599817690720. d
5. Isaac V. et al. Altered Cervical Vestibular-Evoked Myogenic Potential in Children with Attention Deficit and Hyperactivity Disorder. *Front Neurol.* 2017 Mar 13;8:90.

Summary of April 2017 Topic: Neck Disorders & Postural Stability

The receptors in the cervical spine have important connections to the vestibular and visual apparatus as well as several areas of the central nervous system. Dysfunction of the cervical receptors in neck disorders can alter afferent input subsequently changing the integration, timing and tuning of sensorimotor control. Measurable changes in cervical joint position sense, eye movement control and postural stability and reports of dizziness and unsteadiness by patients with neck disorders can be related to such alterations to sensorimotor control (1). This past month the abstracts looked at the relationship between neck problems and postural stability. Subjects with neck problems, such as whiplash injuries, often complain of disturbed equilibrium and, in some instances, provocation of the neck position can elicit such problems. It is concluded that the postural control system is significantly challenged in the head extended backwards condition in both normal subjects and patients with previous whiplash injury and persistent neck problems (2). One study sought to investigate neck muscle activity and postural control in patients with whiplash-associated disorder compared with healthy controls. Increased neck muscle activity and increased postural sway during simple balance tasks indicate disturbed sensory feedback patterns in people with whiplash-associated disorder, which may have negative consequences when performing daily activities (3). Finally a study investigated whether chronic neck pain patients suffering from vertigo and instability have true balance disorders. The study evidenced abnormal static and dynamic balance parameters in chronic neck pain patients with vertigo. These disorders can be explained by impaired cervical proprioception and neck movement limitations. Headache was more frequent in these patients(4)

1. Treleaven J. Sensorimotor disturbances in neck disorders affecting postural stability, head and eye movement control. *Man Ther.* 2008 Feb;13(1):2-11. Epub 2007 Aug 16.

2. Kogler A, Lindfors J, Odqvist LM, Ledin T. Postural stability using different neck positions in normal subjects and patients with neck trauma. *Acta Otolaryngol.* 2000 Mar;120(2):151-5.
3. Juul-Kristensen B, Clausen B, Ris I, Jensen RV, Steffensen RF, Chreiteh SS, Jørgensen MB, Sjøgaard K. Increased neck muscle activity and impaired balance among females with whiplash-related chronic neck pain: a cross-sectional study. *J Rehabil Med.* 2013 Apr;45(4):376-84
4. Yahia A, Ghroubi S, Jribi S, Mâlla J, Baklouti S, Ghorbel A, Elleuch MH. Chronic neck pain and vertigo: Is a true balance disorder present? *Ann Phys Rehabil Med.* 2009 Sep-Oct;52(7-8):556-67.

Summary of February 2017 Topic: Vestibular Migraines

The first study evaluated vestibular function test results in vestibular migraine (VM) patients, including caloric, vestibular evoked myogenic potential (VEMP), and dynamic posturography measurements and assessed their relationship with treatment responses. Abnormal vestibular ratios on posturography and abnormal VEMP responses were frequent findings in VM patients with recurrent attacks for more than 6 months and were indicators of a poor prognosis. More than 70% of the patients with VM experienced improvements in both headache and vertigo through a combination of lifestyle changes and prophylactic medications (1). A second study looked further into VEMPS and compared ocular vestibular evoked myogenic potential (oVEMP) and cervical vestibular evoked myogenic potential (cVEMP) prevalence and response characteristics in patients with suspected VM and in control patients. They found VEMP presentation differs for some patients diagnosed with VM. The higher rates of abnormal oVEMPs may suggest greater vulnerability within the ascending utricular-ocular pathway in patients with VM (2). The next abstract evaluated patients with vestibular migraine and analyzed whether different vestibular symptoms were able to discriminate different subgroups. They found spontaneous rotatory vertigo was more frequent in migraine with aura, whereas triggered nonrotatory vertigo was more frequent in migraine without aura (3). Finally a literature review of Randomised controlled trials (RCTs) was performed to assess the effects of pharmacological agents for the prevention of vestibular migraine. No evidence from RCTs answered the question set out in the review objectives. This review has identified the need for well-designed randomised controlled trials to answer questions about the efficacy of current and new treatments (4).

1. Jung JH1, Yoo MH, Song CI, Lee JR, Park HJ. Prognostic significance of vestibulospinal abnormalities in patients with vestibular migraine. *Otol Neurotol.* 2015 Feb;36(2):282-8.
2. Zaleski A1, Bogle J, Starling A, Zapala DA, Davis L, Wester M, Cevette M. Vestibular evoked myogenic potentials in patients with vestibular migraine. *Otol Neurotol.* 2015 Feb;36(2):295-302.
3. Pereira CB1, Nader SN, Kanashiro AK, de Carvalho WL. Vestibular Migraine: Vestibular Symptom May Identify Different Subgroups. *Otol Neurotol.* 2016 Mar;37(3):281-3.
4. Maldonado Fernández M1, Birdi JS, Irving GJ, Murdin L, Kivekäs I, Strupp M. Pharmacological agents for the prevention of vestibular migraine. *Cochrane Database Syst Rev.* 2015 Jun 21;(6):CD010600.

Summary of January 2017 Topic: BPPV

The first study looked at the clinical characteristics, nystagmographic findings, and treatment outcome of a group of patients with benign paroxysmal positional vertigo (BPPV) secondary to mild head trauma and compared them with a group of patients with idiopathic BPPV. It was found that patients with BPPV secondary to mild head trauma presented the following features, in which they differed from the patients with idiopathic BPPV: (1) lower mean age, with more

intense symptoms; (2) increased rate of horizontal and anterior semicircular canal involvement and frequent multiple canal and bilateral involvement; (3) greater incidence of canal paresis and presence of spontaneous nystagmus; (4) poorer treatment results, attributed mainly to coexisting canal paresis in many patients, and higher rate of recurrence. 1 Repeated canalith repositioning procedure (CRP) is commonly used to influence the residual symptoms and the rate of recurrence of benign paroxysmal positional vertigo (BPPV) in patients with post-CRP dizziness. In the second study it was found that while repeated CRP in patients with post-CRP dizziness increased the rate of recovery from dizziness it had no influence on BPPV recurrence. 2 The Sémont maneuver (SM) is also an effective choice in treating benign paroxysmal positional vertigo. The two primary determinants for success of the SM are the time between the movements and the extension of the movements beyond the horizontal. The time between the movements should be at least 45s. Angles of 20° or more below horizontal line (so-called Sémont+) should increase the success rate of SM. 4 Although there has been a wide consensus on the mechanism of nystagmus and clinical presentation of benign paroxysmal positional vertigo (BPPV), the neuroepithelial pathophysiology of BPPV still remains unclear. Findings suggest that the bilateral involvement of the macular neuroepithelium is important in understanding the pathophysiology of BPPV. This finding supports the conclusion that the pathophysiological process starts with neuroepithelial membrane degeneration and continues with otoconia separation. 3

1. Balatsouras DG et al. Benign Paroxysmal Positional Vertigo Secondary to Mild Head Trauma. *Ann Otol Rhinol Laryngol.* 2017 Jan;126(1):54-60.
2. Tirelli G et al. Repeated canalith repositioning procedure in BPPV: Effects on recurrence and dizziness prevention. *Am J Otolaryngol.* 2017 Jan - Feb;38(1):38-43.
3. Karatas et al. Evaluation of Cervical Vestibular-Evoked Myogenic Potential Findings in Benign Paroxysmal Positional Vertigo. *J Int Adv Otol.* 2016 Dec;12(3):316-320. doi: 10.5152/iao.2016.2170. Epub 2016 Aug 1.
4. Obrist D et al. Determinants for a Successful Sémont Maneuver: An In vitro Study with a Semicircular Canal Model. *Front Neurol.* 2016 Sep 16;7:150. eCollection 2016.

Summary of December 2016 Topic: Visual Issues in Concussion

Vestibulo-ocular dysfunction (VOD) has been shown to predict the development of postconcussion syndrome (PCS) and to lead to a prolonged recovery as shown by abstracts this past month. There was a statistically significant increase in the adjusted odds of developing postconcussion syndrome (PCS) among patients with acute sports-related concussion (SRC) who had VOD compared with those without VOD. Evidence of VOD was detected in a significant proportion of children and adolescents with acute SRC and PCS who were referred to a multidisciplinary pediatric concussion program. This clinical feature was a significant risk factor for the subsequent development of PCS in this pediatric acute SRC cohort (1). Another study sought to identify important potential risk factors for the development of VOD following pediatric SRC. Results show confirmatory evidence that VOD at initial consultation is associated with prolonged recovery and is an independent predictor for the development of PCS. Independent predictors of VOD at initial consultation included female sex, preinjury history of depression, posttraumatic amnesia, and presence of dizziness, blurred vision, or difficulty

focusing at the time of injury. Independent predictors of PCS among patients with acute SRC included the presence of VOD at initial consultation, preinjury history of depression, and posttraumatic amnesia at the time of injury (2)

Convergence Insufficiency (CI) was common (~42%) in athletes evaluated within 1 month after an Sports Related Concussion. Athletes with CI had worse neurocognitive impairment and higher symptom scores than did those with normal Near Point Convergence (NPC). Clinicians should consider routinely screening for NPC as part of a comprehensive concussion evaluation to help inform treatment recommendations, academic accommodations, and referrals for vision therapy (3). If such deficits are found vision therapy should be considered. Vision therapy had a successful or improved outcome in the vast majority of cases that completed treatment (4).

1. Ellis MJ, Cordingley D, Vis S, Reimer K, Leiter J, Russell K. Vestibulo-ocular dysfunction in pediatric sports-related concussion. *J Neurosurg Pediatr.* 2015 Sep;16(3):248-55
2. Ellis MJ et al. Clinical predictors of vestibulo-ocular dysfunction in pediatric sports-related concussion. *J Neurosurg Pediatr.* 2016 Sep 30:1-8.
3. Pearce KL et al. Near Point of Convergence After a Sport-Related Concussion: Measurement Reliability and Relationship to Neurocognitive Impairment and Symptoms. *Am J Sports Med.* 2015 Dec;43(12):3055-61
4. Gallaway M, Scheiman M, Mitchell GL. Vision Therapy for Post-Concussion Vision Disorders. *Optom Vis Sci.* 2016 Aug 8.

Summary of November 2016: Mal de Debarquement

MdDS is the prolonged rocking sensation, typically after a lengthy exposure to motion such as a long sea voyage and is more prevalent (80%) in middle aged women. The long duration of symptoms is what separated MdDS from land sickness. Studies are ongoing regarding treatment with visual habituation and transcranial stimulation. 1 Treatment options are limited due to poorly understood pathogenesis and limited studies. There is suggestion that MdDS can be caused by maladaptation of the vestibulo-ocular reflex (VOR) to roll of the head during rotation. 2 A proposed treatment of MdDS can be rolling the head from side-to-side while watching a rotating full-field visual stimulus. Seventeen of 24 subjects had a complete or substantial recovery on average for approximately 1 year. Six were initially better, but the symptoms recurred. The authors concluded the adaptive processes associated with roll-while-rotating are responsible for producing MdDS, and that the symptoms can be reduced or resolved by readapting the VOR. Caution must be taken with this study and the author's conclusion though given the lack of control group. 3 There is evidence that the dizziness, mood and anxiety symptoms of MdDS can be improved with 10Hz rTMS over left DLPFC beyond the treatment period in selected individuals. rTMS may be a useful adjunctive treatment for the management of chronic rocking dizziness in individuals with MdDS but treatment durations longer than 5 days or maintenance treatment are likely needed for sustained symptom suppression. 4

1. Hain TC, Cherchi M. Mal de débarquement syndrome. *Handb Clin Neurol.* 2016;137:391-5
2. Van Ombergen A, Van Rompaey V, Maes LK, Van de Heyning PH, Wuyts FL. Mal de débarquement syndrome: a systematic review. *J Neurol.* 2016 May;263(5):843-54. doi: 10.1007/s00415-015-7962-6. Epub 2015 Nov 11
3. Dai M, Cohen B, Smouha E, Cho C. Readaptation of the Vestibulo-Ocular Reflex Relieves the Mal De Debarquement Syndrome. *Front Neurol.* 2014 Jul 15;5:124.

4. Cha YH, Deblieck C, Wu AD. Double-Blind Sham-Controlled Crossover Trial of Repetitive Transcranial Magnetic Stimulation for Mal de Debarquement Syndrome. *Otol Neurotol*. 2016 Jul;37(6):805-12.

Summary of October 2016: Idiopathic Scoliosis and the Vestibular System

Despite its high incidence and severe morbidity, the etiology of idiopathic scoliosis is still unknown. This past month we looked at abstracts exploring the relationship between scoliosis and vestibular abnormalities. Eighteen manuscripts of level 3-4 clinical evidence support an association between adolescent idiopathic scoliosis (AIS) and dysfunction of the vestibular system. These studies include data from physiologic and morphologic studies in humans (1). Adolescents with idiopathic scoliosis exhibit morphological vestibular asymmetry, probably determined well before birth. Since the vestibular system influences the vestibulospinal pathway, the hypothalamus, and the cerebellum, this indicates that the vestibular system is a possible cause of later morphological, hormonal and neurosensory anomalies observed in AIS. Moreover, the simple lateral SCC MRI measurement demonstrated here could be used for early detection of AIS (2). VEMP amplitudes were higher in patients with scoliosis than in controls, whereas the amplitude asymmetry ratio was similar in both groups(3). A final study investigated whether feed-forward vestibulomotor control or sensory reweighting mechanisms were impaired in adolescent scoliosis patients. They found scoliosis onset could be related to abnormal sensory reweighting, leading to altered sensorimotor processes(4).

1. Hawasli AH, Hullar TE, Dorward IG. Idiopathic scoliosis and the vestibular system. *Eur Spine J*. 2015 Feb;24(2):227-33. doi: 10.1007/s00586-014-3701-4. Epub 2014 Nov 28.
2. Hitier M, Hamon M, Denise P, Lacoudre J, Thenint MA, Mallet JF, Moreau S, Quarck G. Lateral Semicircular Canal Asymmetry in Idiopathic Scoliosis: An Early Link between Biomechanical, Hormonal and Neurosensory Theories? *PLoS One*. 2015 Jul 17;10(7):e0131120. doi: 10.1371/journal.pone.0131120. eCollection 2015.
3. Pollak L, Shlamkovic N, Minewicz A, Mirovsky Y. Otolith dysfunction as a possible cause for the development of idiopathic scoliosis. *J Pediatr Orthop*. 2013 Apr-May;33(3):293-7. doi: 10.1097/BPO.0b013e31827c0643.
4. Pialasse JP, Descarreaux M, Mercier P, Blouin J, Simoneau M. The Vestibular-Evoked Postural Response of Adolescents with Idiopathic Scoliosis Is Altered. *PLoS One*. 2015 Nov 18;10(11):e0143124. doi: 10.1371/journal.pone.0143124. eCollection 2015.

Summary of September 2016 Topic: Video Head Impulse Test (vHIT)

Video head impulse test (vHIT) is a new testing which able to identify the overt and covert saccades and study the gain of vestibulo-ocular reflex (VOR) of each semicircular canal. vHIT is physiological quick test, which studied the VOR at high frequency of each semicircular canal by calculating the duration ratio between the head impulse and gaze deviation. vHIT is more sensitive than clinical head impulse test (cHIT), especially in patient with isolated covert saccades.(1) In peripheral vestibulopathy, there was weak concordance in the assessment of horizontal semicircular canal function among vHIT, caloric and rotatory chair tests . vHIT had sufficient statistical power to be recommended as the first-line test.(3) Use of vHIT has been initiated in children with cochlear implants, and it was found that lateral semicircular canal high frequency vestibulo-oculomotor reflex of bilaterally implanted children is

comparable to normal hearing children when using vHIT.(4) A complementary suppression head impulse paradigm (SHIMP) has also been investigated, in which the participant is fixating a head-fixed target to elicit anticompany saccades as a sign of vestibular function. SHIMP saccades usually appear later than HIMP saccades, therefore being more salient to the naked eye and facilitating vestibulo-ocular reflex gain measurements.(2)

1. Video head impulse test: a review of the literature. Alhabib SF1, Saliba I2. Video head impulse test: a review of the literature. *Eur Arch Otorhinolaryngol*. 2016 Jun 21.
2. A new saccadic indicator of peripheral vestibular function based on the video head impulse test. MacDougall HG, McGarvie LA, Halmagyi GM, Rogers SJ, Manzari L, Burgess AM, Curthoys IS, Weber KP. A new saccadic indicator of peripheral vestibular function based on the video head impulse test. *Neurology*. 2016 Jul 26;87(4):410-8.
3. Comparison of three diagnostic tests in detecting vestibular deficit in patients with peripheral vestibulopathy. Eza-Nuñez P, Fariñas-Alvarez C, Fernandez NP. Comparison of three diagnostic tests in detecting vestibular deficit in patients with peripheral vestibulopathy. *J Laryngol Otol*. 2016 Feb;130(2):145-50.
4. Preliminary results of video Head Impulse Testing (vHIT) in children with cochlear implants. Nassif N1, Balzanelli C2, Redaelli de Zinis LO3. Preliminary results of video Head Impulse Testing (vHIT) in children with cochlear implants. *Int J Pediatr Otorhinolaryngol*. 2016 Sep;88:30-3.

Summary of August 2016 Topic: Dizziness in the ER

Patients who present to the emergency department with symptoms of acute vertigo or dizziness are frequently misdiagnosed. Despite good published evidence regarding its use the Head Impulse Test (HIT) is under-utilized in the ER. Physicians need to be aware of the HIT and newer video HITs and make use of them in practice. In the first study, HIT was performed in only 31 of 642 (5%) patients with vertigo. In the acute constant group it was negative in 6 of 6 patients ultimately diagnosed with stroke and positive in 6 of 13 cases of peripheral vertigo (1). In using Video HIT, VOR gains differ between peripheral and central causes of Acute Vestibular Syndrome (AVS). PICA strokes were readily separated from neuritis using gain measures, but AICA strokes were at risk of being misclassified based on VOR gain alone (2).

Over the past decade, novel bedside approaches to diagnose patients with the acute vestibular syndrome have been developed and refined. A battery of three bedside tests of ocular motor physiology known as "HINTS" (head impulse, nystagmus, test of skew) has been shown to identify acute strokes more accurately than even magnetic resonance imaging with diffusion-weighted imaging (MRI-DWI) when applied in the early acute period by eye-movement specialists. Successful implementation would likely result in improved quality of emergency care for hundreds of thousands of peripheral vestibular patients and tens of thousands of strokepatients, as well as an estimated national health care savings of roughly \$1 billion per year (3).

In a final study emergency physicians' (EP) current perceptions, practice, and attitudes towards evaluating stroke as a cause of dizziness were evaluated. Symptom quality and typical vascular risk factors increased suspicion for stroke as a cause of dizziness. Most respondents reported obtaining head computed tomography (CT) (74%). Nearly all respondents used and felt confident using cranial nerve and limb strength testing. A substantial minority of EPs used the Epley maneuver (49%) and HINTS (head-thrust test, gaze-evoked nystagmus, and skew

deviation) testing (30%); however, few EPs reported confidence in these tests' bedside application (35% and 16%, respectively) (4).

1. McDowell T, Moore F. The Under-Utilization of the Head Impulse Test in the Emergency Department. *Can J Neurol Sci.* 2016 May;43(3):398-401. doi: 10.1017/cjn.2015.330. Epub 2016 Jan 20.
2. Mantokoudis G et al. VOR gain by head impulse video-oculography differentiates acute vestibular neuritis from stroke. *Otol Neurotol.* 2015 Mar;36(3):457-65.
3. Newman-Toker DE et al. Diagnosing Stroke in Acute Vertigo: The HINTS Family of Eye Movement Tests and the Future of the "Eye ECG". *Semin Neurol.* 2015 Oct;35(5):506-21. doi: 10.1055/s-0035-1564298. Epub 2015 Oct 6.
4. Kene MV et al. Emergency Physician Attitudes, Preferences, and Risk Tolerance for Stroke as a Potential Cause of Dizziness Symptoms. *West J Emerg Med.* 2015 Sep;16(5):768-76. doi: 10.5811/westjem.2015.7.26158. Epub 2015 Oct 20.

Summary of July 2016 Topic: Falls Prevention in Vestibular Deficits

Falls are an important consequence of bilateral vestibular hypofunction, as there is a significant difference in the incidence of falls reported by patients with unilateral (UVL) and bilateral (BVL) vestibular hypofunction. Patients should be counseled about the increased risk of falling and fall prevention programs should be addressed. Assistive devices should be considered, especially for persons aged >65 years with BVL (1). Signs of vestibular asymmetry among elderly with multisensory dizziness could predict falls, and can be addressed at bedside to assist in fall prevention and to screen for risk factor for falls among the elderly (2). As we know, vestibular dysfunction is significantly more prevalent in older adult fallers versus non-fallers, and a greater awareness of vestibular impairments may lead to more effective management and treatment for older adult fallers (3). It is important to consider other concomitant diagnoses as contributors to fall risk, such as diabetes. Vestibular dysfunction may represent a newly recognized diabetes-related complication, as there was a higher prevalence of vestibular dysfunction in patients with diabetes with longer duration of disease (4).

1. Herdman SJ, Blatt P, Schubert MC, Tusa RJ. Falls in patients with vestibular deficits. *Am J Otol.* 2000 Nov;21(6):847-51.
2. Hansson, E and Magnusson M. Vestibular asymmetry predicts falls among elderly patients with multisensory dizziness. *BMC Geriatrics.* 2013. 13:77. DOI: 10.1186/1471-2318-13-77.
3. Liston MB, Bamiou DE, Martin F, Hopper A, Koohi N, Luxon L, Pavlou M. Peripheral vestibular dysfunction is prevalent in older adults experiencing multiple non-syncopal falls versus age-matched non-fallers: a pilot study. *Age Ageing.* 2014 Jan;43(1):38-43.
4. Agrawal Y1, Carey JP, Della Santina CC, Schubert MC, Minor LB. Diabetes, vestibular dysfunction, and falls: analyses from the National Health and Nutrition Examination Survey. *Otol Neurotol.* 2010 Dec;31(9):1445-50.

Summary of June 2016 Topic: Cervicogenic Dizziness

Although advances have been made in recent years, cervicogenic dizziness, can still be difficult to diagnose and treat. Abstracts this month offered updates on recent advancements but also showed much more research needs to be done. Little progress has been made over the last year

concerning cervicogenic vertigo. As neck disturbances combined with dizziness are commonly encountered in the clinic, the lack of a diagnostic test that establishes that a neck disturbance causes vertigo remains the critical problem that must be solved (1). Manual therapy is effective for reducing cervicogenic dizziness in the short term. One study assessed the effects of sustained natural apophyseal glides (SNAGs) and passive joint mobilisations (PJM) on cervicogenic dizziness compared to a placebo at 12 months post-treatment. At 12 months both manual therapy groups had less dizziness frequency lower DHI scores and higher GPE compared to placebo. These results provide evidence that both forms of manual therapy have long-term beneficial effects in the treatment of chronic cervicogenic dizziness (2). Diagnosing cervicogenic dizziness is difficult but there are some differentiating signs and symptoms. One study showed differences in sensorimotor disturbances between the two groups, particularly in the control of head and eye movements and cervical proprioception. Patients with cervicogenic dizziness were more likely to have a sensation of drunkenness and lightheadedness, have pain induced during the physical examination of the upper cervical vertebrae, have an elevated joint position error of 4.5 degrees during the cervical relocation test, and exhibit more than 2 degrees per second nystagmus during the cervical rotation test (3). Dizziness after a sports-related concussion is very common and is associated with prolonged recovery. The purpose of the final abstract was to identify proper clinically administered tests and measures that are useful in differentiating between cervicogenic and other causes of dizziness after a sports-related concussion. At the conclusion of the study, ten clinical tests achieved the designation of strong clinical utility, six were determined to have weak clinical utility and seven achieved no consensus among the experts (4).

1. Hain TC. Cervicogenic causes of vertigo. *Curr Opin Neurol*. 2015 Feb;28(1):69-73.
2. Reid SA, Callister R, Snodgrass SJ, Katekar MG, Rivett DA. Manual therapy for cervicogenic dizziness: Long-term outcomes of a randomised trial. *Man Ther*. 2015 Feb;20(1):148-56
3. L'Heureux-Lebeau B1, Godbout A, Berbiche D, Saliba I. Evaluation of paraclinical tests in the diagnosis of cervicogenic dizziness. *Otol Neurotol*. 2014 Dec;35(10):1858-65
4. Reneker JC, Clay Moughiman M, Cook CE. The diagnostic utility of clinical tests for differentiating between cervicogenic and other causes of dizziness after a sports-related concussion: An international Delphi study. *J Sci Med Sport*. 2015 Jul;18(4):366-72.

Summary of May 2016 Topic: Acupuncture and Dizziness

There are several research articles providing evidence of acupuncture treating dizziness and vertigo but few studies of acupuncture as an emergent intervention. The first study provides clinical evidence on the efficacy and safety of acupuncture to treat dizziness and vertigo in the emergency department. Acupuncture demonstrates a significant immediate effect in reducing discomforts and VAS of both dizziness and vertigo.(1) Acupressure devices are also often commonly utilized, and demonstrated efficacy in improving neurovegetative symptoms in patients affected by acute spontaneous and provoked vertigo, without any interference with VOR.(2) Acupressure bands are commonly used with the claim to assist in motion sickness through stimulation of specific pressure points, however it was found that neither band nor placebo prevented the development of motion sickness, regardless of whether the bands were used correctly or incorrectly.(3)

1. Chiu CW, Lee TC, Hsu PC, Chen CY, Chang SC, Chiang JY, Lo LC. Efficacy and safety of acupuncture for dizziness and vertigo in emergency department: a pilot cohort study. *BMC Complement Altern Med*. 2015 Jun 9;15:173. doi: 10.1186/s12906-015-0704-6.
2. Alessandrini M1, Napolitano B, Micarelli A, de Padova A, Bruno E. P6 acupressure effectiveness on acute vertiginous patients: a double blind randomized study. *J Altern Complement Med*. 2012 Dec;18(12):1121-6. doi: 10.1089/acm.2011.0384.
3. Miller KE, Muth ER. Efficacy of acupressure and acustimulation bands for the prevention of motion sickness. *Aviat Space Environ Med*. 2004 Mar;75(3):227-34.

Summary of April 2016 Topic: Concussion

April's abstracts revisited a topic discussed in the past, but with updated literature. It has long been thought that strict rest is essential to recovery from concussion. The first study was done to determine if recommending strict rest improved concussion recovery and abstract outcome after discharge from the pediatric emergency department. They found recommending strict rest for adolescents immediately after concussion offered no added benefit over the usual care. There was no clinically significant difference in neurocognitive or balance outcomes. However, the intervention group reported more daily postconcussive symptoms and slower symptom resolution (1). Recovery from concussion is also influenced by other factors such as anxiety, post traumatic migraine (PTM), and history of prior concussion. A combination of low mood and high anxiety sensitivity (AS) may act as a psychological diathesis for the development of persisting PC symptoms. Early identification could provide a focus for early intervention to prevent the development of postconcussion syndrome after mTBI (2). Although previous research has demonstrated that patients with posttraumatic migraine after concussion report more symptoms and cognitive deficits after injury than do those without PTM, it is not known whether these effects persist beyond the first week of injury or whether PTM predicts recovery time. Results from the third abstract suggest that PTM is associated with cognitive impairments and protracted recovery and that headache alone is not a good predictor of recovery (3). Finally concussed athletes with a history of ≥ 3 concussions take longer to recover than athletes with 1 or no previous concussion(4).

1. Thomas DG, Apps JN, Hoffmann RG, McCrea M, Hammeke T. Benefits of strict rest after acute concussion: a randomized controlled trial. *Pediatrics*. 2015 Feb;135(2):213-23. doi: 10.1542/peds.2014-0966. Epub 2015 Jan 5.
2. Wood RL, O'Hagan G, Williams C, McCabe M, Chadwick N. Anxiety sensitivity and alexithymia as mediators of postconcussion syndrome following mild traumatic brain injury. *J Head Trauma Rehabil* 2014 Jan-Feb;29(1):E9-E17. doi: 10.1097/HTR.0b013e31827eabba.
3. Kontos AP, Elbin RJ, Lau B, Simensky S, Freund B, French J, Collins MW. Posttraumatic migraine as a predictor of recovery and cognitive impairment after sport-related concussion. *Am J Sports Med*. 2013 Jul;41(7):1497-504.
4. Covassin T, Moran R, Wilhelm K. Concussion symptoms and neurocognitive performance of high school and college athletes who incur multiple concussions. *Am J Sports Med*. 2013 Dec;41(12):2885-9.

Summary of March 2016 Topic: CSM Recap

Uncompensated vestibular hypofunction results in postural instability, visual blurring with head movement, and subjective complaints of dizziness and/or imbalance. Vestibular clinicians should offer vestibular rehabilitation to persons with unilateral and bilateral vestibular hypofunction

with impairments and functional limitations related to the vestibular deficit, however clinicians should not include voluntary saccadic or smooth-pursuit eye movements in isolation (ie, without head movement) as specific exercises for gaze stability. Clinicians may prescribe a minimum of 3 times per day for the performance of gaze stability exercises over the course of approximately 10 weeks.

In the aging population, a high prevalence of compensatory saccades was seen in healthy older adults with "normal" VOR gain. These saccades may represent sub-clinical changes in function of the VOR associated with healthy aging, using head impulse testing as a measure of identifying rotational vestibular weakness.

In patients with diabetes, a combination of both BPPV and Type 2 Diabetes may have increased postural instability, which places them at a higher risk for falls. Assessing these patients on foam with eyes closed and in tandem may be effective positions to identify these postural deficits. The Vestibular/Ocular Motor Screening (VOMS) Assessment was recently developed to serve as an additional tool for clinicians to evaluate the vestibular/ocular motor system after a concussion. Symptom provocation when implementing the VOMS most commonly did not occur in a group of adolescents with/without a history of concussion. The near point convergence reference values reported fall within five centimeters which has been recommended as a cutoff to determine a concussion. The near point convergence seems to demonstrate a potential fatigue effect with increasing distance noted across measures.

1. Hall CD, Herdman SJ, Whitney SL, Cass SP, Clendaniel RA, Fife TD, Furman JM, Getchius TS, Goebel JA, Shepard NT, Woodhouse SN. Vestibular Rehabilitation for Peripheral Vestibular Hypofunction: An Evidence-Based Clinical Practice Guideline: FROM THE AMERICAN PHYSICAL THERAPY ASSOCIATION NEUROLOGY SECTION. J Neurol Phys Ther. 2016 Feb 24.

2. TITLE: Identifying subclinical gaze stability deficits in older adults

PRESENTATION TYPE: Platform

AUTHORS (LAST NAME, FIRST NAME): Anson, Eric R.1; Bigelow, Robin T.1; Semenov, Yevgeniy 1; Schubert, Michael1; Agrawal, Yuri1

INSTITUTIONS (ALL): 1. Johns Hopkins Medicine, Baltimore, MD, United States

3. TITLE: Postural Stability is Significantly Impaired in Individuals with Type 2 Diabetes and Concurrent Benign Paroxysmal Positional Vertigo.

PRESENTATION TYPE: Platform

Concurrent Benign Paroxysmal Positional Vertigo.

AUTHORS (LAST NAME, FIRST NAME): D'Silva, Linda; Kluding, Patricia; Dai, Hongying; Whitney, Susan L.; Santos, Marcio J.

INSTITUTIONS (ALL): 1. Physical Therapy and Rehabilitation Science, University of Kansas

Medical Center, Kansas City, KS, United States, 2. Department of Biostatistics, Children's Mercy Hospital, Kansas City, MO, United States, 3. School of Health and Rehabilitation Sciences, University of Pittsburgh, Pittsburgh, PA, United States

4. TITLE: Baseline Performance of Adolescents on Vestibular/Ocular Motor Screening

PRESENTATION TYPE: Platform

AUTHORS (LAST NAME, FIRST NAME): Yorke, Amy M. ; Alsalaheen, Bara; Babcock, Mitch; Smith, Laura

INSTITUTIONS (ALL): 1. Physical Therapy and Rehabilitation Science, University of Kansas Physical Therapy, University of Michigan-Flint, Flint, MI, United States.

Summary of February 2016 Topic: Downbeating Nystagmus

According to some studies, the cause of downbeating nystagmus (DBN) maybe unknown in up to 44% of cases. Several studies in this past month's abstracts sought to determine the cause of DBN. In a study of 117 patients with DBN. In 62% or 72 patients, etiology was identified with the most frequent causes being cerebellar degeneration (n=23) and cerebellar ischaemia (n=10). In 38% or 45 patients, no cause was found(1). A second study looked at 50 patients. In 38 patients there was evidence of CNS disease (central group) but in 12 there was not (idiopathic group). Furthermore bilateral positive Dix-Hallpike manoeuvre was found in nine of 12 patients and selective provocation by the straight head-hanging manoeuvre in two (2). Downbeat nystagmus has associated symptoms of oscillopsia and gait disturbance. A study of 50 healthy controls and 50 patients with downbeating nystagmus showed gait velocity was reduced with a reduced stride length, increased base of support, and increased double support in those with DBN. Walking with eyes closed led to significant gait changes in both HS and DBN. These changes were more pronounced in DBN patients (3). Finally the effects of 4-aminopyridine (4-AP) were studied and were shown to reduce the slow phase velocity of DBN, improve near visual acuity and some locomotor parameters. Therefore it is though 4-AP is a useful medication for DBN syndrome and that older patients in particular benefit from the effects of 5 mg 4-AP on nystagmus and postural stability (4).

1. Wagner JN, et al. Downbeat nystagmus: aetiology and comorbidity in 117 patients. *J Neurol Neurosurg Psychiatry*. 2008 Jun;79(6):672-7. E pub 2007 Sep 14.
2. Bertholon P, Bronstein AM, Davies RA, Rudge P, Thilo KV. Positional down beating nystagmus in 50 patients: cerebellar disorders and possible anterior semicircular canalithiasis. *J Neurol Neurosurg Psychiatry*. 2002 Mar;72(3):366-72.
3. Schniepp R, Wuehr M, Huth S, Pradhan C, Schlick C, Brandt T, Jahn K. The gait disorder in downbeat nystagmus syndrome. *PLoS One*. 2014 Aug 20;9(8):e105463.
4. Claassen J, Spiegel R, Kalla R, Faldon M, Kennard C, Danchaivijitr C, Bardins S, Rettinger N, Schneider E, Brandt T, Jahn K, Teufel J, Strupp M, Bronstein A. A randomised double-blind, cross-over trial of 4-aminopyridine for downbeat nystagmus-effects on slowphase eye velocity, postural stability, locomotion and symptoms. *J Neurol Neurosurg Psychiatry*. 2013 Dec;84(12):1392-9.

Summary of January 2016 Topic: Visual Motion Sensitivity/Visual Vertigo

Although repositioning maneuvers are usually very effective in patients with BPPV, some patients still complain residual dizziness. The use of trimetazidine, betahistine, and ginkgo biloba extract in the treatment of residual dizziness after successful repositioning maneuvers there was found to be no statistically significant difference in the treatment of residual dizziness. 1 However, the use of Danhong injection (DHI), a traditional Chinese medicine, results demonstrate that DHI can significantly improve the residual dizziness after successful repositioning treatment in patients with BPPV. 2 Downbeat nystagmus (DBN) is the most frequent form of acquired persisting fixation nystagmus with different symptoms such as unsteadiness of gait, postural instability, and blurred vision with reduced visual acuity (VA) and oscillopsia. There is new evidence that the use of Chlorzoxazone (CHZ) may improve eye movements and visual fixation in patients with downbeat nystagmus. 3 In those that experience migraine plus vertigo, cinnarizine is safe and effective in reducing both headache and vertigo

among the patients who suffer from either vestibular migraine or migraine with brainstem aura associated with vertigo. 4

1. Acar B, Karasen RM, Buran Y. Efficacy of medical therapy in the prevention of residual dizziness after successful repositioning maneuvers for Benign Paroxysmal Positional Vertigo (BPPV). *B-ENT*. 2015;11(2):117-21.
2. Deng W, Yang C, Xiong M, Fu X, Lai H, Huang W. Danhong enhances recovery from residual dizziness after successful repositioning treatment in patients with benign paroxysmal positional vertigo. *Am J Otolaryngol*. 2014 Nov-Dec;35(6):753-7. doi: 10.1016/j.amjoto.2014.07.001. Epub 2014 Jul 9.
3. Feil K, Claaßen J, Bardins S, Teufel J, Krafczyk S, Schneider E, Schniepp R, Jahn K, Kalla R, Strupp M. Effect of chlorzoxazone in patients with downbeat nystagmus: a pilot trial. *Neurology*. 2013 Sep 24;81(13):1152-8. doi: 10.1212/WNL.0b013e3182a55f6d. Epub 2013 Aug 23.
4. Taghdiri F, Togha M, Razeghi Jahromi S, Refaeian F. Cinnarizine for the prophylaxis of migraine associated vertigo: a retrospective study. *Springerplus*. 2014 May 7;3:231. doi: 10.1186/2193-1801-3-231. eCollection 2014.

Summary of December 2015 Topic - Superior Canal Dehiscence

Superior Canal Dehiscence is a rare but debilitating vestibular disorder, affecting about .1% of the population, where bone does not cover the inner ear membranes. This past months abstracts looked at incidence of this disorder and outcomes after surgery. In the first study 649 temporal bones were assessed from 334 children (under 18 years of age). The prevalence rate of superior canal dehiscence (SCD) was 1.7% (3.3% of individuals). Age under 3 years was associated with a higher prevalence of thinning but not dehiscence (1). This is higher than in the general population.

Patients with SSCD also demonstrated higher BMIs, higher rates of obstructive sleep apnea (OSA), and were more likely to have accompanying tegmental defects. These results may support a possible causality between increased intracranial pressure and the formation of superior semicircular canal dehiscence (2). There is still much to be learned about the cause or formation of a SCD. The bony otic capsule was significantly thinner in the SCD patients than in the controls. However, even within unaffected individuals, SCs lacking overlying air cells were also thinner than those with overlying air cells. These results suggest that both embryological and acquired factors affect the occurrence of SCD (3).

Most often surgery is recommended to repair the missing layer of bone. Patients often have complaints of imbalance and dizziness for which they are referred to vestibular therapy. Balance measures were significantly impaired immediately but not 6 weeks after SCDS repair. All patients demonstrated deficient vestibulo-ocular reflexes for HITs in the plane of the superior canal following surgical repair. Unexpectedly, spontaneous or post-head-shaking nystagmus beat ipsilesionally in most patients, whereas contrabeating nystagmus was noted only in patients with complete canal paresis (ie, positive HITs in all canal planes). There were no significant deviations in subjective visual vertical following surgical repair. Finally The degree of audiometric air-bone gap normalized 6 weeks after surgery(4). Health utility value (HUV) is an outcome measure used to calculate quality adjusted life years (QALYs) and to determine cost-effectiveness of medical treatments. SCDS patients have significantly lower HUV compared with the general U.S. HUV demonstrated improvement after surgery. Nonoperated patients have ongoing impaired quality of life (5).

1. Saxby AJ et al. Radiological prevalence of superior and posterior semicircular canal dehiscence in children. *Int J Pediatr Otorhinolaryngol*. 2015 Mar;79(3):411-8. doi: 10.1016/j.ijporl.2015.01.001. Epub 2015 Jan 14.
2. Schutt CA et al. The correlation between obesity, obstructive sleep apnea, and superior semicircular canal dehiscence: a new explanation for an increasingly common problem. *Otol Neurotol*. 2015 Mar;36(3):551-4
3. Park JH, Kang SI, Choi HS, Lee SY, Kim JS, Koo JW. Thickness of the bony otic capsule: etiopathogenetic perspectives on superior canal dehiscence syndrome. *Audiol Neurootol*. 2015;20(4):243-50. doi: 10.1159/000371810. Epub 2015 May 12.
4. Janky KL. Balance dysfunction and recovery after surgery for superior canal dehiscence syndrome. *Arch Otolaryngol Head Neck Surg*. 2012 Aug;138(8):723-30
5. Remenschneider AK et al. Health Utility Improves After Surgery for Superior Canal Dehiscence Syndrome. *Otol Neurotol*. 2015 Oct 12.

Summary of November 2015 Topic: Visual Motion Sensitivity/Visual Vertigo

Certain patients with balance disorders report a 'visual vertigo' in which their symptoms are provoked or aggravated by specific visual contexts. Visual vertigo emerges in vestibular patients if they have increased visual dependence and difficulty in resolving conflict between visual and vestibulo-proprioceptive inputs. 1 Visual vertigo is a heterogeneous syndrome with peripheral or central etiologies and may occur if patients with balance disorders show high visual field dependence. 2 Posturography testing often shows that patients show abnormally large body sway induced by full field visual motion stimulation. 2 It is argued that treating these patients with visual motion desensitization, e.g. repeated optokinetic stimulation, should be beneficial. 1 Visual/vestibular conflicts may induce motion sickness and are due to inconsistent visual and sensory inputs, and visual blur can exacerbate motion sickness symptoms perhaps because of differential influences of visual pathways. 3

1. Guerraz, L.Yardley, P.Bertholon, L.Pollak, P.Rudge, M. A.Gresty, A. M.Bronstein, Visual vertigo: symptom assessment, spatial orientation and postural control. *Brain*. 2001 Aug;124(Pt 8):1646-56.
2. Bronstein, AM. Visual vertigo syndrome: clinical and posturography findings. *J Neurol Neurosurg Psychiatry* 1995;59:472-476 doi:10.1136/jnnp.59.5.472.
3. Bonato F, Bubka A, Thornton W. Visual blur and motion sickness in an optokinetic drum. *Aerosp Med Hum Perform*. 2015 May;86(5):440-4. doi: 10.3357/AMHP.4105.2015.

Summary of October 2015 Topic: Pediatric Vestibular Disorders

Vestibular disorders in the pediatric population can be difficult to diagnose. This past month abstracts help with identifying signs and symptoms in this population. VNG is often useful to look for vestibular abnormalities, but given that normative pediatric data on this test is different from adult norms, caution must be exercised when interpreting this test, particularly if central findings are reported (1). A test that is useful in this population is subjective visual vertical (SVV). Mean SVV deviation was significantly higher in the peripheral vestibular loss group compared to BPPV, central vertigo, and nonvestibular dizziness (2). In the second study patients

were also assessed for VOD, which was defined as more than one subjective vestibular and oculomotor complaint (dizziness, blurred vision, and so on) and more than one objective physical examination finding (abnormal smooth pursuits, saccades, vestibulo-ocular reflex, and so on). Evidence of VOD was detected in a significant proportion of those with acute sports related concussion and with post concussive syndrome. Furthermore if VOD was present acutely there was a significant risk factor for the subsequent development of post concussive syndrome (3). Vestibular migraine (VM) is the most common cause of episodic vertigo in children. Patients with definite, probable, and suspected VM do not differ in the frequency of ocular motor, vestibular, or postural abnormalities. While it is essential to establish diagnostic criteria in clinical studies, in clinical practice however, the most reasonable diagnosis should be made in order to begin treatment (4).

1. Doetl SM, Plyler PN, McCaslin DL, Schay NL. Pediatric Oculomotor Findings during Monocular Videonystagmography: A Developmental Study. *J Am Acad Audiol.* 2015 Sep;26(8):703-15.
2. Brodsky JR, Cusick BA, Kenna MA, Zhou G. Subjective visual vertical testing in children and adolescents. *Laryngoscope.* 2015 May 25.
3. Ellis MJ, Cordingley D, Vis S, Reimer K, Leiter J, Russell K. Vestibulo-ocular dysfunction in pediatric sports-related concussion. *J Neurosurg Pediatr.* 2015 Sep;16(3):248-55.
4. Langhagen T, Lehrer N, Borggraefe I, Heinen F, Jahn K. Vestibular migraine in children and adolescents: clinical findings and laboratory tests. *Front Neurol.* 2015 Jan 26;5:292

Summary of September 2015 Topic: Vestibular disorders and aging

Dizziness and unsteady gait are common in the elderly but are too often dismissed as supposedly nonspecific, inevitable accompaniments of normal aging. Dizziness interferes with the everyday activities of 30% of persons over age 70 and is so severe that it constitutes a reason for consulting a physician.¹ If a specific cause can be identified, dizziness and gait unsteadiness in old age can often be successfully treated. The presence of dizziness in the elderly is a strong predictor of falls, which is the leading cause of accidental death in people older than 65 years. The elderly tend to report less rotatory vertigo and more non-specific dizziness and instability than younger patients, making diagnosis more complex.² Dizziness in the aged is an incompletely understood process involving vestibular, oculomotor, visual acuity, proprioception, motor, organ system and metabolic weaknesses and disorders, and requires expertise in the care of these individuals.³ The importance of diagnosing, treating, and potentially screening for vestibular deficits to reduce the burden of fall-related injuries and deaths in the United States is paramount in the elderly population.⁴ In addition to general balance and unsteadiness, the prevalence of BPPV in 75 year olds is common. Elderly individuals with BPPV also displayed significantly impaired balance in static and dynamic balance tests compared with persons without BPPV.⁵

1. Jahn K, Kressig RW, Bridenbaugh SA, Brandt T, Schniepp R. Dizziness and Unstable Gait in Old Age. *Dtsch Arztebl Int.* 2015 Jun 5;112(23):387-93.
2. Fernández L, Breinbauer HA, Delano PH. Vertigo and Dizziness in the Elderly. *Front Neurol.* 2015 Jun 26;6:144. doi: 10.3389/fneur.2015.00144. eCollection 2015.

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Summary of August 2015 Topic: Meniere's Disease

This past month literature on Menieres Disease was reviewed, and particularly information regarding diagnosis. One study sought to compare those with familial Menieres Disease to sporadic onset. It was found that familial patients were affected 5.6 years earlier than sporadic patients, and they suffered from significantly longer spells of vertigo. The prevalence of rheumatoid arthritis and other autoimmune diseases was higher among the familial patients, who also had more migraine and hearing impairment in their families. (2) Using vestibular function testing can be essential in diagnosing Meneries. Use of calorics and hearing tests is fairly standard practice, but one article also included the use of video head impulse testing. Those results showed all 3 patients demonstrated moderate, flat, sensorineural hearing losses; significant caloric asymmetries; and bilaterally normal video head impulse testing. This pattern of findings suggests differential preservation of high-frequency function (video head impulse testing) with impairment of low-frequency function (unilaterally abnormal caloric test results) in these patients. (4) When using VEMP testing it is recommended to use of the shift upward to 1000 Hz with a caloric asymmetry as the clinical protocol to maximize the use of the cVEMP threshold-response curve for assistance in the identification of MD, in the context of a $\geq 25\%$ caloric asymmetry. Finally treatment was briefly explored and in particular treatment of second sided Menieres Disease. A possible treatment included simultaneous surgical labyrinthectomy and cochlear implantation.(1)

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Summary of July 2015 Topic: Vestibular schwannoma

Many vestibular schwannoma (VS) patients complain of balance dysfunction; however, validated standardized assessments are lacking. Because imbalance significantly affects quality of life in this group and vestibular rehabilitation may improve outcomes, determining the severity of balance dysfunction is important to understand long-term rehabilitation needs. Older VS patients are at significant risk of falls. Balance symptoms are more severe than in healthy controls but less than other neuro-otological patients. Balance symptom severity, anxiety symptoms, and ambulant posture were significant contributors to disability and should be the focus of vestibular rehabilitation strategies. (1) Significant posttreatment features strongly associated with poor long-term DHI scores included frequency and severity of ongoing headache. Treatment modality did not influence long-term dizziness handicap. Treatment modality does not appear to influence long-term DHI score. There was a strong association found between posttreatment headache and poor dizziness handicap. (2). Long-term (>5 years) quality-of-life outcomes measured by the PANQOL in VS patients show no significant differences between stereotactic radiation, observation, and microsurgical intervention. (3) When considering surgical intervention and post surgical vestibular rehab, gaze stability seems to improve from contralesional VOR gain restoration and reduced latency of compensatory saccades. (4) Long-term follow-up after VS surgery has shown that 22% of the patients display a particular abnormality in the VOR because refixation saccades occur in a random fashion after elicitation of the reflex in the HIT test. These patients report the higher level of vestibular disability and handicap. (5)

1. Saman Y, Bamiou DE, Murdin L, Tsioulos K, Davies R, Dutia MB, Obholzer R, Gleeson M. Balance, falls risk, and related disability in untreated vestibular schwannoma patients. *J Neurol Surg B Skull Base*. 2014 Oct;75(5):332-8. doi: 10.1055/s-0034-1372469. Epub 2014 May 2.
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Summary of June 2015 Topic: Vestibular Schwannoma

Many vestibular schwannoma (VS) patients complain of balance dysfunction; however, validated standardized assessments are lacking. Because imbalance significantly affects quality of life in this group and vestibular rehabilitation may improve outcomes, determining the severity of balance dysfunction is important to understand long-term rehabilitation needs. Older VS patients are at significant risk of falls. Balance symptoms are more severe than in healthy controls but less than other neuro-otological patients. Balance symptom severity, anxiety

symptoms, and ambulant posture were significant contributors to disability and should be the focus of vestibular rehabilitation strategies. (1) Significant posttreatment features strongly associated with poor long-term DHI scores included frequency and severity of ongoing headache. Treatment modality did not influence long-term dizziness handicap. Treatment modality does not appear to influence long-term DHI score. There was a strong association found between posttreatment headache and poor dizziness handicap. (2). Long-term (>5 years) quality-of-life outcomes measured by the PANQOL in VS patients show no significant differences between stereotactic radiation, observation, and microsurgical intervention. (3) When considering surgical intervention and post surgical vestibular rehab, gaze stability seems to improve from contralesional VOR gain restoration and reduced latency of compensatory saccades. (4) Long-term follow-up after VS surgery has shown that 22% of the patients display a particular abnormality in the VOR because refixation saccades occur in a random fashion after elicitation of the reflex in the HIT test. These patients report the higher level of vestibular disability and handicap. (5)

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3. Robinett ZN, Walz PC, Miles-Markley B, Moberly AC, Welling DB. Comparison of Long-term Quality-of-Life Outcomes in Vestibular Schwannoma Patients. *Otolaryngol Head Neck Surg*. 2014 Mar 4;150(6):1024-1032.
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Summary of May 2015 Topic: Rare Diagnoses with Vestibular Implications

Typical Cogan's Syndrome is a rare disease of young adults consisting of flares of interstitial keratitis and sudden onset of Meniere-like attacks (nausea, vomiting, tinnitus, vertigo, and hearing loss). Vestibular dysfunction often preceded hearing loss. The importance of being aware of auditory-vestibular dysfunction occurring in patients with ocular inflammation and the role of early immunotherapy in preventing deafness has to be emphasized. (1) Fear of movement may contribute to functional limitations and loss of well-being among individuals with fibromyalgia (FM). Kinesiophobia, balance complaints, vertigo, PTSD, and joint hypermobility were common in this population of people with FM. Sources of movement-related fear correlated to overall wellness and perceived function as measured by the FIQR and FIQR-pf. (2) Patients with RA may present with the characteristics of hearing loss, vestibular responses and the incidence of vestibular disturbances. There was no association between VNG abnormalities in patients with RA and age, sex, duration of disease, accompanying vertigo complaint. There is an association of

RA and audiovestibular system dysfunction regardless of clinical and demographic situation of patients. The hearing and vestibular disturbances in RA are more prevalent than previously recognized. Also hearing losses in high frequencies in RA patients may be considered as an indicator of cochlear involvement in this disease. (3) It is important for ENTs and therapists to recognize Chiari malformations as part of the differential diagnosis of balance disorders because patients may initially be seen with symptoms referable to the vestibular system, including ataxia, nystagmus, or vertigo. Patients fell into two different vestibular test result profiles. First, patients with advanced symptoms demonstrated oculomotor dysfunction, central vestibular nystagmus, abnormal vestibular visual interaction, and abnormal tilt suppression of postrotatory nystagmus. On the other hand, a number of patients were identified with incidentally noted Chiari malformation on MRI who had a vestibular test profile consistent with peripheral vestibulopathy without signs and symptoms of central nervous system dysfunction. (4)

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Summary of April 2015 Topic: Pharmacology & Vestibular Rehabilitation

Pharmacology has its place in vestibular disorders and rehabilitation. Our abstracts showed that vestibular suppressants can help with symptoms after a CRP (1). This may be beneficial for very symptomatic patients who aren't able to complete a CRP due to symptoms or have strong symptoms afterwards. If you have a patient with an acute vestibular neuritis (VN), corticosteroid therapy may lead to earlier resolution. Long term treatment with vestibular exercises seems equivalently effective as treating them with corticosteroid therapy though (2). Another study looked at promethazine versus lorazepam in vertigo-related nausea. Patients having trouble with nausea may benefit from promethazine to help with symptoms (3). Finally Gentamicin is an effective treatment in Meniere's Disease, which is a condition where therapy is not always indicated (4).

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trial of efficacy and safety. *J Vestib Res.* 2014;24(1):39-47. doi: 10.3233/VES-130506. Accessed December 23, 2014.

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