VESTIBULAR REHABILITATION SIG

APTA & Academy of Neurologic Physical Therapy

IN THIS ISSUE:

Message from the Chair

Rachel Wellons, PT, DPT, NCS
Vestibular Rehab SIG Chair

As I wrap up on my first year as the Chair of the Vestibular SIG I'd like to recap some of the major events and initiatives marking this past year. I'm thankful for the mentorship from previous chair **Anne Galgon**.

The Vestibular SIG has seen growth in membership and offerings in several areas over this past year. I've been extremely proud of the monthly Facebook Live educational events on the 1st Wednesday of the month at 8:00 EST (Thanks to **Emma Van Sickle**, **Rebecca Russell**, and **Lynn Johnson**). We have posted a Pathway to Advanced Practice in Vestibular Rehabilitation (Thanks to **Carrie Hoppes**) on our website. The Vestibular SIG created and disseminated a research collaboration survey (Thanks to **Carrie Hoppes**), which we hope to make an ongoing feature on our website.

Combined Sections Meeting (CSM) 2021 was quite different than usual. Due to COVID 19 this conference moved to a virtual format. I missed the interactions and collegiality of CSM immensely. However, a silver lining to the virtual format was the accessibility of the high quality education associated with CSM to **ALL** members. The financial cost, of both the conference itself and saved travel costs, was significantly less than usual.

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Message from the Chair cont.

Synchronous and asynchronous learning options were offered giving participants flexibility. I believe CSM is best when delivered in person, but perhaps moving forward there will be a virtual option to accompany the live conference. We could take the best of both worlds – the flexibility and accessibility of a virtual conference **AND** the interaction and collegiality of a live conference – to deliver the highest quality education and interaction opportunities to the most members.

As usual the Vestibular content at CSM was strong, with 11 vestibular programming options, 4 platform presentations, and 16 posters. I've noted the commonalities between Vestibular rehab and chronic pain and pain science frameworks for a while, so I was happy to see this programming featured ("Chronic Pain and Chronic Dizziness: Parallels in Pathophysiology and Intervention" and "Fear Avoidance Behaviors in Concussion Management: Using the Pain Science Framework to Improve Outcomes"). We continue to build the basic science foundations and to have researchers translate that programming to clinical practice (Perceiving is Believing: Understanding Verticality Perception, Navigation, and Motion Perception in Health and Impaired Populations).

It was my honor and pleasure to present several awards at CSM this year. First I'd like to recognize **Dr. Jeffery Hebert** for winning the Newsletter Article of the Year for the article entitled "The Evolving Landscape of Vestibular-related Rehabilitation for Patients with Multiple Sclerosis: From Conceptualization to Current Best Evidence ". **Lisa Heuisel-Gillig** won the Vestibular SIG 2021 Service Award, a small thank you in comparison to all the work she has completed on Vestibular Face Sheets, Vestibular SIG Nominating Committee, Peripheral Vestibular Hypofunction appraisal team, and faculty of the Emory/Duke Vestibular Rehabilitation Competency Conference. Lastly I'd like to thank and recognize the service of outgoing officers **Ryan Schrock** (Nominating Committee) and **Chuck Plishka** (Secretary).

Looking forward, the challenge that presents itself is how we as a profession and vestibular therapists will move forward past COVID. By now we are all sick of hearing the phrase the "New Normal". I'd like to introduce another phrase: The "Improved Normal". There is no denying that telehealth is extremely valuable to vestibular therapists and COVID-19 has moved this area of practice forward by leaps and bounds. We would be fools to go back to 100% in-person care. We would be remiss not to mention the disproportionate burden that the COVID-19 pandemic and illness has placed upon underserved populations. This is a call-to-duty for all Vestibular Therapists to meet the needs of underserved populations by improving the equity to which our services are provided. The Vestibular SIG will work closely with the Academy of Neurologic Physical Therapy to improve Diversity, Equity, and Inclusion initiatives among our membership.

Acknowledging Vestibular Dysfunction in the Wake of a Multitude of Cardiovascular and Pulmonary Presentations

Authors: Daniel Ludwig PT, DPT, NCS; Kerry Lammers PT, DPT, CCS; Heather Littier PT, DPT, MS

Hospitalized patients routinely complain of dizziness. Those with a history or primary diagnosis of cardiovascular or pulmonary disease are at increased risk for this non-specific symptom, which is often multi-factorial in etiology. Uncovering and treating the contributing factors to dizziness can be difficult even for experienced clinicians, therefore vestibular dysfunction is often underdiagnosed and under treated in dizzy hospitalized patients. Patients with cardiovascular and pulmonary diagnoses are at increased risk for vestibular dysfunction due to the pathophysiology and pharmacologic treatment of their conditions. Physical therapists in acute care have a unique opportunity and skillset to fill this gap. Vestibular differential diagnosis is emerging as an important clinical skill that physical therapists should add to their toolbox and vestibular testing and intervention are recognized as an important skill in the Core Competencies for Entry Level Practice in Acute Care Physical Therapy. Physical therapists can contribute to diagnosis and treatment of vestibular disorders through thorough chart review, subjective history, patient examination, and skilled intervention. Improving physical therapists' understanding and confidence in vestibular differential diagnosis has the potential to improve patient symptoms, function, and quality of life as well as contributing to cost savings for health systems, and is therefore an integral component of physical therapy practice.

Vestibular differential diagnosis in patients with cardiovascular and pulmonary presentations can be difficult and typically requires the clinician to rule in or rule out potential causes of dizziness, much like peeling the layers of an onion. The use of a systematic approach can improve clinician accuracy and confidence. We recommend the following comprehensive process to help clinicians accurately reason through differential diagnosis: Start with a thorough chart review, implement strong subjective questioning regarding patient symptomology, and utilize standardized oculomotor and vestibular examination techniques in conjunction with suggestive and functional testing. Additionally, clinicians should seek to achieve a comprehensive understanding of common cardiovascular, pulmonary, and vestibular conditions; specifically, how they overlap in presentation as well as unique identifying features that will assist clinicians with putting the entire clinical picture together to identify and treat the appropriate diagnosis.

A thorough chart review should mimic a typical review for all hospitalized patients with particular attention to history of present illness and medical course while hospitalized. In addition to the "typical" chart review, a review of patients at risk for or with suspected vestibular dysfunction should include identification of key vestibular words, review of medications and pharmacology specifically related to vestibular symptoms and dysfunction, and identification of vestibular risk factors. Vestibular key words may include: dizziness, vertigo, imbalance, falls, and nausea/vomiting. These can be contrasted with cardiopulmonary specific words such as: syncope or pre-syncope, orthostasis, and diuresis. Identifying consistent use of terminology in the chart can help clinicians begin to build a clinical picture before stepping into the patient's room.

Acknowledging Vestibular Dysfunction in the Wake of a Multitude of Cardiovascular and Pulmonary Presentations cont.

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Medication review should target medications that can cause symptoms of dizziness or produce unintended vestibular dysfunction through ototoxicity. Some examples include diuretics, aminoglycosides, insulin, and other cardiac medications. A full review of medications and pharmacology is beyond the scope of this review, but it should be noted that some medications such as Lasix (a common diuretic) can affect both the cardiovascular and pulmonary systems (removing fluid can result in orthostasis) as well as the vestibular system (high dosages can be ototoxic). Lastly, clinicians should identify other vestibular risk factors such as increased age, hypertension, diabetes, polypharmacy, osteoporosis, and prolonged immobility that may further increase a patient's risk of vestibular dysfunction.

Subjective questioning regarding the patient's symptomology may be the most important tool in the therapist's toolbox, especially in an acute care setting where the number of potential causative factors is high and time is limited. Clinicians should ask probing questions aimed at defining the patient's dizziness symptoms. These should include questions regarding tempo/time (acute onset, chronic onset, spells) and type of symptoms (vertigo, imbalance, oscillopsia, lightheadedness, fainting). These questions are meant to discriminate between vestibular and non-vestibular causes and to differentiate potential vestibular diagnoses. Additionally, the clinician should develop an understanding of the circumstances under which patients experience their symptoms (head motion induced, position changes, spontaneous onset). The results of subjective questioning in conjunction with prior chart review should result in a diagnostic hypothesis which will guide the clinician in determining the tests and measures that are needed to support or refute their hypothesis. It will also help the clinician to prioritize which tests and measures are most essential to perform in a setting with numerous time constraints.

The final piece of the differential diagnosis puzzle is performance and interpretation of relevant oculomotor, vestibular, suggestive, and functional testing. This examination may also include close monitoring of vital signs with positional changes to assess for orthostatic hypotension as well as items more consistent with a "typical" physical therapy examination. Oculomotor examination, which is a combination of ocular range of motion, saccades, and smooth pursuits testing, should be performed to provide baseline data about eye movements. These data are necessary for ruling out red flags and for observation during more provocative testing (since the eyes are the window to the vestibular system). Vestibular special tests include: assessment of gaze evoked and spontaneous nystagmus, head impulse/head thrust testing, VOR cancellation, and positional testing for BPPV. Suggestive testing includes use of the modified clinical test of sensory interaction on balance (mCTSIB) for determining the vestibular systems contribution to balance deficit and a modified or bedside version of dynamic visual acuity for identifying functional gaze stability impairments.

Acknowledging Vestibular Dysfunction in the Wake of a Multitude of Cardiovascular and Pulmonary Presentations cont.

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Functional testing may include standardized measures such as the Functional Gait Assessment or the Dynamic Gait Index, however it may be necessary to select an alternative functional measure for hospitalized patients due to co-morbidities or environmental restrictions. The VestibularEDGE task force has provided recommendations for outcome measures based on acuity and these recommendations can be used to assist in selecting an appropriate standardized measure.

As noted previously, physical therapists who are looking to improve their dizziness differential diagnosis skillset can use the above framework to assist with organizing their processes and thoughts. It is also necessary to develop a comprehensive understanding of both common vestibular and cardiopulmonary conditions and presentations due to the potential for overlapping symptoms. An important aspect of developing this comprehensive understanding is identification of red flag symptoms (diplopia, dysarthria, dysphagia, dysmetria, and other focal neurologic deficits such as unilateral weakness, sensory change or cranial nerve palsies). Red flag symptoms require immediate referral to a provider. Consideration of background information, evidence gathered from chart review, subjective questioning, and objective examination aids the clinician to formulate and test appropriate hypotheses by narrowing potential causes or diagnoses. When clinicians lack a comprehensive understanding of the diagnoses, comorbidities, and red flags, diagnosis becomes more difficult, as potentially distinguishing features may not be recognized or prioritized during the differential diagnosis process.

In closing, dizziness is a pervasive and sometimes debilitating symptom experienced by many hospitalized patients. Vestibular dysfunction is a potential cause of reported dizziness and can be successfully managed in the acute hospital setting by physical therapists with vestibular differential diagnosis training. Physical therapy management of vestibular dysfunction in this population has the potential to decrease length of stay, improve functional and subjective outcomes, and decrease health system costs. Acute care physical therapists should strongly consider investing in continuing education related to these topics to improve their quality of care.

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Differential Diagnosis of Post-Acute Sequelae of COVID-19 (PASC): Unraveling Elements of Dysautonomia, ME/CFS, Altered Central Processing and Maladapted Balance

Author: Nicole Miranda, PT, DPT

Introduction

While vestibular rehabilitation has become widely available and many physical therapists have developed clinical interest in this topic, the differential diagnosis of central dizziness remains challenging for many clinicians. Dysregulation of the autonomic nervous system has been recognized as a complication in many with post-acute sequelae of COVID-19 (PASC).[1] Healthcare providers are frequently challenged to recognize and differentiate signs of orthostatic intolerance, dysautonomia, myalgic encephalomyelitis/chronic fatigue syndrome (ME/CFS), central and peripheral vestibular dysfunction, migraine/headache and other chronic issues with limited objective diagnostic testing.[2,3] This case study illustrates a progressive differential diagnosis of impairments contributing to orthostatic intolerance, fatigue, headaches, dizziness, pain, nausea, brain fog, and activity intolerance following COVID-19 and the role of physical therapy as a primary care provider engaged in multidisciplinary care.

Case Presentation

History of Present Illness – A 48 yo female healthcare provider became infected with the SARS-CoV-2 virus in June of 2020 and was acutely ill for 2 weeks. Three weeks from onset, she attempted a slow return to work but noticed a recurrence of viral-like symptoms. Three weeks later she attempted to work 1.5 – 2.5 hours per day, but after working for 2 weeks she again regressed. She experienced severe dyspnea and chest pain when sitting upright after standing 30-45 minutes to cook a meal. In late July 2020 she was diagnosed by a cardiologist with inappropriate sinus tachycardia and was started on 12.5mg of Metoprolol. She was advised to drink fluids, increase sodium, wear compression garments, and to begin an exercise program. In September 2020 she enrolled in an online COVID Bootcamp through the Pulmonary Wellness Foundation.[4] She had moderate success in the program but attempted to wean off of the beta blocker two times unsuccessfully. In December she had an ER visit that resulted in doubling the beta blocker dose, and in February the taper was aborted on day 4 due to severe symptom exacerbation. She is 69.5" tall and has lost 25 pounds with a current BMI of 17.7 (underweight) and came to physical therapy via direct access in February 2021.

Past Medical History - Migraines as a teen but not diagnosed until her 20s (notes significant migraine reduction on beta blockers); sinorhinoplasty 1991; right shoulder labral injuries in her early 20s; endometrial ablation 2018

Prior Level of Function - Independent in all ADLs and managed her own private practice as a full-time healthcare provider. Two years prior to the onset of COVID-19 she was active in ballroom dancing and yoga. Immediately prior to her illness she routinely walked 45-60 minutes/day.

Diagnostic Testing - Ruled out pericarditis and myocarditis

- Cardiology: ECHO x 2 – normal (8/2020); repeated after acute flare (9/2020)
  EKG Holter - Inappropriate Sinus Tachycardia; ECHO normal (9/2020)
  Cardiac MRI; repeat EKG Holter (12/2020)
  Exercise Stress Test - exercise intolerance at 7 min. (12/2020)

Differential Diagnosis of Post-Acute Sequelae of COVID-19 (PASC): Unraveling Elements of Dysautonomia, ME/CFS, Altered Central Processing and Maladapted Balance cont.

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- Sleep Study: Chest CT – normal; small nodes of inflammation in upper lobes (5/2021)
  Mild central sleep apnea, supplemental O2 ordered (February 2021)

Medications - Patient has started many over the counter (OTC) medications and supplements based on abundant online resources regarding mast cell disease, histamine intolerance, and management of chronic fatigue, 'brain fog' and dysautonomia.[5,6]

Rx: Metoprolol 25 mg BID; sumatriptan prn prior to illness
OTC: aspirin, fexofenadine, famotidine
Supplements: Vit D, C, Niacin, NADH, coQ10, quercetin, multivitamin, fish oil, NAC, curcumin, d-ribose

Physical Therapy Initial Examination, Patient Education and Progressive Intervention Plan

Subjective - Pt. spent most of her day reclined in bed due to orthostatic intolerance, fatigue, nausea and occasional lightheadedness. She showered about once every 2 weeks, had groceries delivered and ate meals in bed. She had food and drink accessible from her bed in her room at all times and had her TV moved into her bedroom. She reported feeling 'burpy' after meals with early satiety and had intermittent bouts of diarrhea. She was able to stand and walk for toileting and to get supplies as needed and performed a daily 10-minute NASA standing wall lean per MD recommendations.[7] She discovered the Levine protocol and the Dysautonomia International exercise guidelines but requested guidance on how to start and what equipment to consider purchasing.[8,9]

Pain - She reported chest pain and shortness of breath with sitting, post-exertional malaise, fatigue, and nausea after sitting in upright postures. She also reported burning back pain near T4 on the left side coupled with left chest pain upon sitting upright. See Figure 1. If she avoided sitting upright the chest and back pain were controlled. She had an occasional 'Charlie horse' pain in the left calf and some mild tingling in the left leg. Sleep was restorative; if she exerted herself too much the next day she experienced fatigue, headache, and anorexia.

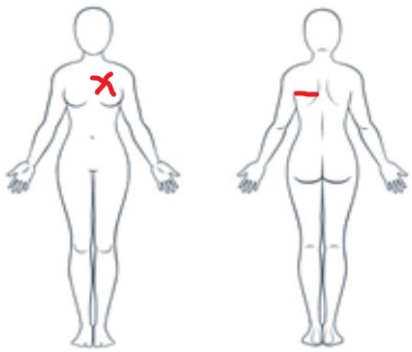

Figure 1: Patient Diagram of Pain Locations

Differential Diagnosis of Post-Acute Sequelae of COVID-19 (PASC): Unraveling Elements of Dysautonomia, ME/CFS, Altered Central Processing and Maladapted Balance cont.

Author: Nicole Miranda, PT, DPT

Vital Signs: BP reclined in bed during exam 106/63; HR resting 54; RR 22; Sa02 98%; temp 97.5. Pt. used a Fitbit® to track her vitals and was able to take her BP with a digital device at home. She does not have an inappropriate orthostatic BP response. See Figure 2.

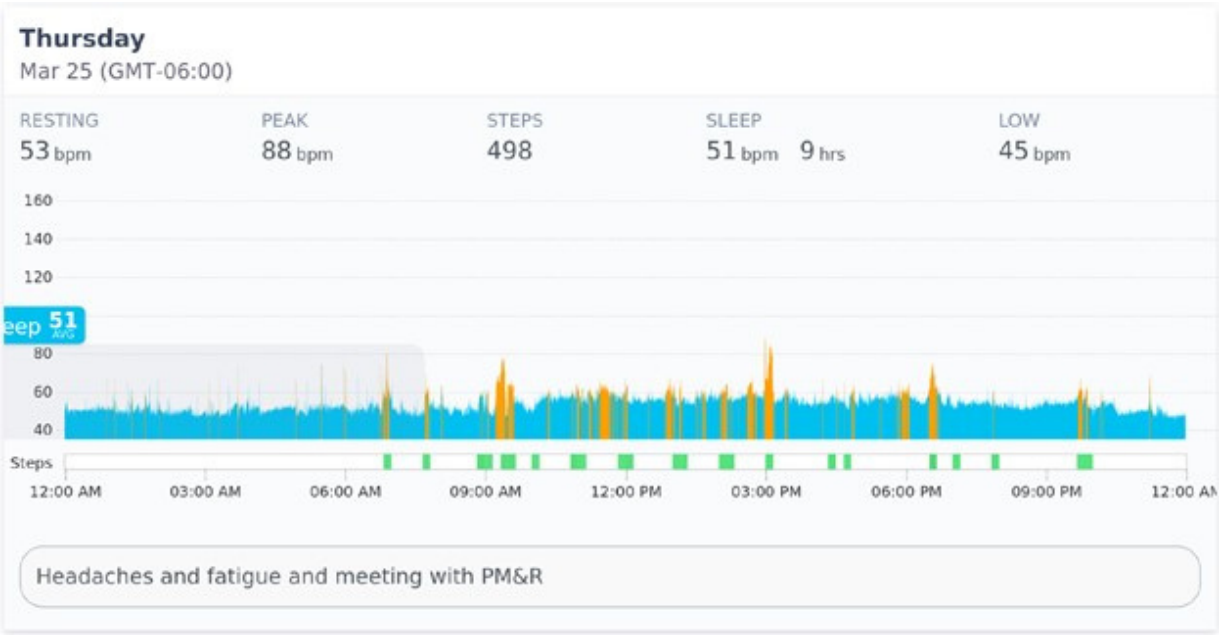

Figure 2. A snapshot of HR data recordings from Fitbit® coupled with the Cardiogram App. The patient was taking Metoprolol 25 mg BID. The green markings indicate she is moving and walking around the home with a total of 498 steps in the day. The blue markings indicate her resting HR, which is bradycardic overnight. Orange spikes are periods of elevated HR with activity though she has a blunted HR response due to the beta blocker. Her online meeting with PM&R occurred from 11:30 AM – 12:30 PM, which resulted in cognitive fatigue.
Dizziness Handicap Inventory - Total score 52 (Function: 26; Emotional: 14; Physical Aspects: 12), which falls in the moderate range (31-60) of perceived handicap related to dizziness.

Vestibular Assessment - Testing revealed intact VOR and no dizziness or imbalance with head motion or sustained head tilts with eyes open or closed. VSR testing revealed intact ankle and step strategy responses with a slight reduction in hip strategy activation. She had mild postural sway with eyes closed activity and difficulty maintaining balance on a tilted surface with eyes closed, indicating mild otolithic sensitivity or impaired head righting responses without visual reference. Tandem stance, single limb support, and other balance postures were influenced by muscular weakness.

Vision Assessment - She has worn corrective lenses for many years. Oculomotor control and binocular control examination was normal, but she exhibited signs of visual dependence for balance. Because she had not left her home for months, her sense of visual motion hypersensitivity had not been fully tested nor had she been exposed to this type of stimulation.

Differential Diagnosis of Post-Acute Sequelae of COVID-19 (PASC): Unraveling Elements of Dysautonomia, ME/CFS, Altered Central Processing and Maladapted Balance cont.

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Cervical and Somatosensory Assessment - Patient was noted to have an elevated right shoulder with known history of shoulder injury. Her cervical joint position error was within normal limits seated on a firm surface, but she was unable to stabilize her core posture on a compliant surface or in standing to isolate cervical motion. She had mild adaptive shortening of the deep cervical extensors and required cues to recruit the deep cervical flexors during static postures or during controlled isolated movements. In quadruped she was uncertain of the location of her hips relative to her knees and noticed that her body composition had drastically changed. She struggled to maintain prolonged upper extremity weight bearing without resting over an ottoman for core support.

Musculoskeletal Assessment - Pt. was unable to activate the gluteus maximus against gravity but was able to perform hip extension with hamstring recruitment through partial range of motion. She had difficulty engaging the transverse abdominal muscles and controlling her respiratory pattern with very simple targeted exercises for postural stabilization. She had tightness in her calf muscles bilaterally. Her Beighton score was 2/9 with bilateral knee hyperextension.

Pulmonary Assessment - During all exercises and movement analysis the patient was noted to hold her breath and needed cueing to coordinate her breathing with exercise.

Cardiovascular Assessment - Heart rate is persistently bradycardic even with exertion. Patient on beta blocker and unable to mount compensatory tachycardic response with exertion. She has been unsuccessful in attempts to wean off the medication in the recent past.

Integumentary Assessment - Patient wore full length toeless compression stockings to the waist. She had notable Beau's lines on the first digits of her feet bilaterally.[10]

Functional Gait Assessment - Pt. scored 24/30 points, indicating a mild fall risk. She had difficulty walking with eyes closed and walking backwards, preferred to hold rail on stairs, hesitated to step over obstacles, and had slight imbalance with pivot turns.

Patient Identified Short-Term Goals:

- Walk to the mailbox daily, which is located 6 houses down the street, roughly 1 city block.
- Stand to prepare meals daily (45-60 minutes) without the need to sit and rest.
- Shower at least every other day without excessive fatigue or body temperature regulation issues.

Discussion

Post-acute sequelae of COVID-19 (PASC), or long-COVID, has been reported to vary in presentation ranging from cardiovascular and neurological complications to dysautonomia and chronic fatigue syndrome.[1] While there are diagnostic tests and criteria available for Postural Tachycardia Syndrome, a form of dysautonomia, and for ME/CFS, a refined diagnosis that can account for varied symptoms of dizziness, headache, fatigue, nausea, and orthostatic intolerance often remains elusive.[11, 12]

Differential Diagnosis of Post-Acute Sequelae of COVID-19 (PASC): Unraveling Elements of Dysautonomia, ME/CFS, Altered Central Processing and Maladapted Balance cont.

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The consequences of prolonged inactivity have far reaching effects on central sensory motor processing for balance. The contributions from various movement systems must be considered in the interpretation of clinical tests as well as the design and dosage of targeted intervention plans.

The examination findings from this case presentation suggest that her primary impairments are related to adaptive shortening and fatigue of many postural stabilizing muscles as well as disrupted breathing during activity. These musculoskeletal issues give rise to changes in motor recruitment patterns and coordinated motor control during active movement resulting in calf pain, headaches, and fatigue. Her cardiovascular response to exercise, reliance on a beta blocker, and the need for supplemental oxygen also contribute to her fatigue, headaches, chest pain, brain fog, and orthostatic intolerance. She relies on visual cues for balance and has reduced postural control on uneven surfaces due to the central processing sensory motor demands of routine daily activities, which further results in fatigue and brain fog.

Conclusion

Physical therapists have a unique role as primary care providers who are able to engage with patients at a higher frequency than physicians or other prescribing providers. Continuous interpretation of an individual's response to clinical testing and interventions can provide rapid insight into the underlying factors contributing to abnormal movement patterns, maladaptive balance strategies, and responses to pharmacological and non-pharmacological interventions. This case requires further collaboration between physical therapy and cardiology to determine optimal therapies including when a beta-blocker is necessary to regulate her heart rhythm, and what other combination of therapies will best expedite a gradual return to her previous life activities.[13] Dysautonomia is clearly present in this case and her orthostatic intolerance has resulted in prolonged inactivity which has led to musculoskeletal complications as well as central processing of vestibular, visual and somatosensory input. Whether post exertional malaise and ME/CFS is present and the degree to which it interferes with her response to paced activity will be determined over time.

Note on Consent: The subject of this article willingly contributed her case for online publication and has reviewed the content of the article for accuracy.

Differential Diagnosis of Post-Acute Sequelae of COVID-19 (PASC): Unraveling Elements of Dysautonomia, ME/CFS, Altered Central Processing and Maladapted Balance cont.

Author: Nicole Miranda, PT, DPT

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Fear Avoidance Behaviors in Concussion Management...Using the Pain Science Framework to Improve Outcomes

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Characteristics of individuals at risk for experiencing post-concussive syndrome (PCS) include a previous history of psychological conditions such as anxiety, depression and/or mood disorders, history of headaches/migraines and post-concussive vestibular ocular dysfunction.[1-3] The nature and extent of PCS is complex and has been associated with fear-avoidance behaviors similar to those with chronic pain, fibromyalgia and persistent postural perceptual dizziness (3PD).[1] Fear-avoidance behavior has been associated with chronic disability in musculoskeletal conditions and has recently shown to be a predictor of adverse clinical outcomes associated with concussion injury.[4] Patients with mTBI have potential to misinterpret information regarding their injury, catastrophizing their symptomology, with resultant increased levels of anxiety and avoidance behavior over time. Physical therapists are in a unique role to alter behaviors contributing to protracted recovery through education and self-care promotion, which are hallmarks for success in the pain science model.[5] Early intervention utilizing active rehabilitation in concussion can reconceptualize fear avoidance and potentially alter neurophysiology associated with these behaviors, decreasing the significant cost associated with post-concussive symptomology.[6-8]

Treatment of concussion in 2021 looks very different than just 5 years ago.We have pivoted to a more active rehabilitation approach to include early aerobic activity, 24-48 hours of complete rest and specialized care to target clinical trajectories complicating full recovery.[7,9,10] Despite advancement in the treatment of concussion, translation of best practice into the clinical environment is slow and often mis-informed by sensationalism of the media and/or healthcare's over-medicalization of conditions, which has been shown to occur in musculoskeletal pain practice.[11] When information on concussion is outdated too much medicine can be prescribed and investigation or interventions can be justifiably excessive. In concussion management this occurs in the over prescription of rest and missed school and/or activities or when too much focus on symptomatic response to interventions.[11] Parallel to musculoskeletal care, concussion has put excessive clinical labels or diagnoses post injury that are considered as abnormal, but possible were pre-existing conditions or variables that are complicating recovery such as anxiety.[11,12] Evidence of pre-existing symptoms such as anxiety and mood disorders, history of headaches/migraines, learning disability and even genetic biomarkers have shown association with protracted recovery post-concussion injury.[13] It has also been shown that multiple presenting symptoms, age (younger), vestibular ocular deficits, exercise intolerance and sleep cycle disruptions also show relationship to prolonged recovery and increased time experiencing symptoms, which can lead to fear avoidance.[8,9,14,15] Many of these constructs are associated with development of chronic pain and are part of the biopsychosocial model used to effectively treat chronic pain conditions. (Link to Biopsychosocial model: https://www.mdpi.com/pharmacy/pharmacy-06-00018/article_deploy/html/images/pharmacy-06-00018-g001.png)

When looking at the parallels of chronic pain among adolescents and post-concussion syndrome there are multiple patient related factors to take into consideration such as physical factors, lifestyle factors, psychosocial factors and biological factors.[1,5]

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What our patients bring to the table with them needs to be a consideration when building the therapeutic alliance and plan of care. Individuals beliefs, thoughts, feelings and actions, such a maladaptive behaviors and/or responses to pain are part of the psychological piece of the biopsychosocial model.[17,18] Social factors include support network, family, friends, access to care, community and society's culture of beliefs surrounding injury.[19,20] We cannot forget that what the therapist's beliefs are regarding injury or physical environment in which they provide care can also influence the situation.[21] At the root of the model are the biological aspects which can follow the current clinical trajectory model of care and encompass impairments specific to ocular, vestibular, cervical, cognitive/fatigue and post-traumatic headache.[22]

Using the biopsychosocial model can assist the clinician in looking at the big picture and provide patient-centered care which has been shown to be superior in the area of concussion management.9 Clinicians can learn and apply similar principles used in the pain neuroscience framework to our chronic or more complex patients who have suffered a concussion. These patients often present with similar avoidance behaviors that can be explained by the fear avoidance behavior model. (Link to Image of pain fear avoidance model: https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcSmbj8v9Czr_3jyd615EgBfIUMMRuvbX-0pAw&usqp=CAU) This model is well-validated in patients with similar distress syndromes including chronic pain, tinnitus, cancer survivors, chronic fatigue, fibromyalgia, and fatigue in multiple sclerosis.[1] This model can provide a framework of treatment options for these patients and has shown that interventional strategies such as exposure therapy, cognitive behavioral and mindfulness based treatment can assist in recovery.[1] Patient's suffering from post-concussion syndrome may (mis)interpret information regarding the damage to their brain and its immediate consequences in a catastrophic way, which results in increasing anxiety and avoidance behaviors over time.[1,2] According to the model, symptoms are wrongly interpreted as a sign of serious injury or disease over which one experiences little or no control or have received mis-information regarding recovery. It is proposed that such misinterpretation of symptoms typically leads to a disproportional fear of symptoms and is named the avoidance cycle, well known in chronic pain literature.[1,16] Thoughts specific to the injury and rumination lead to a disabling fear of experiencing symptoms such that people will avoid those activities that are presumed to worsen their problem.[1]

The fear avoidance construct can be measured and tools specific to concussion have been developed.[2] The Fear Avoidance Behavior – Traumatic Brain Injury (FAB-TBI) is one such measure and looks at individual constructs of activity avoidance, cogniphobia, and symptom avoidance to assist in narrowing the focus of interventional strategies.[2] The pain neuroscience framework suggests practical tips to assist in management. These include:

- Care should be patient centered
- Screen for serious pathology/red flag conditions
- Assess psychosocial factors
- Undertake a physical examination
- Progress should be evaluated including the use of outcome measures

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- Provide patient education/info about their condition and management options
- Provide management addressing physical activity and/or exercise
- Apply manual therapy only as adjunct to other EBP treatments
- Facilitate continuation or resumption of work, school, sports or other activities.

It has also been recommended to utilize intentional changes in approach to not over-asking about symptoms, which include not over-surveying using symptoms scales, but instead re-focusing growth mindset frameworks. This includes changing to, "what have you been able to do since your last visit" and not "how bad is your pain today?" When a patient is completing symptom inventories frequently it reinforces their pain and/or symptoms, which then causes rumination about lack of progress.[1] A newly developed subjective outcome measure, the Concussion Clinical Profile Screening Tool (CCPST) is one way to not over-survey but instead track specific clinical trajectories that are influencing and driving symptomolgies.[23] This can assist in identifying the driving subtype as well as help direct interventional care and guide multidisciplinary referrals when needed.[6,24] Utilization of current trajectory models for delivery of care and utilizing best practice to include the Vestibular Ocular Motor Screening Tool and Buffalo Concussion Treadmill Test to identify vestibular ocular deficits and autonomic dysfunction early can lead to early intervention and potentially decrease length of time an individual suffers symptoms, which can lead to fear avoidance behaviors.[10,25-27]

The biggest role physical therapists can provide these patients is one reassurance, education on best practice as well as providing a positive environment focused on what the patient can do. These actions may help prevent or interrupt the cycle of catastrophizing, avoidance behaviors and self-induced reduced activity, which should lead to better outcomes and less time suffering with symptoms. This has a large potential to effect quality of life as well as overall cost to both the individual and healthcare system.

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