Indexing Metadata/Description

**Title/condition:** Postconcussion Syndrome

**Synonyms:** Postconcussive syndrome; postconcussional syndrome; mild traumatic brain injury; chronic neurocognitive impairment; persistent post-concussion symptoms

**Anatomical location/body part affected:** Brain/cortex and limbic system

**Area(s) of specialty:** Neurologic Rehabilitation, Orthopedic Rehabilitation, Pediatric Rehabilitation, Sports Rehabilitation, Veterans Health

**Description**

- Postconcussion syndrome (PCS) is a complication of mild traumatic brain injury (mTBI). The persistent nature of neurocognitive signs and symptoms in patients with PCS (often lasting for weeks to months) distinguishes it from mTBI, in which neurological recovery usually occurs in 1–2 weeks.\(^1\)\(^,\)\(^2\)\(^,\)\(^3\)\(^,\)\(^14\)\(^,\)\(^15\) It is also often referred to as persistent post-concussion symptoms (PPCS) in the pediatric population. The transition from symptoms to syndrome is poorly understood;\(^15\) a standard definition is lacking for the minimum duration of symptoms required to diagnose PCS\(^10\)
- Patients with PCS usually complain of headache, sleep disturbances, changes in mood, and fatigue. Symptoms of severe PCS may also involve depressive behavior, anxiety and fear reactions, and cognitive deficits\(^25\)\(^,\)\(^26\)
- The World Health Organization ICD-10 classification requires that 3 or more of the following 8 symptoms be identified for the diagnosis of PCS\(^1\)\(^,\)\(^3\)
  - Headache
  - Dizziness
  - Fatigue
  - Irritability
  - Insomnia
  - Difficulty concentrating
  - Impaired memory
  - Reduced tolerance of stress, emotions, or alcohol
- In addition, to meet the criteria for PCS the following symptoms of severe TBI must be excluded\(^3\)
  - Loss of consciousness longer than 30 minutes
  - Less than (<) 13 on the Glasgow Coma Scale (GCS) after 30 minutes
  - Amnesia lasting longer than 24 hours
- **Incidence**
  - 1.6 to 3.8 million sports-related concussions occur annually in the United States and contribute to incidence of mTBI\(^26\)
  - The reported incidence of PCS varies because of the overlap in mTBI and PCS symptoms and duration\(^15\)
  - 80–90% of concussion cases in sports recover from symptoms within 7–10 days (slightly longer in children)\(^15\)
- **Nonpharmacologic therapy for PCS involves the following:**\(^2\)
  - Early psychological intervention and cognitive rehabilitation
Physical and occupational therapy to improve physical functioning
Avoidance of alcohol, narcotics, and factors associated with sleep disturbance
Patient education: regarding symptoms and expectations; early reassurance for recovery of symptoms; encouragement to cope with symptoms and avoid catastrophizing outcomes

ICD-9 codes
- 310.2 postconcussion syndrome, postcontusion syndrome or encephalopathy; posttraumatic brain syndrome, nonpsychotic; status post commotio cerebri
- 850.1 concussion without loss of consciousness
- 850.2 concussion with loss of consciousness, less than one hour

ICD-10 codes
- F07.2 postconcussional syndrome; postcontusional syndrome (encephalopathy), posttraumatic brain syndrome, nonpsychotic

(G-Codes are provided for the reader’s reference, not for billing purposes)

G-Codes
- Mobility G-code set
  - G8978, Mobility: walking & moving around functional limitation, current status, at therapy episode outset and at reporting intervals
  - G8979, Mobility: walking & moving around functional limitation; projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  - G8980, Mobility: walking & moving around functional limitation, discharge status, at discharge from therapy or to end reporting
- Changing & Maintaining Body Position G-code set
  - G8981, Changing & maintaining body position functional limitation, current status, at therapy episode outset and at reporting intervals
  - G8982, Changing & maintaining body position functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  - G8983, Changing & maintaining body position functional limitation, discharge status, at discharge from therapy or to end reporting
- Carrying, Moving & Handling Objects G-code set
  - G8984, Carrying, moving & handling objects functional limitation, current status, at therapy episode outset and at reporting intervals
  - G8985, Carrying, moving & handling objects functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  - G8986, Carrying, moving & handling objects functional limitation, discharge status, at discharge from therapy or to end reporting
- Self-Care G-code set
  - G8987, Self-care functional limitation, current status, at therapy episode outset and at reporting intervals
  - G8988, Self-care functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  - G8989, Self-care functional limitation, discharge status, at discharge from therapy or to end reporting
- Other PT/OT Primary G-code set
  - G8990, Other physical or occupational therapy primary functional limitation, current status, at therapy episode outset and at reporting intervals
  - G8991, Other physical or occupational therapy primary functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
  - G8992, Other physical or occupational therapy primary functional limitation, discharge status, at discharge from therapy or to end reporting
- Other PT/OT Subsequent G-code set
  - G8993, Other physical or occupational therapy subsequent functional limitation, current status, at therapy episode outset and at reporting intervals
  - G8994, Other physical or occupational therapy subsequent functional limitation, projected goal status, at therapy episode outset, at reporting intervals, and at discharge or to end reporting
G8995, Other physical or occupational therapy subsequent functional limitation, discharge status, at discharge from therapy or to end reporting

<table>
<thead>
<tr>
<th>G-code Modifier</th>
<th>Impairment Limitation Restriction</th>
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</thead>
<tbody>
<tr>
<td>CH</td>
<td>0 percent impaired, limited or restricted</td>
</tr>
<tr>
<td>CI</td>
<td>At least 1 percent but less than 20 percent impaired, limited or restricted</td>
</tr>
<tr>
<td>CJ</td>
<td>At least 20 percent but less than 40 percent impaired, limited or restricted</td>
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<tr>
<td>CK</td>
<td>At least 40 percent but less than 60 percent impaired, limited or restricted</td>
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<td>CL</td>
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<tr>
<td>CM</td>
<td>At least 80 percent but less than 100 percent impaired, limited or restricted</td>
</tr>
<tr>
<td>CN</td>
<td>100 percent impaired, limited or restricted</td>
</tr>
</tbody>
</table>

Source: https://www.cms.gov/

- **Reimbursement**: No specific issues or information regarding reimbursement has been identified for the general patient population. The U.S. Veterans Benefits Administration does identify several issues related to compensation and has proposed changes to ratings schedules.

- **Presentation/signs and symptoms**
  - The most commonly reported symptoms in PCS are\(^{(1,2,3,4,15,25)}\)
    - headache
    - irritability
    - dizziness and vertigo
    - poor balance
    - forgetfulness
    - difficulty learning or remembering
    - difficulty concentrating
    - sleep disturbance (e.g., insomnia, hypersomnolence)
    - unusual fatigue/lethargy
    - disturbed balance may impair gait
    - reduced physical work capacity
    - depression
    - anxiety
    - sensitivity to noise and light
    - worsening academic performance (children) or occupational performance (adults)\(^{(16)}\)
    - preoccupation with symptoms and fear of brain damage\(^{(16)}\)
    - nausea in some cases
  - Other potential signs/symptoms include hearing loss, tinnitus, blurred vision, diplopia, convergence insufficiency, diminished taste and smell, personality change, decreased libido, decreased appetite, post-traumatic stress disorder (PTSD), and slowing of reaction time\(^{(4)}\)

- **Causes, Pathogenesis, & Risk Factors**
  - **Causes**
    - Low-velocity direct blow to head\(^{(1,2)}\)
• Indirect head trauma\(^{(1,2,3)}\)
  – Concussion due to intracranial acceleration and deceleration (e.g., whiplash)
  – Concussion due to shearing forces transmitted to head after a blow to the body (e.g., explosion, tackling in football, checking in ice hockey)

• Depression and anxiety may contribute to the etiology or maintenance of PCS symptoms\(^{(14)}\)

• Expectation/misattribution (“expectation-as-etioly” hypothesis): a patient with mTBI may expect negative outcomes that reinforce and prolong symptoms, leading to PCS\(^{(14)}\)

› Pathogenesis

– TBIs are classified as mild, moderate, or severe depending on motor, eye, and verbal responses used on the GCS to evaluate the level of consciousness

– The neurological damage in patients with mTBI was once thought to have the same mechanism as that of moderate and severe TBI (i.e., diffuse axonal injury/neuronal death). Cellular impairment may continue for hours after mTBI secondary to free radical formation and other inflammatory factors\(^{(4)}\)

– However, neuronal dysfunction, rather than cell death, likely promotes headache, short-term amnesia, and the other cognitive symptoms seen in patients with mTBI.\(^{(16,17)}\) On the other hand, patients with PCS are more likely to have diffuse cerebral neuronal injury, small petechial hemorrhages, edema, and apoptosis\(^{(1,2,3)}\)

– The routine electroencephalogram (EEG) usually is normal in patients with PCS.\(^{(2)}\) Quantitative EEG, which measures the frequency of electrical “bursts,” may identify PCS with high sensitivity\(^{(2)}\)

– Authors of a case series (n = 20 patients with PCS) in India found that prefrontal lobe clinical dysfunction (as indicated by disturbances of sleep, behavior, and memory and reduced mental speed on neuropsychological testing) was associated with lesions in the frontal and temporal lobes on magnetic resonance imaging (MRI)\(^{(6)}\)

– Changes in functional MRI activation patterns in PCS suggest that PCS symptoms may be related to abnormal cerebral blood flow regulation\(^{(18)}\)

– Authors of an MRI study of 16 patients with PCS after mTBI (1 year post injury), conducted in the United Kingdom, found that there was evidence of both white and gray matter injury when compared to 9 controls. They also found an association between amount of injury and symptoms of PCS\(^{(33)}\)

– The development of PCS is likely due to interactions among biological injury, pre-existing risk factors, and psychosocial issues\(^{(17,25)}\)

› Risk factors

• Major risk factors for PCS include clinical symptoms that continue or worsen in the first few days after mTBI, such as
  – amnesia, migraine, self-reported cognitive decline, noise and light sensitivity, and depression/anxiety\(^{(15)}\)
  – headache on presentation to emergency department: based on a retrospective study (N = 406 children and adolescents, 5 to 18 years of age) in the United States\(^{(19)}\)

• Pre-existing psychiatric disease, including anxiety, depression, and PTSD\(^{(15)}\)

• Pre-existing expectation of poor outcomes in persons who sustain concussion\(^{(15)}\)

• Poor coping strategies, including premature return to sport (so-called “all-or-none” behavior)\(^{(15)}\)

• Poor cognitive reserve\(^{(34)}\)
  – Results from a study conducted in Sweden indicated that patients with poor cognitive reserve (as measured by sub-test Information from Wechsler Adult Intelligence Scale) were 4.14 times more likely to suffer from PCS\(^{(34)}\)

• Participation in contact sports (e.g., football, boxing)\(^{(2)}\)

• Probable risk factors for persistent neurocognitive problems or prolonged return to play in sports include:\(^{(20)}\)
  – post-traumatic headache
  – fatigue/mental fogginess
  – immediate amnesia or severe disorientation
  – younger age or level of play/competition

  - Authors of a study conducted in the United States suggested that younger players be discouraged from “playing up” on varsity teams\(^{(33)}\)
- Based on results indicating that early-pubertal stage is independently associated with longer recovery from concussion in males and heavier weight is associated with longer concussion recovery in females in 145 adolescent ice hockey players, ages 13–18, with concussion.

- Prior concussion is highly likely a risk factor for chronic neurobehavioral impairment across a range of professional sports.1,15,26 Risk increases with further participation in football, soccer, or boxing.

- Authors of a retrospective cohort study (N = 285 athletes; mean age 22.8 years) in Canada found that the prevalence of concussions was highest in ice hockey players compared to football and other contact sports.

Overall Contraindications/Precautions

- Consult physician if patient has a high level of irritability, agitation, or aggressiveness that interferes with compliance with instructions regarding safety.

- There is concern for exercise-related symptom exacerbation in PCS. Athletes should be restricted from returning to sports while symptomatic and generally are advised not to participate in exertional activities while symptomatic from a concussion.9,15 However, prolonged inactivity may promote physical deconditioning (especially in athletes) that may have adverse secondary effects on depressive symptoms in PCS.

- Exercise training intensity should be controlled below the symptom threshold.

- Modify or discontinue exercise therapy if the patient reports or exhibits increased symptoms.

- See specific Contraindications/precautions to examination and Contraindications/precautions under Assessment/Plan of Care.

Examination

- Contraindications/precautions to examination
  - Symptoms that present a barrier to understanding and following instructions
  - Worsening of symptoms during procedures

- History
  - History of present illness/injury
    - Mechanism of injury or etiology of illness
      - Document the mechanism of head trauma
      - Was there loss of consciousness? If so, for how long?
      - Were other injuries sustained besides head trauma? Were there complications associated with head injury (e.g., depressed skull fracture, cerebral contusion, or extradural hematoma)?
      - What was the length of time patient rested after acute concussion?
        - Emerging evidence suggests that increasing physical and mental/cognitive rest beyond the standard 7 to 10 days is associated with a reduction in the duration of PCS symptoms.

- Course of treatment
  - Medical management: Physiological and psychological issues are addressed using patient reassurance, medication, and cognitive behavioral therapy (CBT)
  - Medications for current illness/injury: Medications used to minimize or control symptoms include
    - tricyclic antidepressants (e.g., amitriptyline) and selective serotonin reuptake inhibitors (SSRIs) for sleep disorders, depression, or headache
    - nonsteroidal anti-inflammatory drugs (NSAIDs) for musculoskeletal pain
  - Diagnostic tests completed: TBI can occur without the loss of consciousness. Neuronal dysfunction in PCS cannot be visualized by current imaging techniques. CT scan usually is normal. MRI may show petechial hemorrhages
or cerebral contusions, edema, and frontal lobe lesions. Routine EEG usually is normal. Blood tests are not specific. Symptom-limited exercise testing may indicate an inability to exercise to prior maximum capacity

- **Home remedies/alternative therapies:** Document any use of home remedies (e.g., ice or heating pack) or alternative therapies (e.g., acupuncture) and whether they help.
- **Use of complementary therapies such as acupuncture, chiropractic intervention, yoga, biofeedback, and supplements is common, but they have not been well studied**

- **Previous therapy:** Document whether patient has had occupational or physical therapy for this or other conditions and what specific treatments were helpful or not helpful.
- **Aggravating/easing factors:** Document factors that aggravate patient’s symptoms (and length of time each item is performed before the symptoms come on or are eased). Exacerbation of symptoms with physical exertion is commonly reported

- **Body chart:** Use body chart to document location and nature of symptoms.
- **Nature of symptoms:** Document nature of symptoms. Common symptoms include headache (migraine), neck pain, dizziness and vertigo, paresthesias, difficulty with concentration and memory, insomnia, and irritability. Other symptoms may include hearing loss, tinnitus, blurred vision, diplopia, light and noise sensitivity, diminished taste and smell, decreased libido, and decreased appetite (see Presentation/signs and symptoms, above).
- **Rating of symptoms:** Use a visual analog scale (VAS) or 0–10 scale to assess symptoms at their best, at their worst, and at the moment (specifically address if pain is present now and how much).
- **Pattern of symptoms:** Document changes in symptoms throughout the day and night, if any (A.M., mid-day, P.M., night); also document changes in symptoms due to weather or other external variables.
- **Sleep disturbance:** Document evidence of sleep disturbance.
  - Sleep disturbances are common (e.g., difficulty initiating and maintaining sleep, excessive somnolence in the daytime, and parasomnias).
- **Other symptoms:** Document other symptoms patient may be experiencing that could exacerbate the condition and/or symptoms that could be indicative of a need to refer to physician.
- **Respiratory status:** Document any respiratory factors that could limit patient’s ability to physically exert self.
- **Barriers to learning**
  - Are there any barriers to learning? Yes__ No__
  - If Yes, describe _______________________

• **Medical history**
  - **Past medical history**
    - **Previous history of same/similar diagnosis:** Any history of previous head injury or psychiatric disorder?
    - **Comorbid diagnoses:** Any relevant medical history? Substance abuse may contribute to the development of symptoms.
    - **Medications previously prescribed:** Obtain a comprehensive list of medications prescribed and/or being taken, including over-the-counter drugs and street drugs. If illegal drug abuse is strongly suspected and you are concerned about self-harm, contact your state medical department about whether you are legally required to report the patient.
    - **Other symptoms:** Ask patient about other symptoms he or she may be experiencing.

• **Social/occupational history**
  - **Patient’s goals:** Document what the patient hopes to accomplish with therapy and in general.
  - **Vocation/avocation and associated repetitive behaviors, if any:** Participation in contact sports (e.g., football, rugby, soccer, boxing), unsafe driving (e.g., driving without seat belt), and other high-risk activities. Active military duty is a strong risk factor. Is the patient able to participate in work and/or leisure activities?
  - **Functional limitations/assistance with ADLs/adaptive equipment:** It is important to ascertain the patient’s functional level prior to injury as well as post injury.
  - **Living environment:** Document stairs, number of floors in home, and whether patient lives with caregivers. Identify if there are barriers to independence in the home; any modifications necessary?

• **Relevant tests and measures:** (While tests and measures are listed in alphabetical order, sequencing should be appropriate to patient medical condition, functional status, and setting)
  - **Assistive and adaptive devices:** Usually not needed; monitoring devices (e.g., personal safety alarm) may be required if safety is questioned.
  - **Balance:** Assess for impairment of static and dynamic balance (e.g., Tinetti test).
A thorough assessment of balance is especially important in patients with dizziness/vertigo

**Cardiovascular:**
- Assess vital signs: heart rate (HR), blood pressure (BP), respiratory rate
- The 6-minute walk for distance test (6MWT) can be utilized. Assess subjective effort before and during 6MWT with the Borg Rating of Perceived Exertion (RPE) Scale\(^{(11)}\)
- Exercise testing on a treadmill may reveal undisclosed neurocognitive symptoms in patients with PCS\(^{(22,31)}\)
  - Authors of a cross-sectional study (N = 56) in the United States found that patients with PCS reported increased symptoms or new symptoms that led them to stop before maximum exertion during a graded treadmill exercise test (i.e., their symptoms limited test duration to an average of 8.5 minutes compared to 17.9 minutes for the control group)

**Cervical scan:** Assess myotomes of upper extremity: neck flexion (C1-C2), neck lateral flexion (C3), shoulder elevation (C4), shoulder abduction (C5), elbow flexion/wrist extension (C6), elbow extension/wrist flexion (C7), thumb extension/ulnar deviation (C8), hand intrinsics (T1). Assess ROM as part of the cervical scan

**Cranial/peripheral nerve integrity:** Assess eye movements and control. Referral to audiology testing may be indicated for patients with hearing loss

**Functional mobility:** Assess ability to perform safely (e.g., FIM, Timed Up and Go [TUG] test)

**Gait/locomotion:** Observe for altered or antalgic gait pattern. Assess patient’s ability to walk safely on a slow-moving treadmill belt.\(^{(11)}\) DGI, as indicated

**Joint integrity and mobility:** Assess for injury secondary to head trauma incurred

**Muscle strength:** Assess functional strength of neck, trunk, and limbs using manual muscle testing (MMT)

**Observation/inspection/palpation (including skin assessment)**
- Assess any secondary orthopedic injury
- Assess for muscle spasm/trigger point in upper trapezius and cervical/scapular musculature in patients with mechanical neck pain

**Posture:** Assess general alignment in standing

**Range of motion:** Assess functional ROM of neck, trunk, and limbs

**Reflex testing:** Assess deep tendon reflexes as indicated by injury

**Self-care/ADLs:** Assess ability to perform self-care effectively and safely

**Sensory testing:** Scan for reduced or increased sensation in cervical dermatomes

**Special tests**
- Symptom-limited graded exercise testing on a treadmill or cycle ergometer to prescribe the HR, systolic BP, and Borg RPE for aerobic exercise training that do not increase symptoms or cause new symptoms\(^{(11,31)}\)
  - Rivermead Post Concussion Symptoms Questionnaire\(^{(23)}\)

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**Assessment/Plan of Care**

- **Contraindications/precautions**
  - Patients with dizziness/vertigo are at risk for falls; follow facility protocols for fall prevention and post fall-prevention instructions at bedside, if inpatient. Ensure that patient and family/caregivers are aware of the potential for falls and educated about fall-prevention strategies. Discharge criteria should include independence with fall-prevention strategies
  - Clinicians should follow the guidelines of their clinic/hospital and what is ordered by the patient’s physician. The treatment summary below is meant to serve as a guide, not to replace orders from a physician or a clinic’s specific protocols
  - Modify or discontinue therapy if symptoms worsen and report to physician
  - Avoid applying cold over superficial nerves, areas of diminished sensation, poor circulation, or slow-healing wound
  - Cold may be counterproductive if used to facilitate muscle relaxation and reduce pain in patients who do not tolerate this modality\(^{(4)}\)
  - Rehabilitation professionals should always use their professional judgment regarding use of modalities

**Cryotherapy** contraindications\(^{(12)}\)
  - Cold urticaria
  - Cold intolerance
  - Paroxysmal cold hemoglobinuria
  - Cryoglobulinemia
–Raynaud’s disease or phenomenon
–Over a regenerating peripheral nerve
–Over a circulatory compromise
–Over an area of peripheral vascular disease

• **Cryotherapy** precautions
  – Hypertension
  – Thermoregulatory disorders
  – Over a superficial peripheral nerve
  – Over an open wound
  – Over an area of poor sensation
  – With individuals with poor cognition
  – In the very young and the very old
  – Persons with an aversion to cold

• **Thermotherapy** contraindications
  – Over areas with a lack of intact thermal sensation
  – Over areas of vascular insufficiency or vascular disease
  – Over areas of recent hemorrhage or potential hemorrhage
  – Over areas of known malignancy
  – Over areas of acute inflammation
  – Over infected areas where infection may spread
  – Over areas where liniments or heat rubs have recently been applied
  – In any situation deemed unreliable by the practitioner

› **Diagnosis/need for treatment:** PCS/functional deficits in activities of daily living (ADLs); post-traumatic musculoskeletal pain, postural deficits, dizziness, vertigo, balance problems; reduced aerobic endurance and muscle strength

› **Rule out:** Because of the significant overlap with conditions that cause similar symptoms, the referring physician should exclude migraine headache (vascular or tension), subdural hematoma, skull fracture, cervical spine disc disease, whiplash, seizure, stroke, depression, anxiety, fibromyalgia, chronic fatigue syndrome, PTSD, personality disorders, chronic traumatic encephalopathy, and benign paroxysmal positional vertigo

› **Prognosis**
  • Most patients with PCS recover within 12 weeks; roughly one third continue to experience symptoms 3 months after injury. About 15% have continuing neurologic symptoms at 1 year
  • Authors of a 3-month follow-up study (N = 2,593) in Sweden found that 56% of patients with PCS reported no remaining symptoms, 24% reported 3 or more symptoms, and 10% reported 7 or more symptoms

› **Referral to other disciplines**
  • Neuropsychologist for CBT
  • Psychiatrist as needed for mental illness (e.g., affective disorders, suicidal thoughts)
  • Neurologist for severe sensorimotor deficits
  • Speech or occupational therapist for development of communication skills and work skills and habits
  • Audiologist
  • Physiatrist
  • Home care assistance as indicated

› **Other considerations**
  • Early psychological intervention and cognitive rehabilitation are key for full recovery
  • Implement patient education regarding symptoms and reassurance for recovery early in treatment
  • Nonpharmacologic therapy for PCS involves the following:
    – Early psychological intervention and cognitive rehabilitation
    – Physical and occupational therapy to improve physical functioning
    – Avoidance of alcohol, narcotics, and factors associated with sleep disturbance
    – Patient education: regarding symptoms and expectations; early reassurance for recovery of symptoms; encouragement to cope with symptoms and avoid catastrophizing outcomes
- The multidisciplinary treatment involves education about mTBI, PCS, and the natural recovery course of PCS, reassurance of a good outcome, reduction in activities with increased risk for mTBI, gradual return to ADLs as symptoms permit, monitoring for adverse emotional responses, and symptom-specific treatment when needed.\(^{(28)}\)

› Treatment summary: Guidelines and standardized treatment protocols on physical or occupational therapy interventions are lacking for patients with PCS

- No specific treatment has been definitively shown to improve long-term outcomes in athletes following sports-related concussion.\(^{(9)}\) A consensus statement from the 2012 International Conference on Concussion in Sport provides a systematic approach to increasing the intensity of physical activity according to postconcussive symptoms.\(^{(15)}\)

Symptom-limited aerobic exercise training appears well tolerated and therapeutic.\(^{(10)}\)

- Authors of a prospective case series (N = 6 athletes and 6 nonathletes with refractory PCS) in the United States found that aerobic exercise training below the HR intensity associated with increased PCS symptoms was safe and effective for reducing symptoms.\(^{(10)}\)

  – The exercise program (5 to 6 days per week for at least 4 weeks, at 80% of the HR at symptom onset) significantly improved mean treadmill time from 9.75 min to 18.67 min at 19 weeks post injury

  – Exercise HR at symptom threshold increased from 147 bpm at baseline to 179 bpm after training

- Authors of a retrospective case series (N = 6 pediatric athletes with PCS) in the United States found that physical therapy treatment (an average of 6.8 sessions over 9.8 weeks) was associated with return to the pre-injury level of activity in 4 cases and return to modified activity in 2 cases. Validated assessment tools are needed to guide clinicians on return to sport in this population.\(^{(32)}\)

- Evidence is lacking on whether symptom-limited resistive exercise training has similar therapeutic value compared to aerobic exercise for treating patients with PCS

- Massage therapy may be helpful for treating hospitalized patients with PCS who have associated soft-tissue “whiplash” injuries.\(^{(29)}\)

- Authors of a 2017 study conducted in the United States found that individuals with PPCS may benefit from a multidisciplinary treatment program that includes cognitive rehabilitation, vestibular interventions, headache management, and an integrated behavioral approach to treating PTSD, depression, and sleep disturbance. There was a reduction in self-reported PPCS and PTSD following completion of the study; however, further research is needed in order to identify specific components associated with symptom reduction.\(^{(36)}\)

- Authors of a 2017 prospective study (n = 277) found that an active rehabilitation program that consists of aerobic exercise, coordination drills, and visualization and education improved physical, cognitive, emotional, and sleep-related post-concussionsymptoms in adolescents who were 3 to 4 weeks post-injury.\(^{(37)}\)

<table>
<thead>
<tr>
<th>Problem</th>
<th>Goal</th>
<th>Intervention</th>
<th>Expected Progression</th>
<th>Home Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscular/soft tissue pain (trigger points, spasm) secondary to trauma or PCS symptoms</td>
<td>Decrease/abolish soft tissue defects (trigger points, spasm in upper trapezius and paracervical musculature)</td>
<td>Therapeutic modalities</td>
<td>Teach relaxation techniques</td>
<td>Instruct patient in proper use of heat/cold at home</td>
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<tr>
<td>Neuropsychological dysfunction (e.g., decreased memory, irritability, slowed thinking, poor concentration)</td>
<td>Return to normal cognitive function</td>
<td>CBT</td>
<td>N/A</td>
<td>Facilitate referral to appropriate clinician to address cognitive dysfunction (occupational or speech therapist, neuropsychologist)</td>
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</tr>
<tr>
<td>Fall risk secondary to vertigo/dizziness</td>
<td>Improve balance, decrease fall risk, increase safety and function</td>
<td>Functional training</td>
<td>Therapeutic exercises that address functional deficits</td>
<td>Continue prescribed exercises at home</td>
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<tr>
<td>Reduced physical fitness and exercise capacity</td>
<td>Improve aerobic work tolerance and strength</td>
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<td>Home modifications</td>
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<td>Patient education to perform exercise program safely at home&lt;sup&gt;10&lt;/sup&gt;</td>
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**Desired Outcomes with Outcome Measures**

- Reduced PCS symptoms
  - VAS, reassessment
- Improved aerobic endurance
  - 6MWT, graded exercise testing
- Improved strength
  - MMT, machine or free weights
- Improved posture, balance, and gait, as indicated
  - Reassessment, Tinetti test, DGI
- Improved quality of life
  - SF-36 Health Status Questionnaire (physical functioning scale and physical composite scale)

**Maintenance or Prevention**

- Prevent repeated concussion through patient education on wearing a hard hat in construction areas, a helmet in contact sports and when riding a motorcycle or bicycle; and using a seat belt in automobiles
- Follow defensive driving recommendations to prevent accidents
- Avoid unsafe practices in contact sports (e.g., head butting, helmet spearing)
- Follow return-to-play guidelines
  - Evidence-based guidelines for the evaluation and management of concussion in sport from the American Academy of Neurology include the following recommendations<sup>20</sup>
    - Participation counseling
      - School-based professionals should be educated by licensed healthcare providers (LHCPs) to understand the risks of experiencing a concusion so they may provide accurate information to parents and athletes
      - Accurate information regarding concussion risks should be disseminated to school systems and sports authorities by LHCPs
Suspected concussion
- Team personnel (coach, trainer, sideline LHCP) should immediately remove any athlete suspected of having sustained a concussion from play
- Team personnel should not permit the athlete to return to play until the athlete has been assessed by an experienced LHCP with training in diagnosis and management of concussion

Management of diagnosed concussion
- Individuals supervising athletes should prohibit an athlete with concussion from returning to play or practice until an LHCP has determined the concussion has resolved and the athlete is asymptomatic without medication

Age factors
- Individuals supervising high-school-aged or younger athletes with diagnosed concussion should manage them more conservatively regarding return to play than they manage older athletes

Retirement from play after multiple concussions
- LHCPs should counsel athletes with a history of multiple concussions and subjective persistent neurobehavioral impairment about the risks for developing permanent neurobehavioral or cognitive impairments
- LHCPs caring for contact sport athletes who have objective signs of chronic/persistent neurologic/cognitive deficits (e.g., seen on formal neuropsychological testing) should recommend retirement from the contact sport

› Patient education and balance training to prevent falls
› Early recognition and treatment of PCS symptoms and risk factors

- Authors of a randomized controlled pilot trial (N = 28 patients with mTBI) in Canada found that CBT delivered soon after mTBI may prevent the development of PCS (24)

- Patients at risk for PCS based on their subacute postconcussion symptoms and maladaptive illness beliefs (recovery expectations and perceived consequences) were assigned to a control group or an intervention group
- Control group received usual treatment (education, reassurance, symptom management strategies) from an occupational therapist
- Intervention group received usual treatment plus CBT
- CBT group had fewer cases of PCS at 3-month follow-up (54% vs 91%)

› Home, work, and school environmental modifications
- Avoidance of potential stressors (e.g., bright lights, video games, TV)
- A school-based team may be involved in determining the appropriateness of an Individualized Education Program (IEP) for a child with PCS in need of long-term modifications

Patient Education
› Mayo Clinic website, “Post-Concussion Syndrome,”

References