



Progressive Return to Activity Following Acute Concussion/Mild Traumatic Brain Injury: Guidance for the Rehabilitation Provider in Deployed and Non-deployed Settings

Introduction

More than 287,000 service members have sustained a traumatic brain injury (TBI) between 2000 and the third quarter of 2013.¹ The majority of these (83.3 percent), were classified as mild TBI (mTBI), also known as concussion.^{1,2} The early identification and treatment of mTBI is most beneficial during the acute injury phase and has been reported to decrease disability.³ Current literature including widely accepted consensus guidelines and the “Department of Veterans Affairs (VA)/Department of Defense (DoD) Clinical Practice Guideline (CPG) for Management of Concussion/mTBI” recommends that patients with mTBI gradually return to normal activity as soon as safely possible using progressive activity combining multiple components.^{4,5} The “Concussion Management Tools (CMT) in Deployed Settings” and “Department of Defense Guidance for Management of Mild Traumatic Brain Injury/Concussion in the Deployed Setting” (Department of Defense Instruction DoDI 6490.11) provide guidance for the evaluation and care of service members with mTBI in the deployed setting.^{6,7} However, for those concussed service members who remain symptomatic following the initial recovery period, progression of activity is not well defined.^{6,7} This clinical recommendation (CR) and clinical support tool (CST) offer guidance for rehabilitation providers in both deployed and non-deployed settings from rest through return to pre-injury activity following mTBI. Guidance for the primary care manager (PCM) is outlined in the partner CR and CST, “Progressive Return to Activity Following Acute Concussion/mTBI: Guidance for the Primary Care Manager in Deployed and Non-deployed Settings.” Both rehabilitation provider and PCM versions, as well as patient education materials, are available at dvbic.dcoe.mil.

Background

This CR and CST represent a review of currently published literature and expert contributions obtained by the Defense and Veterans Brain Injury Center (DVBIC) in collaboration with clinical subject matter experts representing the academic, research and civilian sectors; the services; and the VA. The DoD TBI Advisory Committee (TAC) — which includes representatives from the Army, Navy, Marine Corps,

Air Force — Defense and Veterans Brain Injury Center (DVBIC), Army Medical Research and Materiel Command, Joint Trauma Analysis and Prevention of Injury in Combat program, National Intrepid Center of Excellence, U.S. Central Command, Readiness Division of the Defense Health Agency, the United States Coast Guard, Public Health Service and VA have reviewed this recommendation. Each service may mandate service-specific guidance for activity following concussion/mTBI. Patient history of concussion, provider expertise and judgment, and operational requirements may supersede any recommendation for an individual case.

DoD Policy (DoDI 6490.11), the concussion management tools and current literature indicate that the diagnosis and evaluation of acute concussion involves the assessment of a range of clinical symptoms.^{4,6,7,8,9} The progressive activity process includes physical, cognitive and vestibular/balance domains and is organized in stages, starting with Stage 1 (Rest) and progressing through Stage 6 (Unrestricted Activity). The step wise process applies the Neurobehavioral Symptom Inventory (NSI) and Borg’s Rate of Perceived Exertion (RPE) scale as subjective measures. Theoretical Maximum Heart Rate (TMHR) (TMHR = 220 – age) and Blood Pressure (BP) together serve as objective measures of exercise tolerance.^{10,11,12,13,14,15,17} The NSI is a 22-item symptom inventory of non-specific but common mTBI symptoms and is used in this clinical recommendation as a tracking tool for post-concussive symptoms.¹² The Borg’s RPE scale measures the intensity of physical activity based upon the physical responses that a person experiences during exercise. The physiological changes considered in the RPE include increases in heart rate, respiratory rate, sweating and the subjective report of muscle fatigue.¹⁶ RPE is strongly correlated with heart rate.¹⁵

The staged approach considers the need to rest and how to gradually increase activity in physical, cognitive and balance domains. Both inactivity and too much activity may be detrimental.¹⁸ The companion CST consists of five tables that provide detailed information and guidelines for each stage of increasing activity. A sample NSI, Borg’s RPE and references are also included as part of the CST.

Summary

The goal of progressive activity is to promote full recovery by gradually increasing physical, cognitive and vestibular/balance activities. The progressive activity process as defined in this recommendation may begin if symptoms remain following the mandatory recovery period as indicated by DoDI 6490.11 and the CMTs.^{6,7} The service

DoD Clinical Recommendation | January 2014

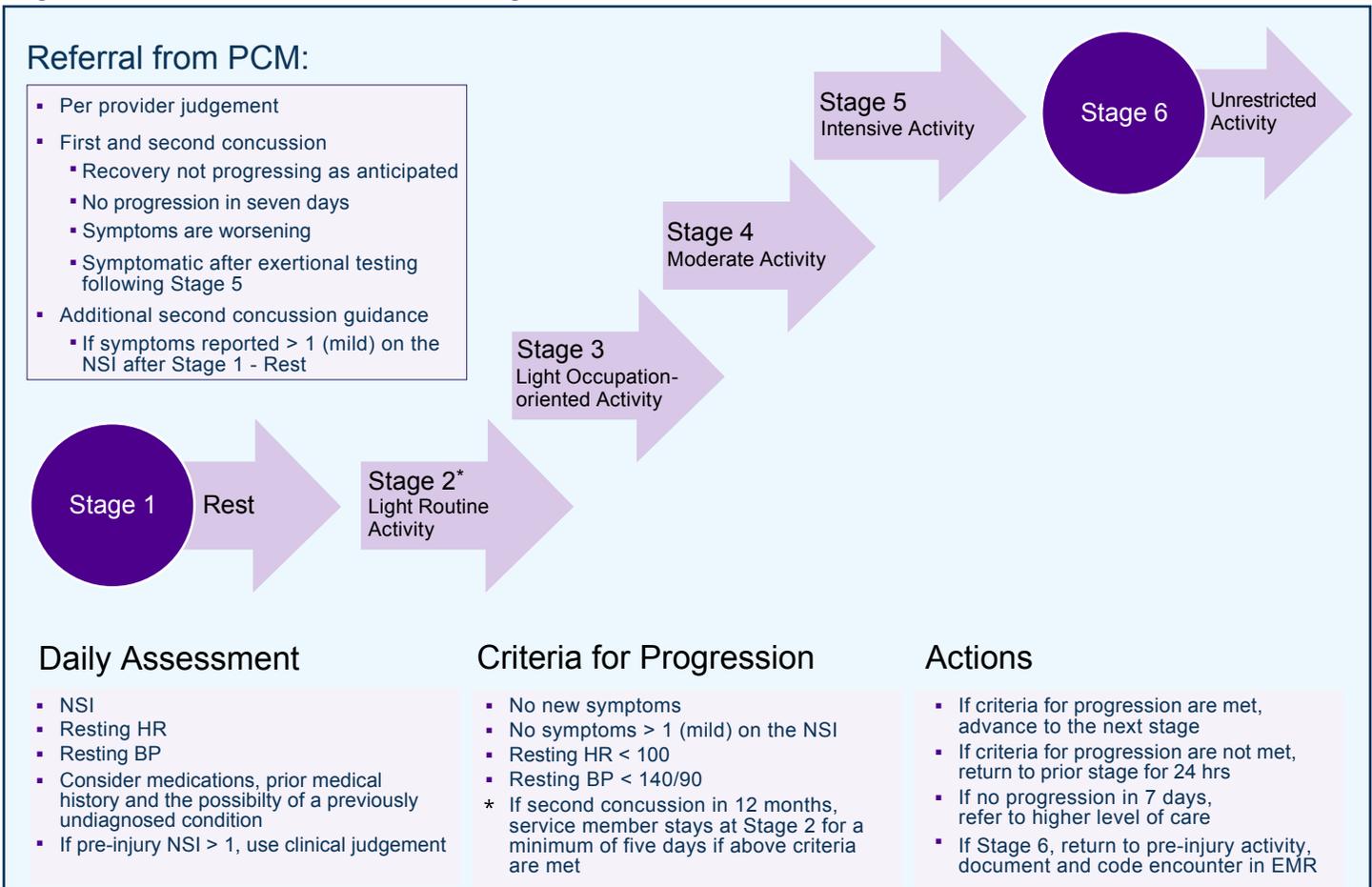
Progressive Return to Activity Following Acute Concussion/Mild Traumatic Brain Injury:
Guidance for the Rehabilitation Provider in Deployed and Non-deployed Settings

member may progress through the stages when symptoms are reported at pre-injury level or no higher than 1 (mild) on the NSI, resting HR is not greater than 100 bpm and resting BP does not exceed 140/90 mm Hg. Patient education by the rehabilitation provider is recommended to include the use of the Patient Activity Guidance After Concussion sheets available at dvbic.dcoe.mil. Additional patient guidance to abstain from alcohol and to avoid substances such as caffeine and nicotine is also recommended as these may affect objective measurement of BP and HR.^{19, 20, 21} Medications that were used prior to the diagnosis of concussion and acetaminophen to treat headache or pain are acceptable throughout the progression process. Upon daily assessment, if the service member does not meet the criteria for advancement, they are to return to the prior stage for another 24 hours. If an individual fails to progress after seven days or if the rehabilitation provider advises, the service member should be referred to a higher level of care. If the situation warrants and unit standard operating procedures require, personal protective equipment (PPE) should be incorporated into the stages of progression. A standardized approach to progressive activity following mild TBI is required for optimal functioning and recovery.

Recommendation

In accordance with the CMTs and DoDI 6490.11, after concussion is diagnosed service members require a 24-hour recovery period.⁷ The framework for referral to the rehabilitation provider for progressive return to activity is based upon symptom severity. Referral to the rehabilitation provider is recommended if recovery is not progressing as anticipated, there is no progression in seven days, symptoms are worsening or the service member is symptomatic after exertional testing following Stage 5. Referral may also be initiated per PCM judgement (Figure 1). If the current concussion is the second concussion/mTBI that the service member has sustained within 12 months, referral to the rehabilitation provider is also recommended if symptoms are rated as 2 (moderate) or higher on the NSI after the day of Stage 1 - Rest. The service member must have seven consecutive days of symptom resolution (defined as symptoms of 0-1 (mild) on the NSI) at Stage 1 and 2 before completing Stages 3-5.⁷ Therefore, service members with second concussions who are asymptomatic should remain at Stage 2 for a minimum of five consecutive days before progressing to Stage 3.

Figure 1: Rehabilitation Provider Diagram



Symptoms

Since altered physiology is often manifested by symptoms and post-mTBI recovery varies based on an individual's physiologic response, symptoms are an important measure in guiding the progression of activity.²² Symptoms such as fatigue or headache are rarely completely absent, especially following exertion even in the non-concussed individual.²³ Coordination with the service member's PCM for symptom management is recommended. Symptom tracking is implemented by use of the NSI to establish an individual's readiness to progress. For the purpose of this CR, asymptomatic is defined to be symptoms reported as 0-1 (mild) on the NSI. Physical and cognitive activity periods are outlined and followed by recommended rest intervals at each stage. Rest is imperative to both physical and cognitive recovery as well as for symptom prevention.¹⁸

Progression through Activity

The following conditions apply to all stages and should be met for the service member to progress to the next stage. If there are seven days without progression, the service member should be referred to a higher level of care.

- **Presence and intensity of mTBI symptoms at rest and with exertion:** During the stages of progression, the service member may progress to the next stage if no new symptoms are reported and all symptoms are no greater than 1 (mild) on the NSI. If the service member reports increase in symptoms during or after an activity, the current activity must be stopped and the service member advised to rest for the remainder of the day.
- **Daily provider assessment:** Includes completion of the NSI, obtaining resting HR and resting BP. Use clinical judgement and consider medication use, prior medical history and the possibility of a previously undiagnosed condition. If the service member has any pre-injury NSI symptoms greater than 1 (mild), use clinical judgement.
- **Conditions for progression:** For any level of activity progression, all the following criteria are recommended: no new symptoms, no symptoms greater than 1 (mild) on the NSI, resting HR less than 100 bpm and resting BP no higher than 140/90 mm Hg. If the conditions for progression are not met, the service member should return to the prior stage for another 24 hours. If there is no progression in seven days, refer to a higher level of care.
- **Activity to rest intervals:** Follow each physical and cognitive activity period with recommended rest periods as delineated for each stage.

Rehabilitation Stages

Stage 1: Rest

According to the DoDI 6490.11 and the CMT, a service member who has sustained a concussion has a mandatory 24 hour recovery period.^{6,7} Stage 1 provides guidance following this mandatory recovery period if symptoms remain or it is the second concussion in 12 months. During this stage extremely light physical, cognitive and vestibular/balance activity is permitted. The service member is allowed to participate in basic activities of daily living and extremely light leisure activity, as tolerated. Target RPE is 6-8 and HR should not exceed 40 percent of TMHR during activity. A baseline resting HR and BP should be established during this stage. Cognitive activities are also extremely light with rest as the primary focus. A quiet environment is recommended, and if photophobia is a problem, low light and sunglasses may be helpful. To limit vestibular/balance symptoms it is recommended that the individual move head and body slowly. No video games, studying or driving are permitted. (Table on next page)

Stage 2: Light Routine Activity

The following day after initiation of Stage 1, the service member should complete the NSI prior to initiation of Stage 2. The objective of Stage 2 is to introduce and promote limited effort. Physical exercises in this stage include light aerobic activity, such as treadmill walking and stationary cycling. Target RPE is 7-11 and HR should not exceed 55 percent of TMHR during activity. Physical activities in Stage 2 are limited to maximum of 30 minutes followed by four hours of rest.²⁴ Cognitive activities are limited to 30 minutes followed by 60 minutes of rest. A light increase in the amount and speed of head and body movements during activities is encouraged. No sit-ups, pull-ups or push-ups are allowed in this stage. No repetitive lifting, resistance training, video games, driving or crowded environments where jostling may occur are permitted during Stage 2.4 (Table on next page).

DoD Clinical Recommendation | January 2014

Progressive Return to Activity Following Acute Concussion/Mild Traumatic Brain Injury:

Guidance for the Rehabilitation Provider in Deployed and Non-deployed Settings

Rehabilitation Stage	Stage Objective	Physical Progression	Cognitive Progression	Vestibular and Balance Progression
Stage 1 Rest	Rest, limit activity to promote recovery No same day return to duty/play Provide and review with patient Stage 1 education sheet	Extremely light physical activity, primarily rest although total bed rest not recommended Sleep as desired Abstain from alcohol Avoid caffeine and nicotine Avoid breath holding RPE Scale rating — extremely light; 6-8 Heart rate not to exceed 40% of age adjusted theoretical maximum heart rate; resting HR not greater than 100 Document resting HR and BP (baseline)	DEMANDS Extremely light cognitive activity, primarily rest Quiet environment with low lighting Ensure service member has corrective lenses and if photophobia is a problem, low light and sunglasses are advised	Slow and limited range of head and body movement when changing positions to limit symptoms Limit positions where head is below the heart
Initiate Stage 2 the next day after Stage 1, if no new symptoms, no symptoms above a rating of 1 on the NSI, resting BP not to exceed 140/90, resting HR not greater than 100		ACTIVITY EXAMPLES		
		Basic activities of daily living Wear comfortable clothes Remain seated as needed (such as for hygiene, showering, dressing, meals) Walking as required — limited to easy pace, even terrain, minimal grade (such as to latrines and dining) No exercise	Extremely light, leisure activity (such as television with rest breaks each hour, short leisure reading, casual conversation) No video games No studying No driving	Movement as required for daily routine at tolerated pace Put on shoes while bringing foot to knee, use slip on shoes No bending with head below heart
Rehabilitation Stage	Stage Objective	Physical Progression	Cognitive Progression	Vestibular and Balance Progression
Stage 2 Light Routine Activity	Introduce and promote limited effort activities Provide and review with patient Stage 2 education sheet	Maximum 30 minutes of light activity to build endurance; followed by four hours of rest RPE Scale rating — light; 7-11 Heart rate not to exceed 55% of age adjusted theoretical maximum heart rate Resting HR not greater than 100; resting BP not to exceed 140/90 Limited lifting of light objects; avoid repetitive lifting Encourage healthy sleep habits	DEMANDS Maximum 30 minutes of light cognitive activity followed by minimum 60 minutes rest between cognitive activities Simple, familiar activities performed one at a time Increasing exposure to light, and distracting noise	Increase amount and speed of head and body movements in daily routine Head movements that require turning, tilting, forward and backward bending as tolerated Increase shifts in visual focus from near to far and right to left Avoid crowded areas where jostling may occur
Initiate Stage 3 the next day after Stage 2, if no new symptoms, no symptoms above a rating of 1 on the NSI, resting BP not to exceed 140/90, resting HR not greater than 100		ACTIVITY EXAMPLES		
		Initiate intentional outdoor activities (mild temperature changes) Walking on level surfaces (treadmill) May wear uniform/boots Stationary cycling at slow pace with no tension Stretching No weight lifting No resistance training No combatives or collision sports	Laundry Leisure reading, including newspaper Computer use (internet navigation, casual email correspondence, etc.) Simple board or card games Assemble/disassemble weapon; clean weapon No video games No driving	Bending tasks (e.g., make bed; pick up objects from ground; put boots/socks on with feet on floor) Stair climbing as tolerated Ball catch and toss, indoor "basketball" (seated; tabletop) with small foam ball No sudden head or body movements

DoD Clinical Recommendation | January 2014

Progressive Return to Activity Following Acute Concussion/Mild Traumatic Brain Injury:
Guidance for the Rehabilitation Provider in Deployed and Non-deployed Settings

Stage 3: Light Occupation-oriented Activity

The following day after Stage 2, the service member should complete the NSI prior to initiation of Stage 3. These objectives are to introduce and promote light occupation-oriented activities. These activities should include physical, cognitive and vestibular/balance skills. Activity periods in Stage 3 do not exceed 60 minutes. A target RPE of 10-12 and HR of 65 percent of the TMHR are recommended. The recommended rest period must follow the activity period to allow for adequate recovery time.^{25, 26, 27} Cognitive activity periods are limited to 30 minutes of light activity followed by a minimum of 60 minutes of rest. No valsalva, combatives or collision sports, video games or driving are permitted in this stage.

Rehabilitation Stage	Stage Objective	Physical Progression	Cognitive Progression	Vestibular and Balance Progression
Stage 3 Light Occupation-oriented Activity	Full body, complicated coordinated movements Provide and review with patient Stage 3 education sheet	DEMANDS		
		Occupation-oriented activities for a maximum of 60 minute periods followed by four hours of rest (1:4) RPE Scale rating — light; 10-12 Heart rate not to exceed 65% of age adjusted theoretical maximum heart rate Resting HR not greater than 100; resting BP not to exceed 140/90 Avoid repetitive lifting Encourage healthy sleep habits	Maximum 30 minutes of light cognitive activity followed by minimum 60 minutes rest between cognitive activities Simple, unfamiliar tasks <i>or</i> complex familiar tasks (more steps, distractions in environment) Activities that require one or more of the following: <ul style="list-style-type: none"> ▪ Using written technical instructions ▪ Visually scanning the environment while moving Increase exposure to light and noise distractions	Increase balance challenges in different light and terrain conditions Increase activities that require one or more of the following: <ul style="list-style-type: none"> ▪ Clear vision during movement ▪ Faster eye, head and body movements ▪ Stooping, stretching and aiming ▪ Motion in the surrounding environment
Initiate Stage 4 the next day after Stage 3, if no new symptoms, no symptoms above a rating of 1 on the NSI, resting BP not to exceed 140/90, resting HR not greater than 100		ACTIVITY EXAMPLES		
		Functional tasks requiring occasional lift and carry; lifting not to exceed 20 pounds May wear helmet and/or load bearing equipment (ammunition belt, suspenders, first aid kit, etc.) Light military tasks (cleaning equipment, organizing personal space) Brisk walk Elliptical or stair climber Sit-ups, pull-ups, pushups — no more than 25% of repetitions on most recent fitness test Plank No valsalva No combatives or collision sports	Shopping for one item Narrated walk (service member identifies and verbally reports landmarks while walking on smooth terrain) Preventive maintenance check on vehicles Tabletop construction tasks that involve written/diagram instructions No video games No driving	Carrying objects indoors that block view of feet Walking on uneven terrain, steps, different lighting conditions Passenger in vehicle as tolerated, switch focus from near to distant landmarks Walking in narrow aisle or hallway Hand-to-hand ball toss overhead Stand on one foot with eyes open, then closed Swimming (avoid flip turns) Squat bender, windmill

DoD Clinical Recommendation | January 2014

Progressive Return to Activity Following Acute Concussion/Mild Traumatic Brain Injury:

Guidance for the Rehabilitation Provider in Deployed and Non-deployed Settings

Stage 4: Moderate Activity

The following day after Stage 3, service members should complete the NSI prior to initiation of Stage 4. The goal of this stage is to increase the intensity and complexity of exercise, cognitive activity and balance movements. A target RPE of 12-16 and HR of 70-85 percent of the TMHR are recommended. Physical activity in Stage 4 is limited to 90 minute intervals. The physical activity to rest ratio should be 1:4. Activity examples include shooting a basketball, throwing and catching a ball while moving, foosball, golf putting, jump rope and swimming with flip turns. Supplementary examples of these exercises and activities can be found on the last page of the CST. Cognitive activity in this stage is recommended at a minimum of 20 minutes but not to exceed 40 minute periods. Maintain a 1:2 cognitive activity to rest ratio. No driving, combative, contact or collision activities are permitted at Stage 4.

Rehabilitation Stage	Stage Objective	Physical Progression	Cognitive Progression	Vestibular and Balance Progression
Stage 4 Moderate Activity	Increase intensity and complexity of exercise and cognitive activity Provide and review with patient Stage 4 education sheet	DEMANDS		
		Maximum 90 minutes of moderate activity RPE Scale rating — somewhat hard; 12-16 Heart rate not to exceed 70-85% of age adjusted theoretical maximum heart rate Resting HR not greater than 100; resting BP not to exceed 140/90 Exercise and rest ratio of 1:4 (30 minute activity requires two hours of rest, 60 minute activity requires four hours rest, etc.) Occasional lifting and carrying of objects; recommend avoiding maximum weight Non-contact activities Encourage healthy sleep habits	Sustained cognitive activity for at least 20 minutes at a time, not to exceed 40 minutes and must be followed by 80 minutes cognitive rest. Cognitive activities require one or more of the following: <ul style="list-style-type: none"> ▪ Remembering to do a task at a specific time ▪ Problem solving ▪ Remembering and following verbal instructions ▪ Shifting back and forth between two tasks ▪ Scanning environment while performing a task 	Increase exercise intensity with activities that require one or more of the following: <ul style="list-style-type: none"> ▪ Improve ability to see clearly with faster head/body movements ▪ Head movements in all directions with visual tracking ▪ Total body movement, up and down (bouncing, jumping, jostling) as tolerated including riding as a passenger in a vehicle ▪ Navigating uneven terrain with reduced ability to visualize foot placement ▪ Short durations as a passenger in a vehicle
		ACTIVITY EXAMPLES		
		Activities from previous stages — increase stress/duration May wear personal protective equipment (body armor, plates, mask, protectors) in progressively weighted manner Non-contact sport-related activities (shooting basketball, throwing/catching ball) Brisk hike (> 3 mph) no additional load Resistance training — 60-75% of 1 rep max Moderate military job tasks Tasks requiring climbing/crawling with no additional load and jogging to running as tolerated Progressive sit-up, push-up, pull-up drills (change hand/body position, speed, duration, etc.) Increase reps of sit-ups, pull-ups, push-ups — no more than 50% of repetition on most recent fitness test No combatives or collision sports	Managing appointments, medications Map reading while walking Orienteering/land navigation Grocery shopping Strategy games (chess, poker) Video games Target practice Weapons simulator Driving simulation No driving	Shooting basketball, throwing/catching ball while moving Carrying objects across rugged terrain Foosball, golf putting, ping pong, video games Agility drills with cutting and quick direction changes Jump rope Mini trampoline Swimming with flip turns
	Initiate Stage 5 the next day after Stage 4, if no new symptoms, no symptoms above a rating of 1 on the NSI, resting BP not to exceed 140/90, resting HR not greater than 100			

DoD Clinical Recommendation | January 2014

Progressive Return to Activity Following Acute Concussion/Mild Traumatic Brain Injury:
Guidance for the Rehabilitation Provider in Deployed and Non-deployed Settings

Stage 5: Intensive Activity

The following day after Stage 4, service members should complete the NSI prior to initiation of Stage 5. Stage 5 prepares the service member for duty by testing physical, cognitive and vestibular/balance skills at full exertion. It is recommended that activities be duty-oriented. Duration and intensity of activity parallels service member's typical role and function. Resistance training is maximized in this stage. RPE target is 16-18, HR is recommended to be at 85-100 percent of the TMHR. Cognitive activity should be sustained for a maximum of 50 minutes and include an environment of exertion and/or distraction. Driving is included in this stage if appropriate. Navigating uneven terrain, jump landing and simulations that include virtual reality are recommended to establish vestibular/balance symptom resolution. No combative, contact or collision activities are permitted at Stage 5.

Rehabilitation Stage	Stage Objective	Physical Progression	Cognitive Progression	Vestibular and Balance Progression
Stage 5 Intensive Activity	Duration and intensity of activity parallels service member's typical role, function(s) and tempo Provide and review with patient Stage 5 education sheet	DEMANDS		
		Resume usual exercise routines (with exceptions below) RPE Scale rating — very hard; maximum exertion; 16+ Heart rate not to exceed 85-100% of age adjusted theoretical maximum heart rate Resting HR not greater than 100; resting BP not to exceed 140/90 Encourage healthy sleep habits	Cognitive activities should be sustained for maximum of 50 minutes during exertion and/or distractions. Include activities requiring one or more of the following: <ul style="list-style-type: none"> ▪ Problem solving ▪ Multi-tasking ▪ Remembering and following verbal instructions ▪ Shifting between multiple tasks ▪ Scanning the environment while performing tasks ▪ Verbally instruct someone how to perform a procedure — monitor and correct their performance 	Greater exercise intensity and dynamic balance in conditions that include one or more of the following: <ul style="list-style-type: none"> ▪ Visual challenges (smoke, low light, night vision goggles, bright lights) ▪ Rapid head and body movements ▪ Visual scanning with rapid head/eye movements while moving quickly ▪ Rapid position changes and greater jarring movements ▪ Increased duration riding as a passenger
Initiate Stage 6 the next day after Stage 5, if no new symptoms, no symptoms above a rating of 1 on the NSI, resting BP not to exceed 140/90, resting HR not greater than 100		ACTIVITY EXAMPLES		
		Participate in normal training activities Heavy military job tasks (digging, soldier carry, getting in and out of the turret of an armored vehicle, getting under a vehicle, change tire, load/unload equipment) Resistance training to maximum No combatives or collision sports	Communicating by signals during patrol duty Using appropriate tactics, techniques and procedures for radio communication Planning and explaining MOS specific tasks (see one, do one, teach one) Participating in typical duty day without going outside wire Participating in usual military and social activities Simulated weapons training Driving as appropriate per pre-driving screens or assessments, supervised, on road rides or simulated driving — as appropriate to MOS or civilian roles — based on available resources and environment	Navigating uneven terrain with full load Running/quick navigation in rough terrain and low-light conditions, night vision goggles, bright light Patrol duty Jump landing Simulations and virtual reality environments

Stage 6: Unrestricted Activity

The following day after Stage 5, service members should complete the NSI prior to initiation of Stage 6. Service members should be advised to return to provider if symptoms return or increase in severity.

Conclusion

Emerging evidence supports a stepwise or progressive approach to return to activity following mTBI. The inclusion of both subjective and objective measures allows for standardized care while promoting optimal individualized return to pre-injury activity following mTBI.

DoD Clinical Recommendation | January 2014

Progressive Return to Activity Following Acute Concussion/Mild Traumatic Brain Injury: Guidance for the Rehabilitation Provider in Deployed and Non-deployed Settings

References

1. Defense and Veterans Brain Injury Center. (2013). DoD Worldwide Numbers for TBI Worldwide totals. Retrieved from: <http://dvbic.dcoe.mil/sites/default/files/uploads/dod-tbi-worldwide-2013-Q1-Q3-as-of-05%20Nov-2013.pdf>.
2. Armed Forces Health Surveillance Center. (2013). Deployment-Related Conditions of Special Surveillance Interest, U.S. Armed Forces, by Month and Service, January 2003–December 2012 (data as of June 2013), Traumatic brain injury. Retrieved from: <http://www.afhsc.mil/msmrToc>
3. McCrea, M. (2008). Mild traumatic brain injury and post-concussion syndrome: The new evidence for diagnosis and treatment. Oxford Press: New York New York
4. McCrory, P., Meeuwisse, W., Aubry, M., Cantu, B., Dvořák, J., Echemendia, R., Engbretsen, L., Johnson, K., Rafferty, M., Sills, A., Benson, B., Davis, G., Ellenbogen, R., Guskiewicz, K., Herring, S., Iverson, G., Jordan, B., Kissick, J., McCrea, M., McIntosh, A., Maddocks, D., Makdissi, M., Purcell, L., Putukian, M., Schneider, K., Tator, C. & Turner, M. (2013). Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012. *British Journal of Sports Medicine* 47, 250-258, retrieved from: dx.doi.org/10.1136/bjsports-2013-092313
5. Management of Concussion/mTBI Working Group. (2009). VA/DoD clinical practice guideline for management of concussion/mild traumatic brain injury. *Journal of Rehabilitation Research and Development* 46(6), CP1–68.
6. Defense Center of Excellence for Psychological Health and Traumatic Brain Injury. (2012). Concussion Management in Deployed Settings version 4.0. Retrieved from: dcoe.mil/Content/Navigation/Documents/DCoE_Concussion_Management_Algorithm_Cards.pdf
7. Department of Defense Instruction 6490.11: DoD Policy Guidance for Management of Mild Traumatic Brain Injury/Concussion in the Deployed Setting. (2012). Retrieved from: <https://www.hsdl.org/?search&collection=public&fct&so=date&submitted=Search&offset=0&tabsection=US+Depts%2C+Agencies+%26+Offices&page=1&publisher=United+States.+Dept.+of+Defense>
8. Defense Veterans Brain Injury Center. (2012). Military Acute Concussion Evaluation, Version 4. Retrieved from: dvbic.dcoe.mil
9. Leddy J., Sandhu, V., Baker, J., & Willer, B. (2012) Rehabilitation of concussion and post-concussion syndrome. *Sports Health* 4,147-154
10. Lutz, R., Kane, S., & Lay, J. (2010). Evidence-based diagnosis and management of mTBI in forward deployed settings: the genesis of the USASOC neurocognitive testing and post-injury evaluation and treatment program. *Journal of Special Operations Medicine: a Peer-Reviewed Journal for SOF Medical Professionals* 10(1), 23-3
11. Hunt, T. & Asplundh, C. (2010). Concussion assessment and management. *Clinical Sports Medicine* 29, 5-17.
12. Cicerone, K., & Kalmar, K. (1995). Persistent post-concussion syndrome: The structure of subjective complaints after mild traumatic brain injury. *The Journal of Head Trauma Rehabilitation* 10(3), 1-17.
13. French, L., Lange, R., Iverson, G., Ivins, B., Marshall, K., & Schwab, K. (2012). Influence of bodily injuries on symptom reporting following uncomplicated mild traumatic brain injury in US military service members. *Journal of Head Trauma Rehabilitation* 21(1), 63-74.
14. Chen, M., Fan, X., & Moe, S. (2002). Criterion-related validity of the Borg ratings of perceived exertion scale in healthy individuals: a meta-analysis. *Journal of Sports Medicine* 20, 873-899.
15. Scherr, J., Wolfarth, B., Christle, J., Pressler, A., Wagenpfeil, S., & Halle, M. (2012). Associations between Borg's rating of perceived exertion and physiological measures of exercise intensity. *European Journal of Applied Physiology* 113, 147–155 doi: 10.1007/s00421-012-2421-x
16. CDC (n.d.). Physical activity for everyone: measuring intensity: Perceived exertion | DNPAO | CDC. Retrieved May 14, 2012, from www.cdc.gov/physicalactivity/everyone/measuring/exertion.html.
17. Leddy, J., Kozlowski, K., Donnelly, J., Pendergast, D., Epstein, L., & Willer, B. (2010). A preliminary study of sub symptom threshold exercise training for refractory post-concussion syndrome. *Clinical Journal of Sport Medicine* 20(1), 21–27
18. Silverberg, N., & Iverson, G. (2012) Is rest after concussion “the best medicine?” Recommendations following concussion in athletes, civilians and military service members. *Journal of Head Trauma* 28(4), 250-259. Retrieved from: www.headtraumarehab.com
19. Lovallo, W., Wilson, M., Vincent, A., Hee- Sung, B., McKey, B., & Whitsett, T., (2004). Blood pressure response to caffeine shows incomplete tolerance after short term regular consumption. *Hypertension* 43, 760-765.
20. Guidice, R., Izzo, R., Manzi, M., Pagano, G., Santoro, M., Rao, M., DiRenzo, G., DeLuca, N., & Trimarco, V. (2012) Lifestyle related risk factors, smoking status, and cardiovascular disease. *High Blood Press Cardiovascular Previews* 19(2), 85-92.
21. Adams, R., Larson, M., Corrigan, J., Horgan, C., & Williams, T., (2012). Frequent binge drinking after combat-acquired traumatic brain injury among active duty military personnel with a past year combat deployment. *Journal of Head Trauma Rehabilitation* 27(5), 349-360.
22. Herring, S., Cantu, R., Guskiewicz, K., Putukian, M., Kibler, W., Bergfeld, J., Boyajian-O'Neill, L., Franks, R., & Indelicato, P. (2011) Concussion (mild traumatic brain injury) and the team physician: a consensus statement — 2011 update. *Medicine and Science in Sports and Exercise* 43(12), 2412-22.
23. Alla, S., Sullivan, J. & McCrory, P. (2012). Defining asymptomatic status following sports concussion: fact or fallacy? *British Journal of Sports Medicine* 46, 562-569.
24. McArdle, W., Katch, F., & Katch, V. (1996). *Exercise Physiology*. Baltimore, MD: Williams and Wilkins
25. Gaesser, G., & Brooks, G. (1984) Metabolic bases of excess post-exercise oxygen consumption: a review. *Medicine and Science in Sports and Exercise* 16(1), 29-43.
26. Karlsson, J., & Saltin, B. (1971). Oxygen deficit and muscle metabolites in intermittent exercise. *Acta Physiologica Scandinavica* 82(1), 115-122.
27. Ramsbottom, R., Nevill, A., Nevill, M., Newport, S., & Williams, C. (1994). Accumulated oxygen deficit and short-distance running performance. *Journal of Sports Science* 12(5), 447-53.

PUID 1626.1.2.2

Released January 2014 | Revised August 2019
by Defense and Veterans Brain Injury Center.

This product is reviewed annually and is current until superseded. 800-870-9244 | dvbic.dcoe.mil