Heart Rate Variability and Exertional Task Analysis in the Recovery of Mild Traumatic Brain Injury in Service-Members (HEARTS)

A Comparison of Service-Members with mTBI and Healthy Controls

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Introduction

- Clinicians commonly determine duty readiness based on the absence of symptoms and return to "normal" performance on clinical assessments with ceiling effects
- Due to the physical demands inherent to active duty and potentially unreliable nature of self-reporting, an objective exertion assessment that may demonstrate physiological autonomic dysfunction is needed to assist clinicians in making appropriate return to duty (RTD) decisions.
- Despite recommendation for exertional testing to target concussion deficits, no standardized and military relevant objective measures currently exist.

Purpose/Objective

- Evaluate two specific tasks, which are clinically feasible and induce an appropriate level of exercise stress to assess autonomic balance using Heart Rate Variability measurement.

Subjects

- 25 individuals who have sustained a concussion in the prior 72 hours (currently 12 enrolled)
- 25 age-matched (+/-2) healthy service-members (SM)

Characteristic	Healthy Controls N = 25	mTBI N = 12	p-value
Age in years	25.7 (5.9)	26.7 (6.4)	0.65[1]
Sex (Male)	25 (100%)	12 (100%)	1.00[2]
Years in military	5.1 (5.5)	4.3 (4.5)	0.67[1]
Been Deployed (Y)	8 (32%)	5 (42%)	0.56[2]
Number of Previous Concussions	0.28 (0.74)	2.1 (1.9)	<0.01[1]

Table 1. NOTE. Values are n (%), mean (SD).[1] t-Test,[2] Chi Square , *p − value =< 0.05

Methods

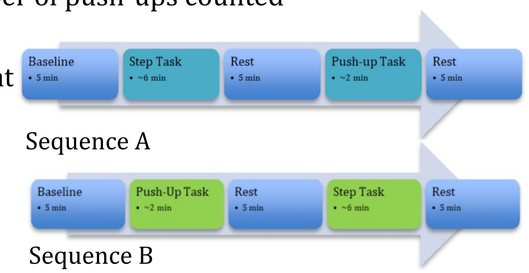
Step Test

- 12 in. step, 6-minute task
- Modified from Chester Step Test
- Metronome paced (speed increases every 2 min)
  - 20 steps/min (80 bpm)
  - 25 steps/min (100 bpm)
  - 30 steps/min (120 bm)

Push-Up Task

- No extra equipment needed, 2-minute task
- Self-paced push-ups for maximum of 2 minutes
- Similar to Army Physical Fitness Test (APFT) Push-up component
- Total number of push-ups counted

- After reported minimal symptoms at rest, mTBI participants complete same testing sequence, and will be age-matched to a healthy control subject



Safety Stopping Rules

- Rating of greater than 16 Perceived Exertion (Borg Scale)
- Symptom increase >2 points
- Heart Rate >85% of predicted age adjusted maximum

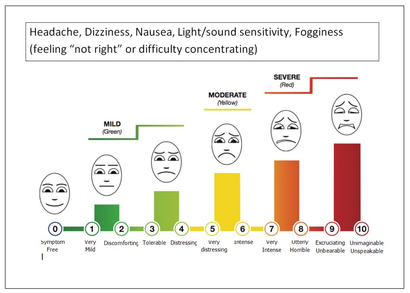
- Ratings of perceived exertion (Borg RPE) and symptom exacerbation (Likert scale) at the beginning of every minute for the duration of each exertional task

Additional Equipment

Polar H10 heart rate monitor worn around chest, with Bluetooth transmission for real-time monitoring (HRV results not reported here)

Borg's Rating of Perceived Exertion (RPE) Scale

Perceived Exertion Rating	Description of Exertion
6	No exertion. Sitting & resting
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion



Results

Healthy SMs were able to successfully complete both tasks consistent with the study criteria. SMs with mTBI were not consistent in completing tasks:

- 6 SMs did not complete the Step task (50%), 1 was stopped because he reported an RPE of 17, couldn't keep cadence, and reported symptom increase, 3 had a HR >85% of age-predicted HR max, and 2 others reported symptom increase
- 6 SMs did not complete the Push-up test, 4 were stopped by the examiner for safety reasons and 2 did not reach the minimum APFT standard for push-ups based on age.
- Preliminary findings indicate exertional conditions of both tasks provoke impairments not evident in a resting state. (Table 2)

Subject ID (mTBI)	Days Since Injury	Age	Step Task Successful Completion	Step Stopping Rule	Push Up Successful Completion	Push Up Stopping Rule
301	5	29	N	Symptoms	N	Symptoms
302	9	43	Y		Y	
304	11	32	N	HR	Y	
305	13	22	N	RPE, Symptoms, cadence	N	RPE
306	14	22	Y		N	
307	5	31	Y		N	HR
309	7	21	N	HR	N	HR, symptoms
311	7	25	Y		Y	
314	7	20	Y		Y	
315	12	26	N	Symptoms	Y	
317	5	26	N	HR	N	Shoulder pain
318	10	23	Y		Y	

Table 2 Information regarding task completion and reason for stopping test in the 12 service members post concussion (mTBI).

Clinical Relevance

- This study provides two exertional tasks that may be easily implemented in primary care practice to test for possible symptom provocation and autonomic imbalance as SMs recover from concussion.
- Test results could help assist military clinicians in acute concussion care, inform return to duty decision making, guide rehabilitation interventions, and reduce risk for re-injury with premature RTD.