Sub-symptom threshold Exercise Protocol

OFFICIAL
HEALTH CARE

JETS

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ATLANTIC HEALTH SYSTEM

Overview

- Return to play protocols
- Science Behind RTP protocol
- Persistent Symptoms
- The Evidence (SSTE)
- New Evidence: Early Aerobic Exercise
- Balke-C protocol (SSTE) (Patients with continued PCS)

Return to Play protocols

Graduated return-to-sport (RTS) strategy
vs
Sub-Symptom Threshold Exercise Protocol

- ## Graduated return-to-sport (RTS) strategy

  Asymptomatic patient

  - 5 day protocol
  - progressing in intensity
  - Assessing recovery from concussion

Table 1 Graduated return-to-sport (RTS) strategy

Stage	Aim	Activity	Goal of each step
1	Symptom-limited activity	Daily activities that do not provoke symptoms	Gradual reintroduction of work/school activities
2	Light aerobic exercise	Walking or stationary cycling at slow to medium pace. No resistance training	Increase heart rate
3	Sport-specific exercise	Running or skating drills. No head impact activities	Add movement
4	Non-contact training drills	Harder training drills, eg, passing drills. May start progressive resistance training	Exercise, coordination and increased thinking
5	Full contact practice	Following medical clearance, participate in normal training activities	Restore confidence and assess functional skills by coaching staff
6	Return to sport	Normal game play	

NOTE: An initial period of 24–48 hours of both relative physical rest and cognitive rest is recommended before beginning the RTS progression.
There should be at least 24 hours (or longer) for each step of the progression. If any symptoms worsen during exercise, the athlete should go back to the previous step.
Resistance training should be added only in the later stages (stage 3 or 4 at the earliest). If symptoms are persistent (eg, more than 10–14 days in adults or more than 1 month in children), the athlete should be referred to a healthcare professional who is an expert in the management of concussion.

Return to Play protocols

Graduated return-to-sport (RTS) strategy
vs
Sub-Symptom Threshold Exercise Protocol

- Balke-C protocol

  OR

  Sub-symptom Threshold Exercise Protocol

  – Establishes a safe HR zone that athletes can exercise in

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Science behind RTP protocol

- Concussion affects the bodies control of its Physiologic Systems (Gall, B. 2004)
  - Heart and Autonomic Nervous System
- Concussed Athletes have: (Hanna-Pladdy B 2001)
  - Exaggerated sympathetic nervous activity and increased HRs (compared to control groups)
- Cerebral Autoregulation and cerebral blood flow is disturbed (DeWitt DS. 2003) (Gall B. 2004) (Leddy 2011)
  - Reason for increased Sx with exercise or other activities

JJ Leddy et al. Regulatory and autoregulatory physiological dysfunction in PCS. 2011

Leddy et al. Clin J Sports Med. Volume 20, Number 1, January 2010

Physiological effects after a Sports Related Concussion

- Sport-related concussion (SRC) is a physiological brain injury that produces cerebral and systemic effects, including exercise intolerance.
  - Concussion affects the autonomic nervous system and its control of cerebral blood flow, which may be why uncontrolled activity can exacerbate symptoms after concussion

- Exercise intolerance after concussion is believed to be the result of autonomic nervous system (ANS) dysfunction.
  - Ventilation is inappropriately low for the level of exercise intensity, raising arterial carbon dioxide (PaCO2) levels.
  - Elevated PaCO2 increases cerebral blood flow (CBF) out of proportion to exercise intensity, which is associated with symptoms that limit exercise performance.

Curr Sports Med Rep. 2018 Aug;17(8):262-270. Exercise is Medicine for Concussion. Leddy JJ1, Haider MN1, Ellis M2, Willer BS3.

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Persistent Symptoms

- Berlin Expert Consensus
  - 'Persistent Symptoms'- Failure of Normal Clinical Recovery- that is, symptoms that persist beyond expected time frame
  - >10-14 days in adults and >4 weeks in children
  - Persisting Post Traumatic Symptoms
    - Requires a detailed multimodal clinical assessment

Paul McCrory et al. Consensus Statement on Concussion in Sport- the 5th international conference on concussion in sport held in Berlin, October 2016. BJSM, Apr 26, 2017

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National Consensus

- The 5th international conference on concussion held in Berlin in 2017
  - Preliminary Evidence to Support: “an individualized symptom-limited aerobic exercise programme in patients with persistent post-concussive symptoms associated with autonomic instability or physical deconditioning, and…”
  - Recommend a brief period of rest, 24-48 hours followed by a progression of activities that is below symptom exacerbation level
  - Comment that the exact amount of rest is not yet well defined and further research is required
  - Early exercise after suffering a concussion may be safe and beneficial but further research is required

McCrory P, et al. Consensus statement on concussion in sport – the 5th international conference on concussion in sport held in Berlin, October 2016. Br J Sports Med 2018;**51**:838–847

National Consensus

- AMSSM Consensus guidelines
  - Symptom-limited exercise protocol is both safe and effective and recommend sub-symptom threshold activities and exercise for patients with prolonged concussion symptoms
  - Endorse 24-48 hours of symptom-limited cognitive and physical rest followed by a gradual increase in activity, staying below symptom exacerbation threshold
- American Academy of Neurology (2013)
  - The AAN felt that no conclusions can be drawn regarding the effects of post-concussion activity
- National Athletic Trainers Association Position Statement
  - An athlete that doesn't show a typical progressive recovery may benefit from other therapies or treatments, but they aren't defined.

Christopher C. Giza, Jeffrey S. Kutcher, Stephen Ashwal, et al. Summary of evidence-based guideline update: Evaluation and management of concussion in sports: Report of the Guideline Development Subcommittee of the American Academy of Neurology. Neurology.
Harmon KG, et al. American Medical Society for Sports Medicine position statement on concussion in sport. Br J Sports Med 2019;**53**:213–225.
Broglio, SP et. al. National Athletic Trainers' Association Position Statement: Management of Sport Concussion. Journal of Athletic Training 2014;49(2):245–265

Benefit or No Harm of Moderate Physical Activity or Controlled Exercise for Concussion

Physical Activity

Majerskeet al. (2008)-Retrospective
Brown et al. (2014)-Retrospective.
Thomas et al. (2015)-RCT
Buckley et al. (2015)-Prospective cohort
Silverberg et al. (2016)- analysis of RCT
Groolet al. (2016)-Prospective multicenter cohort
Howell et al. (2016)-Prospective cohort
Taubmanet al. (2016)-Prospective cohort
Sufrinkoet al. (2017)- analysis of RCT

New Evidence supporting:
Early Subthreshold aerobic exercise as early as 48 hours post injury.

Aerobic Exercise

Gagnon et al. (2009)-Prospective case series
Leddy et al. (2010)-Prospective case series
Baker et al. (2012)- Retrospective
Leddy et al. (2013)-Quasi experimental
Clausen et al (2015)-Prospective cohort
Maerlender et al. (2015)- RCT in acute SRC
Dematteo et al. (2015)-Prospective X-sectional
Cordingley et al. (2016)-Retrospective
Gagnon et al. (2016)-Prospective case series
*Kurowski et al. (2017)- RCT in PPCS.
Chrisman et al. (2017)-Retrospective
*Leddy et al (2017)- RCT of assessment

exercise tolerance in first week after SRC.
Chan et al (2018)-RCT in PPCS.

ATLANTIC HEALTH SYSTEM

A Preliminary Study of Subsymptom Threshold Exercise Training for Refractory Post-Concussion Syndrome

John J. Leddy, MD,† Karl Kozlowski, PhD,‡ James P. Donnelly, PhD,§*
*David R. Pendergast, EdD,¶ Leonard H. Epstein, PhD,‖ and Barry Willer, PhD***

- Inclusion Criteria: Dx of PCS
  - Sx at rest >6 weeks but <52 weeks
  - Demonstrates Sx exacerbation during a graded TM exercise test
- 12 subjects (7 men, 5 women)
  - 27.9 y/o (range, 16-53)
  - Average 19 weeks post injury (range, 6-40 weeks)
  - 6 athletes, 6 non-athletes
- Mean Graded Symptom Checklist
  - 9.67 (range, 2.39-18.46)

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TABLE. Summary Statistics for SMA Analysis of SSTET in PCS Subjects

			Baseline Descriptives			Treatment Descriptives			Treatment Effects: Level		Treatment Effects: Slope	
Subject	Gender	Athlete	n	M (SD)	AR	n	M (SD)	AR	*r*	*P*	*r*	*P*
1	F	Yes	13	7.85 (2.23)	0.17	28	3.43 (1.15)	−0.08	−0.79	.0001	−0.66	.0001
2	M	Yes	18	2.39 (2.16)	0.32	19	0.583 (0.394)	0.07	−0.48	.01	−0.48	.01
3	M	Yes	13	18.46 (1.28)	0.19	28	7.61 (8.72)	0.93	−0.57	.26	−0.93	.002
4	F	Yes	15	13.07 (1.88)	0.32	28	3.92 (4.77)	0.64	−0.72	.001	−0.71	.0002
5	F	Yes	22	6.77 (3.70)	0.54	11	1.0 (0.85)	0.41	−0.66	.005	−0.59	.02
6	M	Yes	13	2.85 (0.66)	−0.03	36	0.81 (1.35)	0.71	−0.63	.0009	−0.79	.0001
7	M	No	15	8.20 (2.20)	−0.09	112	8.51 (3.01)	0.34	0.03	.72	−0.27	.02
8	M	No	16	11.34 (1.96)	0.36	84	8.68 (4.36)	0.88	−0.24	.22	−0.85	.0001
9	M	No	14	16.64 (1.63)	−0.23	80	12.41 (2.34)	0.48	−0.56	.0001	−0.68	.0001
10	M	No	19	2.63 (2.23)	0.03	41	0.88 (0.63)	0.27	−0.52	.0001	−0.51	.0004
11	F	No	16	16.13 (2.03)	0.30	57	11.82 (2.87)	0.31	−0.55	.0002	−0.52	.0001

AR, autocorrelation; F, female; M, male; M, mean number of symptoms; n, days of baseline or treatment; PCS, post-concussion syndrome; *r*, correlation coefficient; SD, standard deviation; SMA, Simulation Modeling Analysis; SSTET, subsymptom threshold exercise training.

Level is total change in # of daily symptoms
Slope change in rate of improvement

Leddy et al. Clin J Sports Med. Volume 20, Number 1, January 2010

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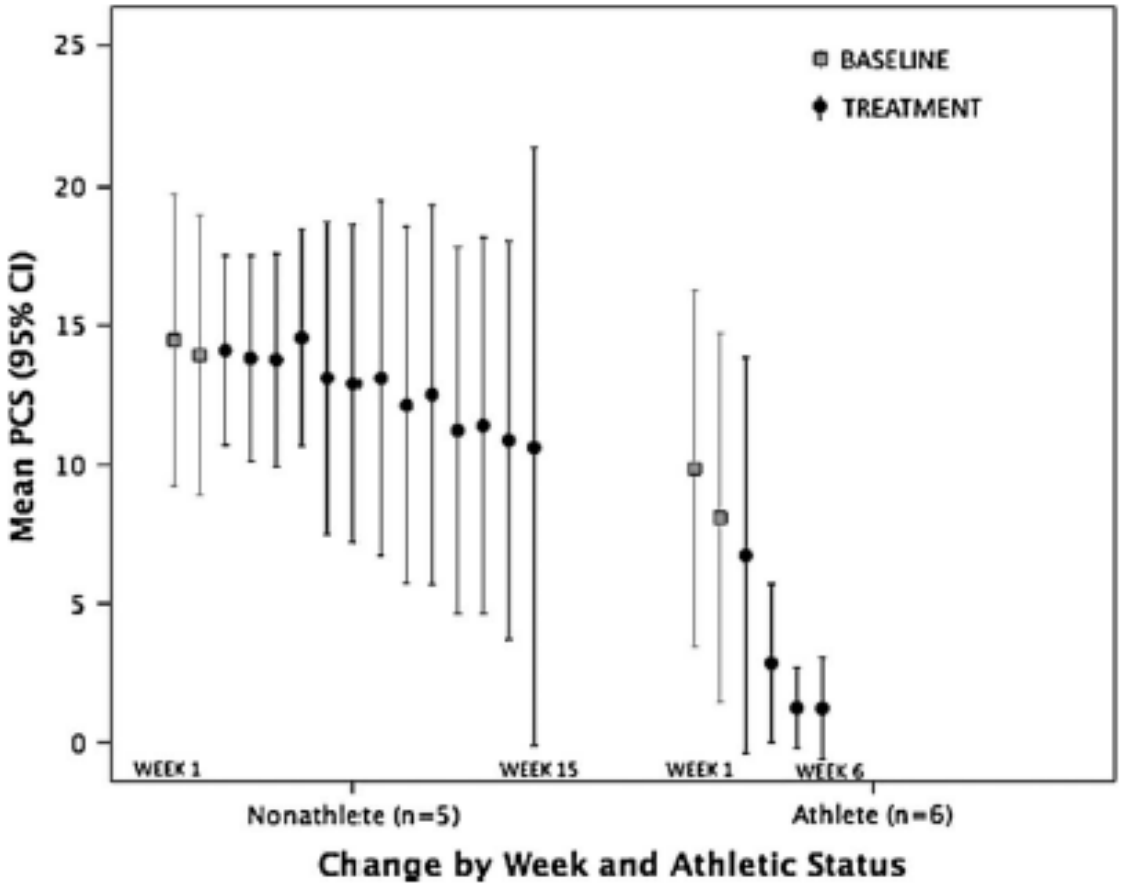

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CONCLUSION:

- Exercise increases:
  - parasympathetic activity
  - reduces sympathetic activation
  - improves cerebral blood flow
- Study shows that PCS may be safely treated:
  - using a program of quantitative, individualized, and progressive subsymptom threshold aerobic exercise
- When compared with the baseline period of no intervention, patients with PCS performing SSTET significantly improved symptomatically

Buffalo Concussion TM Test

Validity: based on the Balke Cardiac Stress Test

- To Evaluate exercise tolerance in persons with prolonged Sx after concussion (>4-6 weeks)
- Used to develop individualized sub-symptom threshold exercise treatment programs to:
  - Restore the physiology to normal and enhance recovery
  - Return of normal exercise tolerance

Conclusions:

- Absolute rest beyond first few days may be detrimental to concussion recovery
- For patients with PCS, sub-symptom threshold exercise improves activity tolerance and is an appropriate treatment option for this patient population

PM R. 2016 Mar;8(3 Suppl):S91-S100. The Role of Controlled Exercise in Concussion Management. Leddy J1, Hinds A2, Sirica D3, Willer B4.

Current Sports Medicine Reports. 12(6):370–376, NOV 2013. **Use of Graded Exercise Testing in Concussion and Return-to-Activity Management.** John J. Leddy; Barry Willer

PT Based- Multimodal Rehab

- 25 patients: 12-20 years old
  - WHO criteria for PCS following Sports related concussion
- Therapy: Multimodal, impairment based PT
  - Vestibular/oculomotor and cervical rehabilitation
  - Sub-Symptom threshold exercise
- Main Measurements:
  - Post-Concussion Symptom Scale
  - Maximum Sx Free HR
  - Balance Error Scoring System
- Outcome:
  - Total PCSS (Pre PT- 18.2 vs Post PT- 9.1)
  - Maximum SFHR- increased 23%
  - BESS Errors- decreased 52%

Phys Ther Sport. 2017 Jan;23:22-30. Epub 2016 Jun 7. Multimodal impairment-based physical therapy for the treatment of patients with post-concussion syndrome: A retrospective analysis on safety and feasibility. Grabowski P1, Wilson J2, Walker A2, Enz D3, Wang S4.

Aerobic Exercise for Adolescents

- 30 Adolescents: ages 12-17, sustained a mTBI
  - 4-16 weeks of persistent symptoms
- Partially Blinded, Pilot RCT
  - Subsymptom exacerbation aerobic training compared with full-body stretching
- Main Measurement: Post-injury Symptom Improvement (Self reported PCSI
- Outcome:
  - Greater rate of Improvement for Subsymptom Exacerbation training group

J Head Trauma Rehabil. 2017 Mar/Apr;32(2):79-89. Aerobic Exercise for Adolescents With Prolonged Symptoms After Mild Traumatic Brain Injury: An Exploratory Randomized Clinical Trial. Kurowski BG1, Hugentobler J, Quatman-Yates C, Taylor J, Gubanich PJ, Altaye M, Wade SL.

The Role of Exercise s/p Concussion

A Systematic Review and Meta-analysis

- Inclusion criteria:
  - evaluating the effect of physical exercise, compared with control, in patients with a concussion or mild traumatic brain injury were included
- 14 studies: (5 RCTs, 1 matching study, 3 cohort studies, and 5 before and after studies)
- Results:
  - Exercise Significantly decreased the PCSS, percentage of patients with Sx and days off work
    - PCSS- Mean difference: -13.06 (-16.57 to -9.55)
    - Days off work- 17.7 days vs 32.2 days
  - Exercise improved reaction time on ImPACT w/out affecting BESS scores

Am J Sports Med. 2018 Mar;46(3):743-752. The Effect of Physical Exercise After a Concussion: A Systematic Review and Meta-analysis. Lal A1, Kolakowsky-Hayner SA1, Ghajar J1,2, Balamane M1.

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Early Aerobic Exercise

in Adolescent Males

- Objective: Early Aerobic Exercise (assessment at initial visit) vs Relative Rest
- Participants: Male Adolescents (13-18 years old) that suffered a Sports Related Concussion within 1-9 days of evaluation.
- Exclusion: Risk Factors of ADHD, Learning DO, depression or anxiety
  - 3 previous concussions
  - PCSS less than 5
- Groups: 1. Exercise Group (n=24)- performed subthreshold aerobic exercise at 80% HR achieved at Symptom exacerbation AND 2. Rest Group (n=30)
  - Symptom Score (PCSS)- reported everyday between 7-10pm for 2 weeks
    - Clusters: *Physical, Cognitive, Sleep, and Affective*
  - Recovery- PCSS less than 7 or returned to baseline

Clin J Sport Med. 2019; 29:353-360. A Preliminary Study of the Effect of Early Aerobic Exercise Treatment for Sport-Related Concussion in Males. John J. Leddy, MD, FACSM,FACP

Symptom Clusters

TABLE 1. Symptom Clusters

Physical (8 Symptoms, Max Score 48)	Cognitive (6 Symptoms, Max Score 36)	Sleep (3 Symptoms, Max Score 18)	Affective (4 Symptoms, Max Score 24)
Headache	Feel slowed down feeling like “in a fog”	Fatigue or low energy	More emotional
Pressure in head	“Do not feel right”	Drowsiness	Irritability
Neck pain	Difficulty concentrating	Trouble falling asleep	Sadness
Nausea or vomiting	Difficulty remembering		Nervous or anxious
Dizziness	Confusion		
Blurred vision			
Sensitivity to light			
Sensitivity to noise			

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Early Aerobic Exercise

in Adolescent Males

- Results

TABLE 3. Recovery Time Since Initial Visit, Total Recovery Time, and Incidence of Delayed Recovery

	EG (n = 24)	RG (n = 30)	*P*
Recovery time since initial visit (d)	8.29 ± 3.85	23.93 ± 41.73	0.048*
Total recovery time (d)	13.04 ± 4.89	28.43 ± 41.78	0.052*
Total symptoms (% not recovered by 14 d)	8% (2/24)	33% (10/30)	0.028†
Physical symptoms (% not recovered by 14 d)	8% (2/24)	33% (10/30)	0.028†
Cognitive symptoms (% not recovered by 14 d)	4.2% (1/24)	27% (8/30)	0.027†
Sleep symptoms (% not recovered by 14 d)	0% (0/24)	23% (7/30)	0.011†
Affective symptoms (% not recovered by 14 d)	8% (2/24)	7% (2/30)	0.816†
Delayed recovery (recovery > 30 d)	0% (0/24)	13% (4/30)	0.063†

** Welch 2-sample t tests with unequal variances.*
† Pearson χ^2 test (2-sided).

- **Recovery time from Initial visit:** 8.29 vs 23.93
- **Total Recovery time:** 13.04 vs 28.43
- **None** of 24 EG participants had delayed recovery
- 4 RG participants had delayed recovery (113.25 +/- 73.6 days)

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Early Aerobic Exercise

University at Buffalo: John Leddy, MD

Sub-Threshold Exercise Treatment for Adolescents With Sports Related Concussion

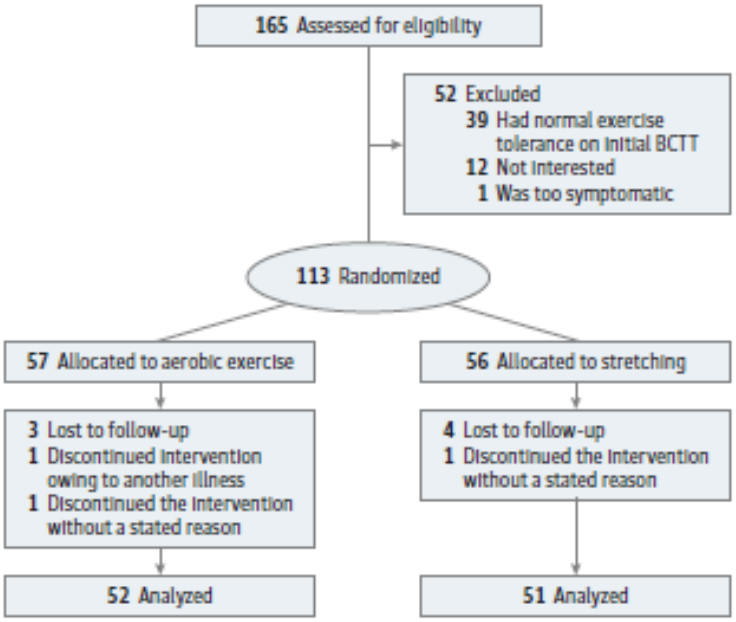
- Adolescents (13-18 y/o): 103 enrolled
  - Inclusion Criteria: Adolescent with concussion injury from sports within first 10 days
  - Exclusion Criteria: Evidence of focal neurologic deficit, ADHD, history of moderate or severe TBI, greater than 3 prior concussions (or having history of long recovery from concussion, >3 mths), PCSS less than 5
- 2 Arms
  - Treatment Group: sub-threshold exercise (80% of their threshold HR)- n=52, 24 female
  - Placebo Group: structured stretching exercise (20 minutes)- n=51, 24 female
- Initial evaluation: (1) structured PE (2) exercise stress test terminated with Sx exacerbation
- Primary Outcome: Time to Recovery
  - Defined as Asymptomatic for 2 days, ability to exercise w/out exacerbation, and MD PE

JAMA Pediatrics. February 4, 2019. Early Subthreshold Aerobic Exercise for Sport-Related Concussion. A Randomized Clinical Trial John J. Leddy, MD, FACSM,FACP

Early Aerobic Exercise

University at Buffalo: John Leddy, MD

Figure 1. Consolidated Standards of Reporting Trials Flowchart



Lost to follow-up was defined as not completing at least 75% of reports and/or missing more than 3 days of reporting in a row. BCTT indicates the Buffalo Concussion Treadmill Test.

Table. Demographics and Buffalo Concussion Treadmill Test Results

Characteristic	Patients, No. (%)	
	Aerobic Exercise Group (n = 52)	Stretching Group (n = 51)
Age, mean (SD), y	15.3 (1.6)	15.4 (1.7)
Female	24 (46)	24 (47)
Previous concussions		
0	26 (50)	29 (57)
1	16 (31)	12 (24)
2	9 (17)	8 (16)
3	1 (2)	2 (4)
Time since injury, mean (SD), d	4.9 (2.2)	4.8 (2.4)
Quantitative findings at first visit, mean (SD)		
Postconcussion symptom scale score[a]	30.8 (16.5)	33.3 (19.7)
Abnormal physical examination findings, No.	2.2 (1.9)	2.8 (1.7)
Resting heart rate, bpm	74.5 (12.7)	75.2 (12.3)
Buffalo Concussion Treadmill Test findings		
Heart rate at symptom exacerbation, bpm	136.9 (26.2)	136.6 (21.2)
Time to symptom exacerbation on first-visit test, min	8.7 (4.9)	8.6 (4.3)
Visual analog scale scores, mean (SD)[b]		
Pretreadmill test score	2.5 (1.8)	2.8 (1.8)
Score at symptom exacerbation	4.7 (2.2)	5.1 (1.9)

[a] Maximum score, 132.

[b] Maximum score, 10.

JAMA Pediatrics. February 4, 2019. Early Subthreshold Aerobic Exercise for Sport-Related Concussion. A Randomized Clinical Trial John J. Leddy, MD, FACSM,FACP

ATLANTIC HEALTH SYSTEM

Early Aerobic Exercise

University at Buffalo: John Leddy, MD

Sub-Threshold Exercise Treatment for Adolescents With Sports Related Concussion

Results

- Aerobic Exercise:
  - Recovered in median of 13 days (10-18.5)
- Stretching Participants
  - Recovered in median of 17 days (13-23)

- Lower incidence of delayed recovery in Aerobic exercise group
  - 2 in Aerobic group VS 7 in the Placebo (stretching) group

JAMA Pediatrics. February 4, 2019. Early Subthreshold Aerobic Exercise for Sport-Related Concussion. A Randomized Clinical Trial John J. Leddy, MD, FACSM,FACP

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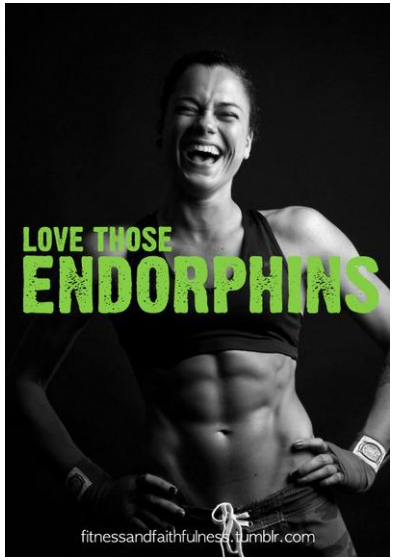
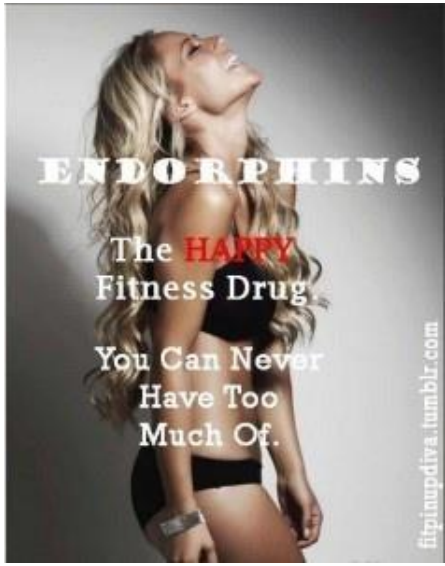




Sub-symptom Threshold Exercise Protocol

Buffalo concussion TM test or Balke-C Protocol

- Obtain baseline Vitals and Graded Symptom Checklist (GSC)
- Follow Sub Threshold protocol test:
  - Performed until patient has exacerbation of Sx
  - **Document HR that this occurs at**
- Aerobic exercise program developed (FITT)
  - Frequency: 5 times/wk
  - Intensity: 80% max HR (sub-symptom threshold heart rate)
  - Time: ideal 45-50 minutes
  - Type: Bike, Run, Elliptical or Swim (Sports specific preferred and modality that athlete can tolerate)
- Retest following protocol every 3 weeks
  - Or when patients completes 5 consecutive training sessions without symptoms
  - Determine the new HR and Duration for symptom threshold

ASH Protocols

- Treadmill
  - SSTE protocol
    - Increasing incline every minute (incline goes to 30)
    - once max incline reached, increasing speed (start 3.3)
  - Modified Incline 15
    - Increases incline every minute (stops at 15)
    - Once max incline reached, increasing speed (again start at 3.3)
  - Modified Jog
    - Increase speed as opposed to incline

BALKE-C PROTOCOL

STAGE	DURATION	SPEED MPH	GRADE (%)	METS	RPE	HR	BP
Baseline Vitals							
1	1:00	3.3	0.0	3.5			
2	1:00	3.3	2.0	4.4			
3	1:00	3.3	3.0	4.9			
4	1:00	3.3	4.0	5.3			
5	1:00	3.3	5.0	5.8			
6	1:00	3.3	6.0	6.2			
7	1:00	3.3	7.0	6.7			
8	1:00	3.3	8.0	7.1			
9	1:00	3.3	9.0	7.6			
10	1:00	3.3	10.0	8.0			
11	1:00	3.3	11.0	8.5			
12	1:00	3.3	12.0	8.9			
13	1:00	3.3	13.0	9.4			
14	1:00	3.3	14.0	9.8			
15	1:00	3.3	15.0	10.3			
16	1:00	3.3	16.0	10.7			
17	1:00	3.3	17.0	11.2			
18	1:00	3.3	18.0	11.6			
19	1:00	3.3	19.0	12.1			
20	1:00	3.3	20.0	12.5			
21	1:00	3.3	21.0	13.0			
22	1:00	3.3	22.0	13.4			
23	1:00	3.3	23.0	13.9			
24	1:00	3.3	24.0	14.3			
25	1:00	3.3	25.0	14.8			
26	1:00	3.5	25.0	15.7			
27	1:00	3.7	25.0	16.5			
28	1:00	3.9	25.0	16.9			
29	1:00	4.1	25.0	17.0			
30	1:00	4.3	25.0	17.1			

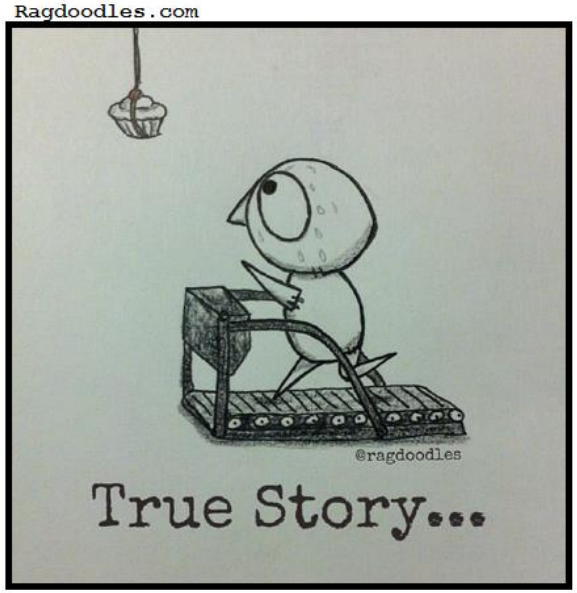
TM Balke-C

ATLANTIC HEALTH SYSTEM

BALKE-C PROTOCOL

STAGE	DURATION	SPEED MPH	GRADE (%)	METS	RPE	HR	BP
Baseline Vitals							
1	1:00	3.3	0.0	3.5			
2	1:00	3.3	2.0	4.4			
3	1:00	3.3	3.0	4.9			
4	1:00	3.3	4.0	5.3			
5	1:00	3.3	5.0	5.8			
6	1:00	3.3	6.0	6.2			
7	1:00	3.3	7.0	6.7			
8	1:00	3.3	8.0	7.1			
9	1:00	3.3	9.0	7.6			
10	1:00	3.3	10.0	8.0			
11	1:00	3.3	11.0	8.5			
12	1:00	3.3	12.0	8.9			
13	1:00	3.3	13.0	9.4			
14	1:00	3.3	14.0	9.8			
15	1:00	3.3	15.0	10.3			
16	1:00	3.5	15.0	10.7			
17	1:00	3.7	15.0	11.2			
18	1:00	3.9	15.0	11.6			
19	1:00	4.1	15.0	12.1			
20	1:00	4.3	15.0	12.5			
21	1:00	4.5	15.0	13.0			
22	1:00	4.7	15.0	13.4			
23	1:00	4.9	15.0	13.9			
24	1:00	5.1	15.0	14.3			
25	1:00	5.3	15.0	14.8			
26	1:00	5.5	15.0	15.7			
27	1:00	5.7	15.0	16.5			
28	1:00	5.9	15.0	16.9			
29	1:00	6.1	15.0	17.0			
30	1:00	6.3	15.0	17.1			

TM
Modified
Incline 15



ATLANTIC HEALTH SYSTEM

BALKE-C PROTOCOL

STAGE	DURATION	SPEED MPH	GRADE (%)	RPE	HR	BP
Baseline Vitals						
1	1:00	3.3	0.0			
2	1:00	3.3	2.0			
3	1:00	3.5	2.0			
4	1:00	3.7	2.0			
5	1:00	3.9	2.0			
6	1:00	4.0	2.0			
7	1:00	4.1	2.0			
8	1:00	4.3	2.0			
9	1:00	4.5	2.0			
10	1:00	4.7	2.0			
11	1:00	5.0	2.0			
12	1:00	5.0	3.0			
13	1:00	5.0	4.0			
14	1:00	5.0	5.0			
15	1:00	5.0	6.0			
16	1:00	5.0	7.0			
17	1:00	5.0	8.0			
18	1:00	5.0	9.0			
19	1:00	5.0	10.0			
20	1:00	5.0	11.0			
21	1:00	5.0	12.0			
22	1:00	5.0	13.0			
23	1:00	5.0	14.0			
24	1:00	5.0	15.0			
25	1:00	5.2	15.0			
26	1:00	5.4	15.0			
27	1:00	5.6	15.0			
28	1:00	5.8	15.0			
29	1:00	6.0	15.0			
30	1:00	6.2	15.0			

TM
Modified JOG

ATLANTIC HEALTH SYSTEM

ASH Protocols

- Bike
  - Modified Balke-C protocol
    - Bike increasing resistance each minute
  - Modified Balke-C protocol- extended
    - Bike increasing resistance every 3-4 minutes

BIKE
Balke-C

BALKE-C PROTOCOL

STAGE	DURATION	Revolutions Per min	Resistance	RPE	HR	BP
Baseline Vitals						
1	1:00	60-80	0.0			
2	1:00	60-80	1.0			
3	1:00	60-80	2.0			
4	1:00	60-80	3.0			
5	1:00	60-80	4.0			
6	1:00	60-80	5.0			
7	1:00	60-80	6.0			
8	1:00	60-80	7.0			
9	1:00	60-80	8.0			
10	1:00	60-80	9.0			
11	1:00	60-80	10.0			
12	1:00	60-80	11.0			
13	1:00	60-80	12.0			
14	1:00	60-80	13.0			
15	1:00	60-80	14.0			
16	1:00	60-80	15.0			
17	1:00	60-80	16.0			
18	1:00	60-80	17.0			
19	1:00	60-80	18.0			
20	1:00	60-80	19.0			
21	1:00	60-80	20.0			
22	1:00	60-80	21.0			
23	1:00	60-80	22.0			
24	1:00	60-80	23.0			
25	1:00	60-80	24.0			

ATLANTIC HEALTH SYSTEM

Questions

ATLANTIC HEALTH SYSTEM