


Neurometabolic Injury Cascade

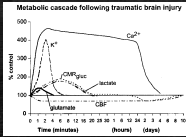
Implications for assessment, recovery and rehab



[FLAWLESS] Concussion Management Specialist Training 4/10/2019 89


89

Neurometabolic Injury Cascade



- Mild cases
 - few seconds of unresponsiveness
 - no histological damage
- Cells may eventually recover or degenerate and die

Ellis, M.J, Leddy JJ, Wiler B (2015); Giza CC, Hovda DA. (2001)



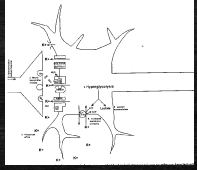

[FLAWLESS] Concussion Management Specialist Training 90

90

Neuro Cascade

Dysregulation of K+ and Spreading Depression

- Ionic flux and wide-spread depolarization
- wide area of brain affected simultaneously
- LOC, amnesia, cognitive impairment

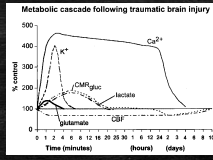



[FLAWLESS] Concussion Management Specialist Training 91

91

Restoration of Homeostasis

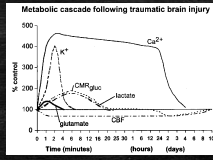
- Hypermetabolism
 - Sodium-Potassium Pump
 - ATP-dependent
 - Glucose metabolism



92

Calcium Cascade

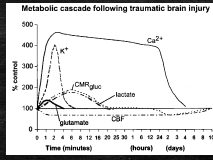
- Protracted mitochondrial dysfunction
 - Decreased glucose utilization and metabolism
 - Increased vulnerability to repeat trauma



93

Global Cerebral Energy Crisis

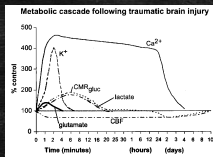
- Repeat trauma poorly tolerated
 - Second Impact Syndrome



94

Cerebral Blood Flow

- Increase in neuronal activity and metabolism tightly coupled with increased CBF
 - Coupling impaired
 - Cerebral hypoperfusion
 - Secondary injury



[FLAWLESS] Concussion Management Specialist Training

95

Return-to-Play

- 30% of HS and college FB players returned same day
- 70% averaged 4 days
- Most RTP guidelines suggest athletes be symptom free for a minimum of 7-10 days.
- 7-10 day waiting period can minimize risk of recurrent injury
- Neurocascade review may tell us why

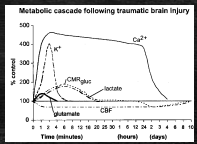
Gulbinatz KM, Brusa SL, Cantu RC, Ferrara ME, Kelly JP, McCrea M, Positano M, Valovich McLeod TC. National Athletic Trainers' Association position statement: management of sport-related concussion, 2004, pp 488-497.

[FLAWLESS] Concussion Management Specialist Training

96

Neurometabolic Cascade Review

- Neurometabolic cascade
 - Foundation for LOC via Spreading depression
 - Uncoupling of CBF
 - Foundation for RTP criteria
 - Second Impact Syndrome and Post-Concussion Syndrome




[FLAWLESS] Concussion Management Specialist Training

97

Recovery


Rest, Assessment, and Predicting Protracted Recovery



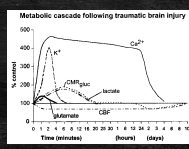
FLAWLESS Concussion Management Specialist Training 4/10/2019 98

98


Cascade and Acute Injury Management



- Special Juice
 - Gatorade
 - Sugar source
 - 1 qt
- Omega-3



Metabolic cascade following traumatic brain injury

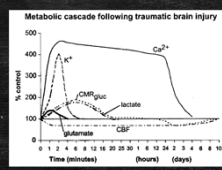


FLAWLESS Concussion Management Specialist Training 4/10/2019 99


99

Rest

- Rationale
 - Reduce the potential for repeat concussion during vulnerable recovery period
 - Prevent SIS
 - Facilitate recovery by reducing stress that hinders restoration of normal neuro and neurometabolic function



Metabolic cascade following traumatic brain injury



FLAWLESS Concussion Management Specialist Training 4/10/2019 100

100

Consensus for Rest

- American Academy of Pediatrics (2010)
- American Medical Society for Sports Medicine (2013)
- American Academy of Pediatrics (2013)
- Concussed athletes should never be permitted to RTP while symptomatic at rest and with exertion
- No same-day RTP even if become asymptomatic**
- Concussed athletes should be asymptomatic before returning to exercise
- Team approach

FLAWLESS Concussion Management Specialist Training 4/10/2019 101

101

Rest is Cornerstone of Proper Care

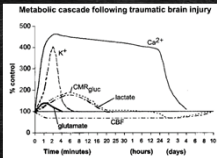
- International Consensus Conference on Concussion in Sport (2013)
- Sensible approach that involves gradual return to school and social activities in a manner that does not exacerbate symptoms
- Cornerstone of concussion management is cognitive rest until asymptomatic then begin grade exercise program

FLAWLESS Concussion Management Specialist Training 4/10/2019 102

102

Consensus on Rest


- Asymptomatic
- Returned to baseline
- Gradual return to play progression
 - Step-Wise RTP



FLAWLESS Concussion Management Specialist Training 4/10/2019 103

103

Sub-Symptom Step-Wise RTP



- 80% - 85% of sports-related concussions will result in an uncomplicated recovery (7-10 days)
 - Initial period of physical and cognitive rest in the early post-injury phase likely beneficial
 - Sub-symptom step-wise RTP progression

Ellis, MJ, Leddy JJ, Wiler B (2015)

IFLAWELESS Concussion Management Specialist Training 4/10/2019 104

104

Use of Rest in Recovery

- Significant variability in use of rest by health care providers
- RICE!




IFLAWELESS Concussion Management Specialist Training 4/10/2019 105

105

Use of Cognitive Rest

- 62% of physicians understand import of cognitive rest
- 11% of records indicated use of cognitive rest
- Only a 12% inc between 2008 and 2012



IFLAWELESS Concussion Management Specialist Training 4/10/2019 106

106

Underuse of Academic Adjustment

- 44.7% worsening symptoms with premature progression
- 50% more school days missed with persistent PCS, but no difference in academic adjustments
- Inc from 24% to 98% after implementation of standardized guidelines!



107

Academic Accommodation

- School Nurse
 - 58% of school nurses responsible for guiding academic re-entry
 - 59% received academic accommodation
- Athletic Trainer
 - 41% receive academic accommodation



How 'bout a Poll?



108

Effectiveness of Rest

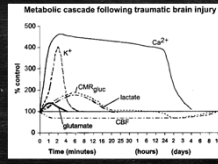
- Valovich McLeod TC, et al.
 - 2 studies that indicated rest improved outcomes
 - 3 studies that identified too much rest as detrimental to outcomes
 - 4 studies showed no association
 - 1 found strict rest lead to prolonged recovery



109

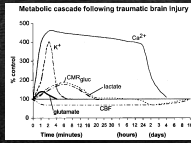
Pragmatic Approach to Rest

- Initial period of rest
 - 72hr rule!
- Step-Wise RTP after symptom resolution and return to baseline
 - 7-10 days
- Sub-Symptom Medically Supervised X-Cise Rx < 30 days
- > 30 days = Protracted Recovery



110

Cascade Implications for RTP



Guskiewicz KM, McCrea M, Marshall SW, et al. Cumulative effects of recurrent concussion in collegiate football players: the NCAA Concussion Study. *JAMA*. 2003;290:1549-555.

- Acute energy crisis and global neurological dysfunction result in initial signs and symptoms
 - On average athletes require 7-10 d to fully recover
- Increased vulnerability or blood-flow changes
- RTP should be a progression that starts after the athlete is symptom free for 7-10 days or up to 30 days.*

111

Assessment Tools Guide Recovery Progress

- Variability in healthcare provider use of concussion-assessment tools



112

RTP Compliance

- Variability in health care provider compliance with accepted RTP protocols

Poll anyone?

How do you feel?

Response	Count	Percentage
Strongly Disagree	0	0%
Disagree	0	0%
Neutral	0	0%
Agree	0	0%
Strongly Agree	0	0%
Other	0	0%
Not Answered	0	0%
Total	0	0%

Number of responses: 0

Response distribution: 0% Disagree, 0% Strongly Disagree, 0% Strongly Agree, 0% Agree, 0% Neutral, 0% Other, 0% Not Answered

Response distribution: 0% Disagree, 0% Strongly Disagree, 0% Strongly Agree, 0% Agree, 0% Neutral, 0% Other, 0% Not Answered

Response distribution: 0% Disagree, 0% Strongly Disagree, 0% Strongly Agree, 0% Agree, 0% Neutral, 0% Other, 0% Not Answered

113

Traditional Modifying Conditions

- Medications
 - RX and OTC
- Pre-Existing conditions
- Concussion history
- Depression
- Gender
- Age
- Nature of sport



114

Younger Athletes


- Guskiewicz KM, *et al.*
 - Age related difference exist between HS and college athletes
 - Increased symptom severity
 - Prolonged recovery
 - Sports-related head injury has a relatively high incidence rate in youth
 - 15% of all ER head injuries
 - 3% of all sports related injuries
 - 24% of all serious head injuries



115

Symptom Groups as Predictors of Protracted Recovery

- Significant
 - amnesia, balance abnormalities, tinnitus & visual impairments at 20 min.
- 87% probability
 - headache & amnesia at 5 min
- 73% probability
 - headache, dizziness & balance abnormalities at 20 min




IFLAWELESS Concussion Management Specialist Training 4/10/2019 116

116

Non-Predictive of Outcome

- Teel EF, *et al.*
 - Amnesia most influenced recovery
 - Recovery within normal timeline
 - Loss of consciousness
 - Concussion Hx
 - Acute symptom group




IFLAWELESS Concussion Management Specialist Training 4/10/2019 117

117

Asymptomatic Step-Wise Progression

- Initial phase of cognitive and physical rest
- Sub-Symptom return to learn progression
 - Academic accommodation
- Sub-Symptom return to play progression
 - [Step-Wise recovery progression](#)



IFLAWELESS Concussion Management Specialist Training 4/10/2019 118

118

Let's Do Some Q & A!

- Session Materials
 - Resources page
 - Materials sections of participation pane
- Quizzes
 - During training
 - Links provided after training
- Moving forward
 - Recordings
 - Case study / Essays
 - RFC
 - Evaluations
 - Follow-up email
- 30 day outlook