Post-Flight Reconditioning

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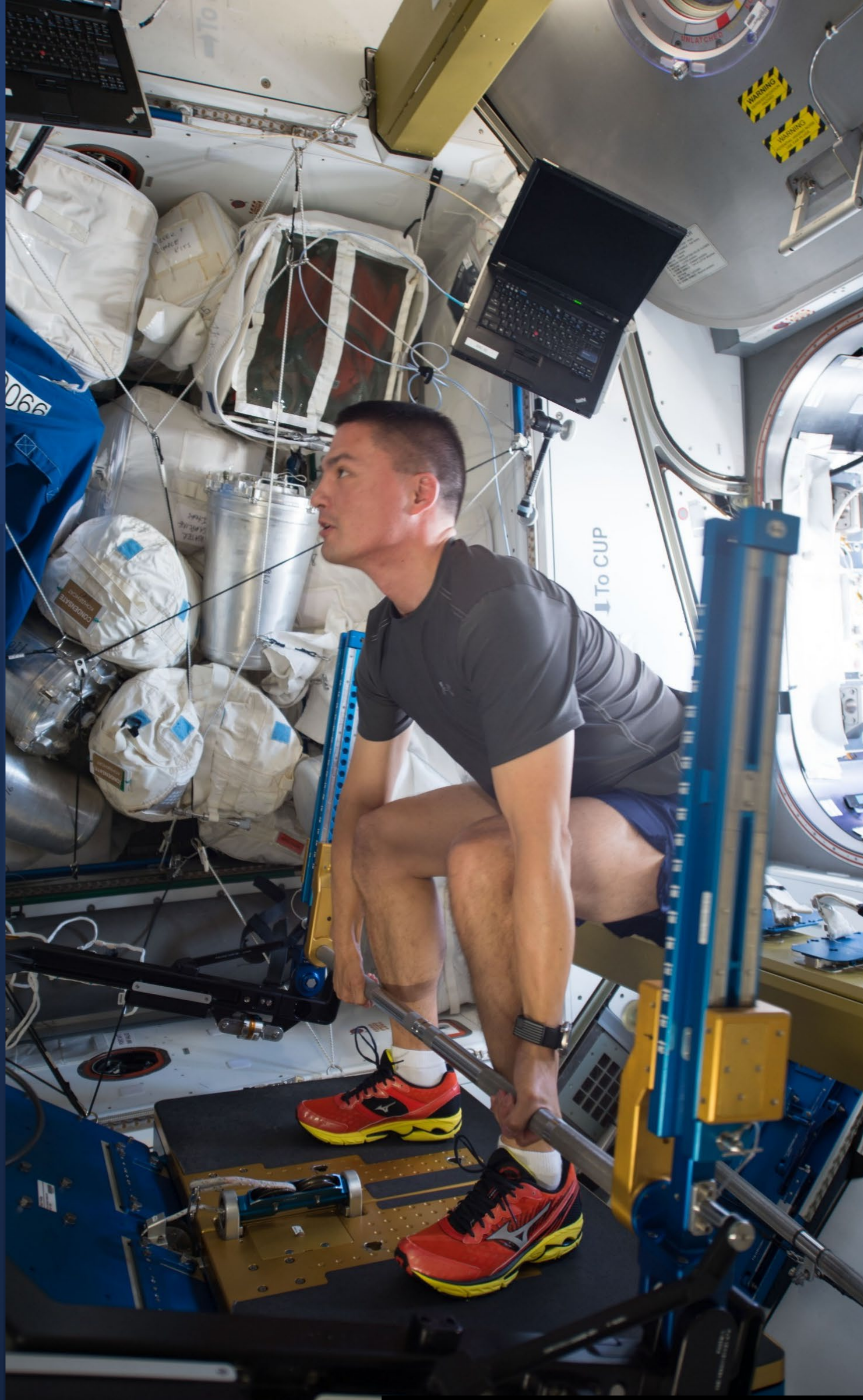
KBR Human Performance Contract



Agenda

Neurovestibular effects and considerations

Gaze stability training, proprioception, and somatosensory training

Orthostatic intolerance considerations

Assessment and exercise planning

Spine effects and considerations

Segmental and muscular change characterization

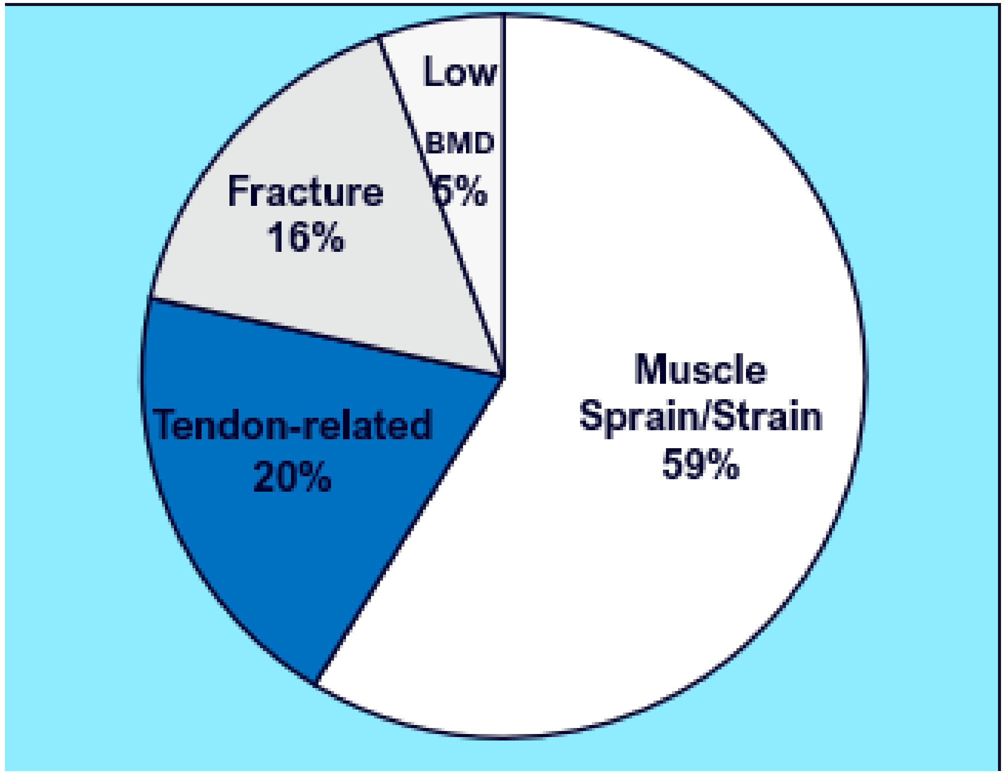
Progression of reconditioning

Mobility/Flexibility considerations

Isolated and multi-joint importance

Mobility through range under load

MSK Injuries Post-Flight



Postflight injuries most common (92%)

Large proportion of injuries (49.6%) occurred within 1 year of landing

- 7.3% within 1 month
- 8.1% between 1-3 months
- 9.2% between 3-6 months
- 25% between 6-12 months

Fewer injuries reported in females, but higher prevalence

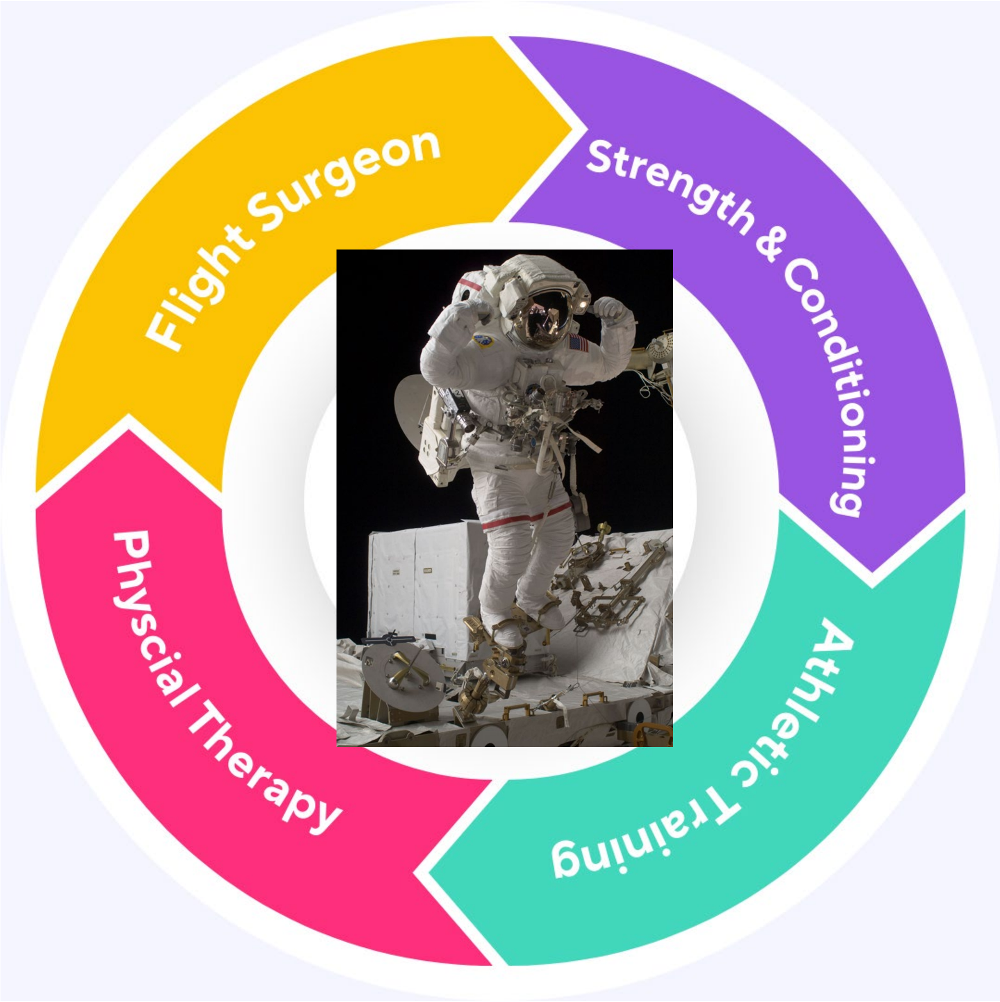
- F: 39 injuries in 20 astronauts
  - 1.95 injuries per female
  - 20% of female injuries occurred in flight
  - Low BMD diagnoses in 15% of females
- M: 244 injuries in 131 astronauts
  - 1.86 injuries per male
  - 4% of injuries occurred in-flight
  - Low BMD diagnosed in 4% male astronauts

30,000 Foot View

Team Approach

Progressively load impairments of the multisystem degradation to ***enhance safe and effective*** re-adaptation and return to ***prior level of function and individualized goals***

Continual ***monitoring*** and ***adjustments*** to programming based on ***individual system priorities and response to stimuli***



Astronaut Strength, Conditioning and Rehabilitation

Corey Twine

- Strength and Conditioning Coach Certified- SCCCa
- Certified Strength and Conditioning Specialist (CSCS)
- Certified Mobility Specialist FRc
- USA Weightlifting, Level 1

Danielle Anderson, Maj, USAF

- Doctor of Physical Therapy/Doctor of Science in PT (DPT/DSC)
- Orthopedic Certified Specialist (OCS)
- Fellow of the American Academy of Orthopedic Manual PT (FAAOMPT)
- Certified Strength and Conditioning Specialist (CSCS)

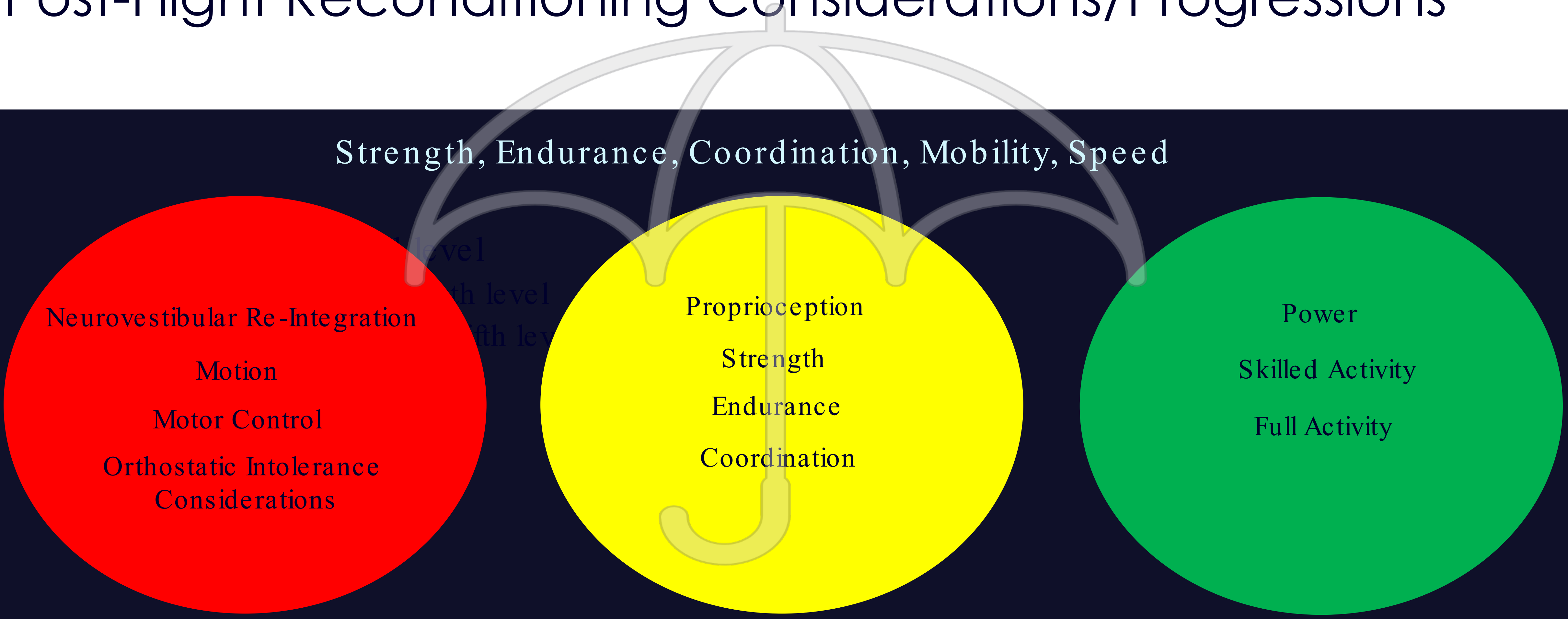
Christi Keeler

- Certified Athletic Trainer (ATC)
- Texas Licensed Athletic Trainer (LAT)
- Certified Orthotist Assistant (COA)
- Certified Mobility Specialist FRc
- Graston Technique Certified

Bruce Nieschwitz

- Certified Athletic Trainer (ATC)
- Texas Licensed Athletic Trainer (LAT)
- USA Weightlifting, Sports Performance Coach (USAW)
- Certified Mobility Specialist FRc

Post-Flight Reconditioning Considerations/Progressions



1.) Physiologic Effects of Space Flight

2.) Functional Abilities

3.) Crew Members Goals and Training Desires

4.) Other demands (operational, research, etc)

On-going Assessment

Red Criteria:
Any NMSK complaints
Tandem stance <15 seconds
VOR Dizziness
Fixated Gaze
<10 single leg heel raises
Double leg bridge <10-20 seconds
Forearm plank <10-20 seconds

Yellow Criteria:
Absence of NMSK
Tandem stance 15-30 seconds
Drinking bird: 3/5 good control
VOR mild symptoms
10-15 single leg heel raises
Double leg bridge 20-30 seconds
Forearm plank 20-30 seconds

Green Criteria:
Absence of NMSK
Tandem stance >30 seconds
Asymptomatic VOR test
>15 heel raises
Double leg bridge 30 seconds
Forearm plank 30 seconds
Drinking bird 5/5 good control

ASTRONAUT POSTFLIGHT READINESS ASSESSMENT TALLY

Crewmember Name:

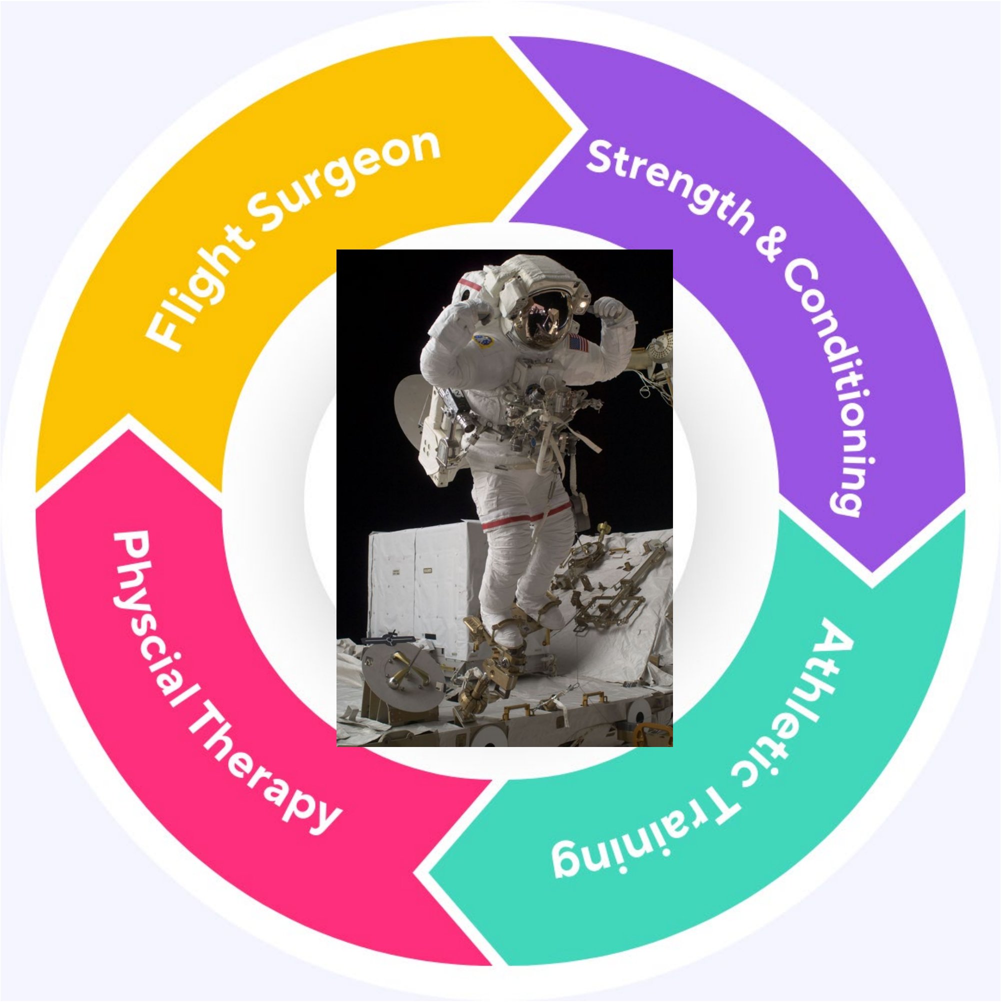
	Initial	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Mobility Assessment								
Standing								
[redacted]								
Prone								
[redacted]								
Motor Control Assessment								
Lower Quarter								
[redacted]								
Core								
[redacted]								
Progressive Vestibular Assessment								
[redacted]								
	Score		Score	Score	Score	Score	Score	Score
	45	37	30	26	20	16	16	16

Green	16, 17, 18, 19, 20, 21, 22, 23, 24, 25
Yellow	26, 27, 28, 29, 30, 31, 32, 33, 35, 36, 37
Red	38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48

30,000 Foot View

Physical Medicine

Strength and Conditioning



Neurovestibular Evidence

Central Nervous System adaptations to space flight → reinterpretation of vestibular and somatosensory inputs

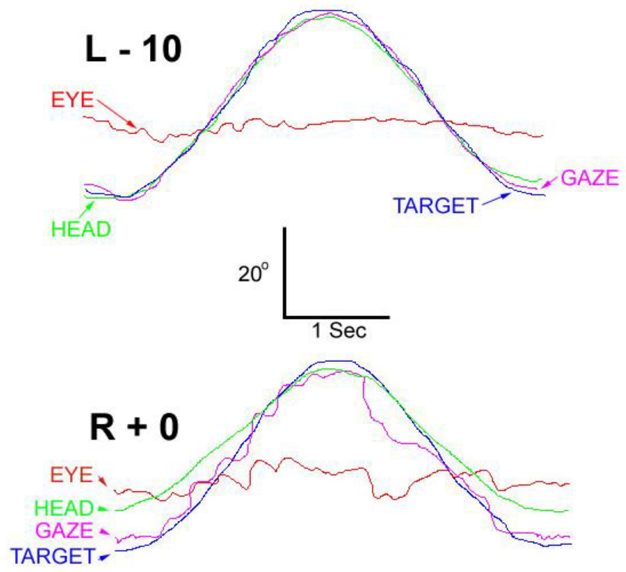
Excessive postural sway, decreased proprioception, and locomotor control

Altered gaze stability

Alterations in muscle activation

Alterations in head-trunk coordination

Impaired cognitive and somatosensory dual processing



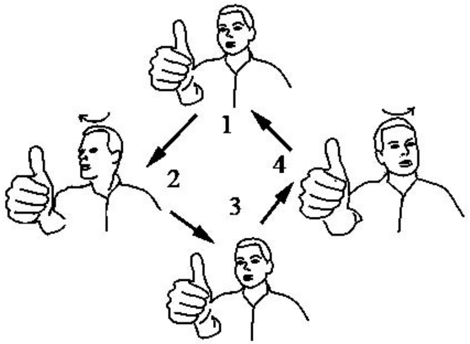
Macaulay, et al, Front Syst Neurosci, 2021

Neurovestibular Evidence

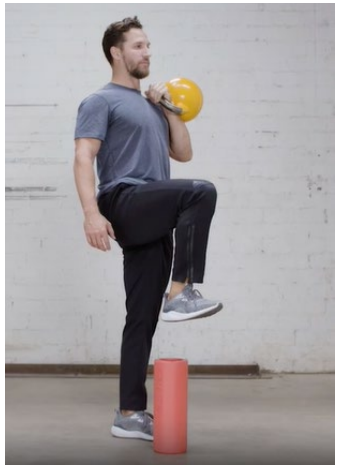
Macaulay, et al, Front Syst Neurosci, 2021

Neurovestibular Considerations- Phase 1

Goals: normalize gaze stabilization, integrate vestibular, somatosensory and visual systems for balance, normalize proprioception and somatosensory system

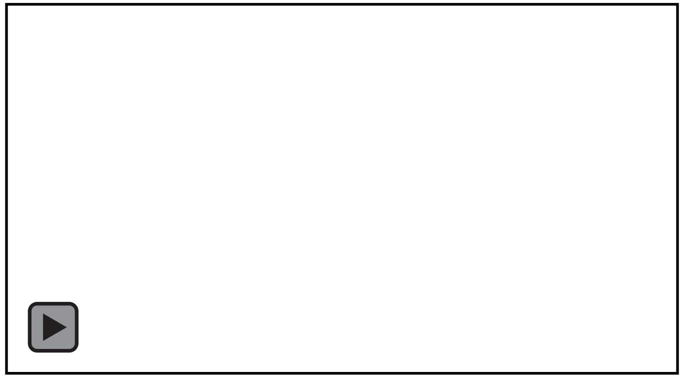


PHASE 1



Neurovestibular Considerations- Phase 2

Goals: progress gaze stability exercises to unstable surface, reactive and varying surface training, and gradual addition of dual-tasking



PHASE 2

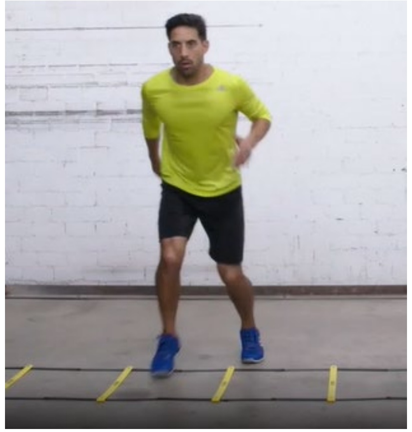
Neurovestibular Considerations- Phase 2

Goals: progress gaze stability exercises to unstable surface, reactive and varying surface training, and gradual addition of dual-tasking

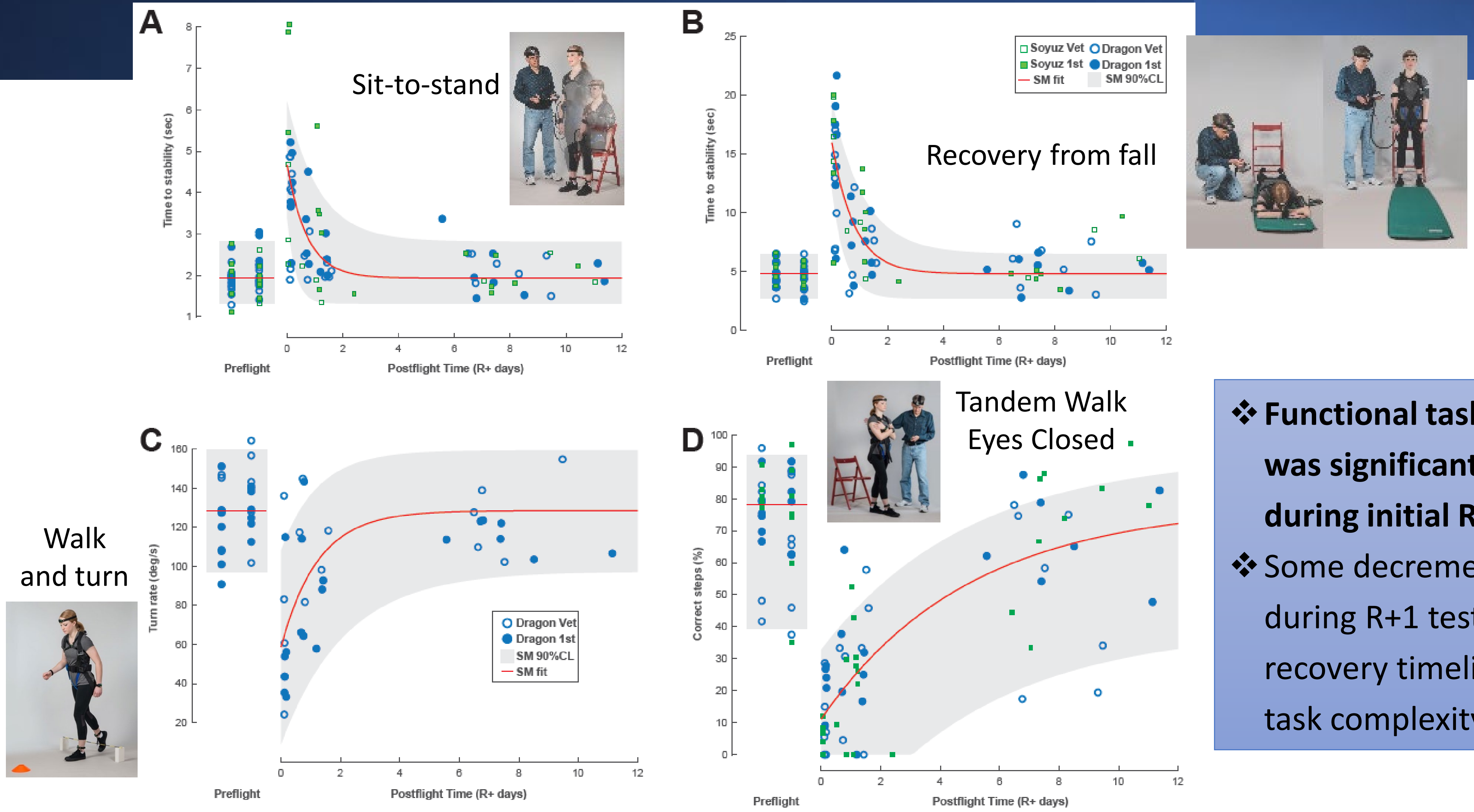
Neurovestibular Considerations- Phase 3

Goals: progression to dual-task training with varying intensity and surfaces, progression of coordination and agility

PHASE 3



State of Knowledge: Balance/Ability to Respond to Environmental Signals (Sensorimotor Risk)



- **Functional task performance was significantly impaired during initial R+0 testing.**
- Some decrements persisted during R+1 testing. The recovery timeline varied with task complexity.

Orthostatic Intolerance Evidence

Orthostatic intolerance post flight is multifactorial → decreased cardiac filling pressure, decrease stroke volume during orthostatic stress due to decreased plasma volume, adrenergic function, and dysfunction of the sympathetic nervous system

When assessed during quiet standing or utilizing a tilt table, crew members experienced more orthostatic intolerance compared to functional and ambulatory positions (calf pump!)

During quiet positions and transition motions, orthostatic intolerance ranges from R+0- R+14 with great individual variability

Qi Fu, et al. *AHA Circulation,* 2019

Orthostatic Intolerance Considerations

Assessment and Exercise Planning Considerations:

Avoidance of assessing and exercising in positions causing valsalva, head down or dependent positions, and minimizing time spent transitioning from supine to stand, prone to stand, etc.

In consultation with Flight Surgeons, consider compression garments for more severe or lingering cases

Spine Evidence

2021 NASA Human Research Program:
Biomechanics of the lumbar spine following spaceflight and incidence of post-flight disc herniation

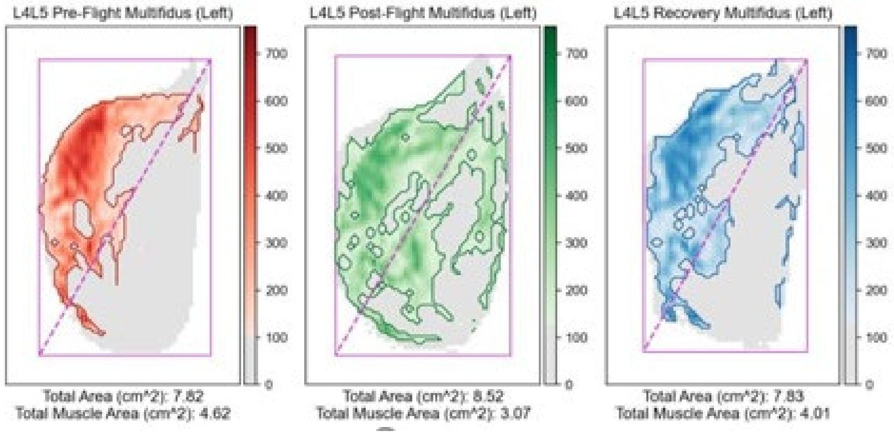
- N=12 subjects (10 males, 2 females)
- Evaluation:
  - **3T MRI** for facet arthropathy, endplate irregularities, HIZ, disc herniation, degeneration, water content and multifidus CSA, mCSA, m%
  - **Spine segment kinematics** max flexion-extension/lateral flexion/translation ROM per segment
  - Time points: pre-flight, R+2-7 (after 6 mos) and R+30-60

Bailey et. Al, IWS, 2021

Spine Evidence

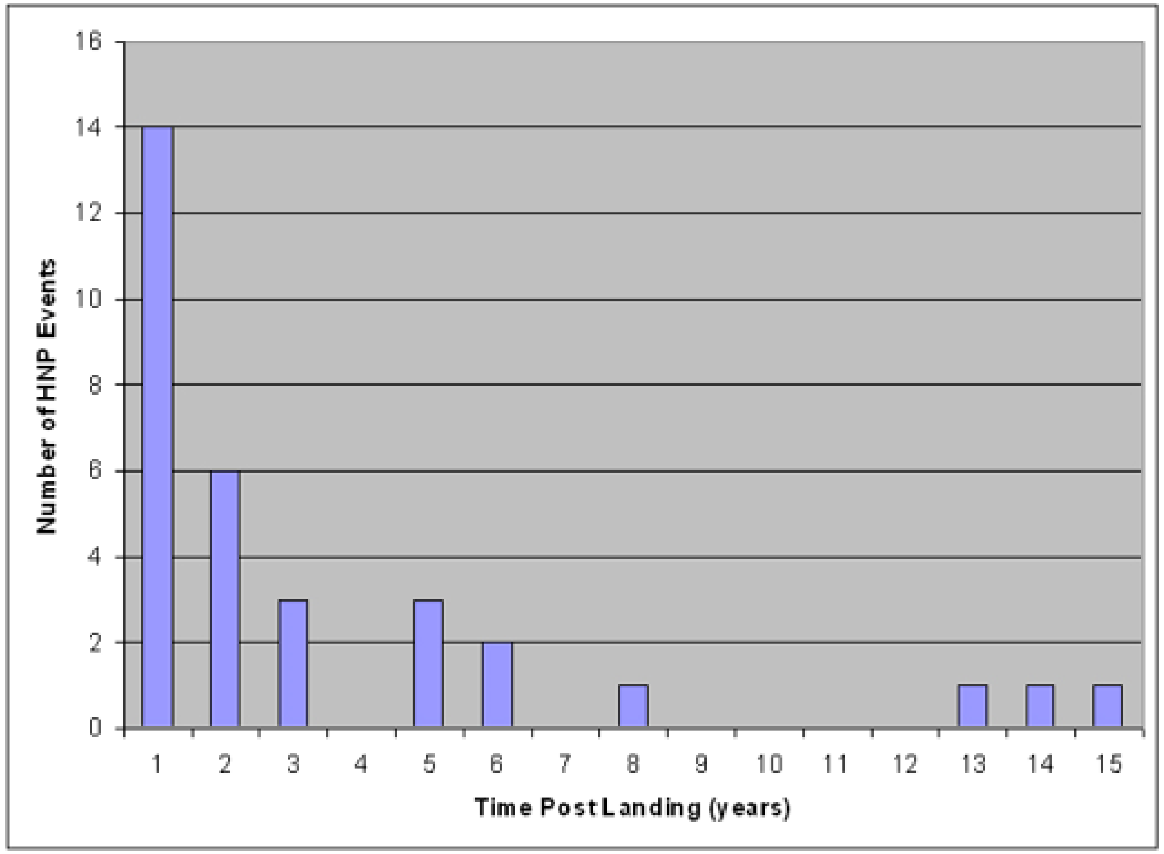
2021 NASA Human Research Program: Biomechanics of the lumbar spine following spaceflight and incidence of post-flight disc herniation

- **Results:**
  - 50% (6 out of 12) of crew members returned from space with a <u>symptomatic</u> disc protrusion/herniation
  - Decreased ROM → upper lumbar spine
    - **Associated with endplate irregularities**
  - Lower pre-flight average multifidus % and higher asymmetry
  - Decreased average multifidus % and increased asymmetry → lower lumbar spine
  - Water content, muscle CSA, other spinal pathology did not associate



Bailey et. Al, IWS, 2021

Spine Evidence



Occurrence of symptomatic HNP greatest in first 2 weeks post flight

RESEARCH ARTICLE

Risk of Herniated Nucleus Pulposus Among U.S. Astronauts

Smith L. Johnston, Mark R. Campbell, Rick Scheuring, and Alan H. Feiveson

Johnston SL, Campbell MR, Scheuring R, Feiveson AH. ***Risk of herniated nucleus pulposus among U.S. astronauts.*** **Aviat Space Environ Med 2010; 81:566–74.**

Introduction: Astronauts have complained of back pain occurring during spaceflight, presumably due to the elongation of the spine from the lack of gravity. Herniated nucleus pulposus (HNP) is known to occur in aviators exposed to high G_z and has been diagnosed in several astronauts in the immediate post-spaceflight period. It is unknown whether astronauts exposed to microgravity are at added risk for developing HNP in the post-spaceflight period due to possible in-flight intervertebral disc changes. ***Methods:*** For a preset study period, incidence rates of HNP were compared between the U.S. astronaut population and a matched control population not involved in spaceflight using the Longitudinal Study of Astronaut Health database. Using a Weibull survival model, time trends of the risk of HNP prior to and after spaceflight were compared within the astronaut group. HNP incidences in other populations that have previously been reported in the literature were also compared with results in this study. ***Results:*** The incidence of HNP was 4.3 times higher in the U.S. astronaut population ($N = 321$) compared to matched controls ($N = 983$) not involved in spaceflight. For astronauts, there was relatively more HNP in the cervical region of the spine (18 of 44) than for controls (3 of 35); however, there was no clear increase of HNP incidence in those astronauts who were high performance jet aircraft pilots. There was evidence suggesting that the risk is increased immediately after spaceflight. ***Conclusions:*** Astronauts are at higher risk of incurring HNP, especially immediately following spaceflight.

Keywords: spaceflight, back pain, back injury, cervical injury, lumbar injury, disc disease, microgravity, weightlessness.

HERNIATED NUCLEUS pulposus (HNP) is usually secondary to degenerative disc disease, although that term is probably a misnomer as hereditary factors also have been found to be important. The peak patient age incidence is between 35 and 55 yr old. Herniation of the nucleus pulposus is due to the failure of the annulus fibrosus to retain nuclear material. This may result from a tear in the annulus or a disruption of the annular attachment to the vertebral body. Herniations in the cervical and lumbar spine that results in symptomatic radicular pain are typically due to extrusion of disc material in a posterolateral direction, causing compression or irritation of a nerve root. The presence of the posterior longitudinal ligament in both the cervical and lumbar regions makes the occurrence of direct central extrusion of disc material into the spinal canal less likely. When this does occur, direct compression of the spinal cord or cauda equina can occur.

The intervertebral disc is formed by the central nucleus pulposus, the outer annulus fibrosus, and the cartilaginous vertebral end plates. Each of the structures consists primarily of collagen, proteoglycans, and water. Fluid shifts occur readily, with the disc expanding during bed rest and contracting during axial loading. The annulus fibrosus is the site of primary pathologic change due to repetitive stress during axial loading and flexion, which is the etiology for herniation (8). The nucleus pulposus usually herniates at the posteriolateral corner, resulting in pressure on the spinal cord or nerve root, which causes pain or neurological deficits.

Several studies have suggested that aviators exposed to a repetitive high G_z environment in high performance aircraft or to the vibratory stress of helicopters have a higher incidence of cervical injuries (11,29,37) and HNP (12,26). Although higher rates of HNP are suspected in high G_z environments, definite statistical proof is still lacking. High G_z maneuvers place considerable stress on the cervical vertebrae, especially when combined with tilting and turning of the neck (37). An increase in degenerative cervical changes has been found on magnetic resonance imaging (MRI) of high G_z fighter pilots (32,33) and one study has shown that 3 out of 10 active fighter pilots demonstrate MRI cervical changes (22). However, MRI abnormalities are seen in asymptomatic patients and are not necessarily indicative of a higher risk of HNP.

Back pain and injury has been known to occur in astronauts during their ground activities (19) and in flight (21,34,35). Generalized back pain during spaceflight has been reported in 53–68% of astronauts responding to a questionnaire, with 28% describing the pain as severe to moderate (38). Back pain is usually most severe at the beginning of flight and gradually subsides as the flight progresses. The etiology of spaceflight back pain has been proposed as a lengthening of the vertebral column due to disc expansion secondary to unloading and loss of the thoracic and lordotic curvatures (16,20). Obviously, back pain is subjective and very difficult to accurately study. Although statistics on HNP are felt to be more objective, reliable, and reproducible, regional var-

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DOI: 10.3357/ASEM.2427.2010

Johnston, et al. Aviat, Space, Env med, 2010

Spinal Considerations- Phase 1

Goals: Reduce adaptation pain, enhance intersegmental mobility, restore normal firing patterns of deep core stabilizers, and improve joint position sense

PHASE 1

Spinal Considerations- Phase 2

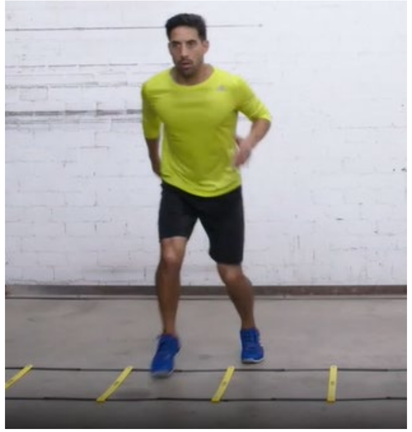
Goals: progress intersegmental and multi-joint mobility, advance neuromuscular re-education to multi-axial movements, progressively begin loading the spine

PHASE 2

Spinal Considerations- Phase 3

Goals: progression of multi-joint mobility with load, advance strength and power, development of skilled and functional activity… build spinal resiliency!!

PHASE 3



Mobility/Flexibility

<u>Common Mobility Restrictions due to Inflight Positioning:</u>

Impaired spinal mobility across all regions and ranges

Hip: hip flexor resistance over extensor, rotational limitations

Shoulder: shoulder flexion resistance over extensor, rotational limitations

Ankle dorsiflexion over plantar flexion

NASA Stock Photo, pulled 1.11.2024

Mobility/Flexibility

Approach:

Progression of single joint (isolated) and multi-joint motion through passive, active, and manual therapy techniques where appropriate

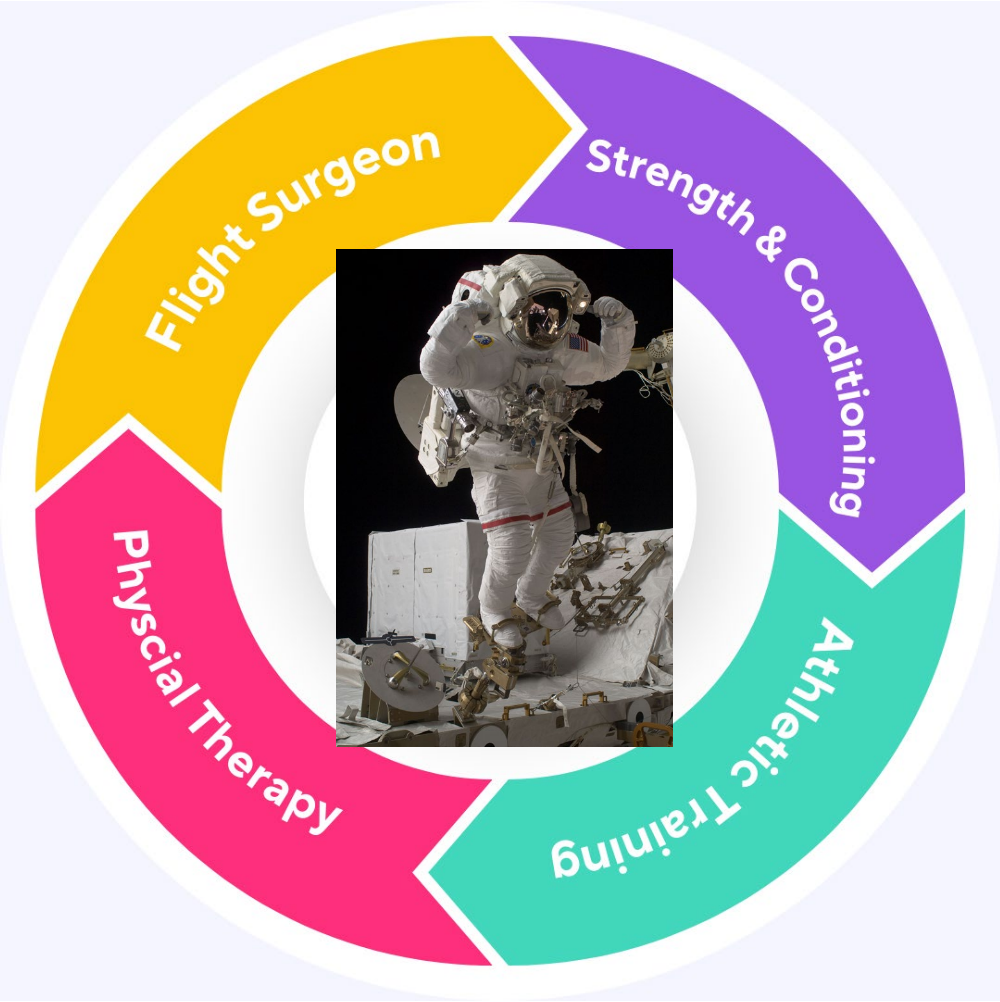
Progressing multi-joint motion under load to optimize functional activities

Continual monitoring with daily and weekly evaluations

30,000 Foot View

Strength and Conditioning

Physical Medicine



Agenda

Overview - First days of Post-flight Reconditioning

Assessment

Develop Plan

Execute Plan

Resistance Training Considerations

Strength Expression

Power Expression

Cardiovascular / Cardiorespiratory Fitness

Based on Maximum Oxygen uptake

Endurance

Agility - as it applies

Acceleration

Deceleration

Post-Flight Considerations

Post-flight Reconditioning Framework

- 45 Days
- 2 Hours Per day

Challenges

- Scheduling Demands
- Life Demands
- Desire to return to a prior level of function and fitness may cause fatigue or risk of injury.
- Fatigue or illness
- Preference - Individual desires may not match an evidence-based approach to appropriate training

MEDB. (MRID) Functional Fitness Assessment

- **Previous Functional Fitness Assessment**
  - Cone Agility: Fastest time through course (3 trials)
  - Hand Grip: Highest of 3 trials
  - Push Ups: Max 2 minutes
  - Sit and Reach: Highest of 3 trials
  - Pull Ups: Max completed
  - Sliding Crunches (Abdominal): Max 2 minutes
  - Single Leg Stork Stand: 15 seconds bilateral
  - Leg Press: 1 Rep Max
  - Bench Press: 1 Rep Max
- **Current Functional Fitness Assessment**
  - Body Mass
  - Hand grip
  - Squat Jump
  - Countermovement Jump
  - Cone Agility
  - Isometric Mid-Thigh Pull
  - Isometric Bench Press
  - Pull ups
  - Hand Release Push-ups

R+5-7, R+30

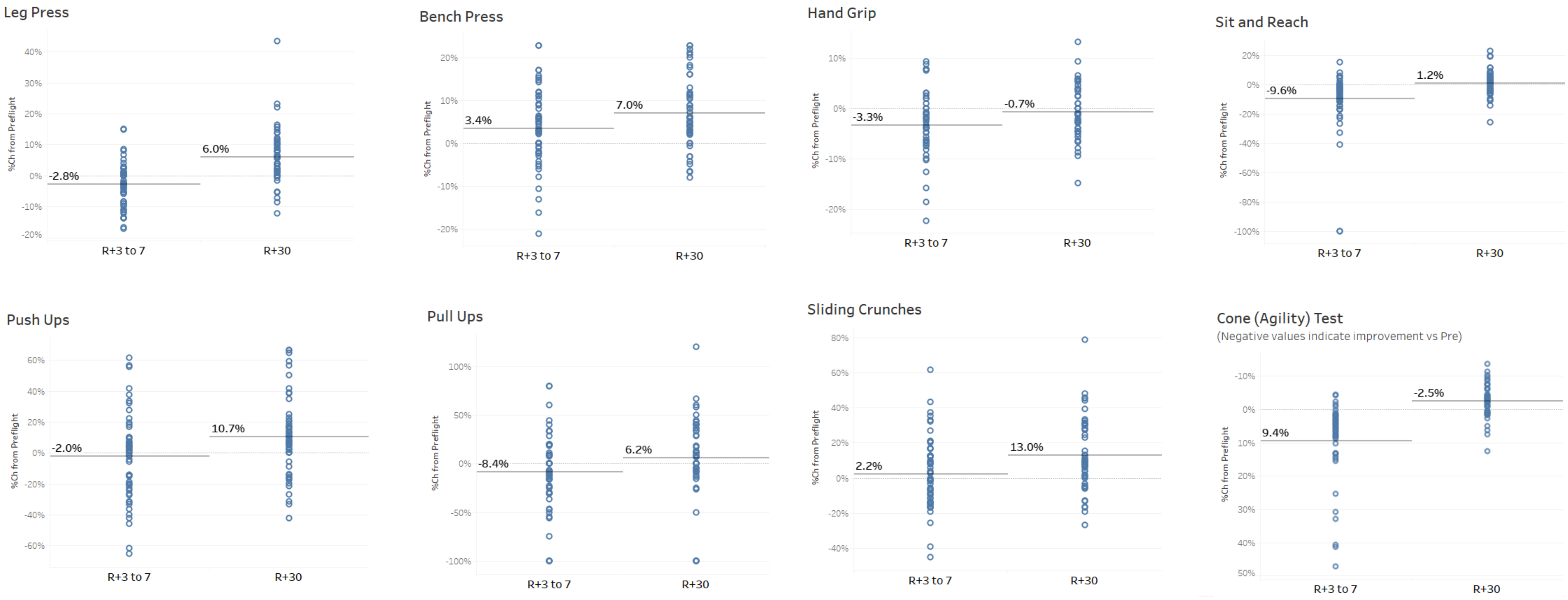
MED B = Medical Evaluation Document (Group B)

MRID = Medical Requirements Integration Document

Meb B. Functional Fitness Assessment

Changes in Functional Fitness after Long-Duration Spaceflight and 30d of Recovery

(%Change from Preflight, n=93)



Monitoring Capabilities: Muscular Strength and Power

IMPT

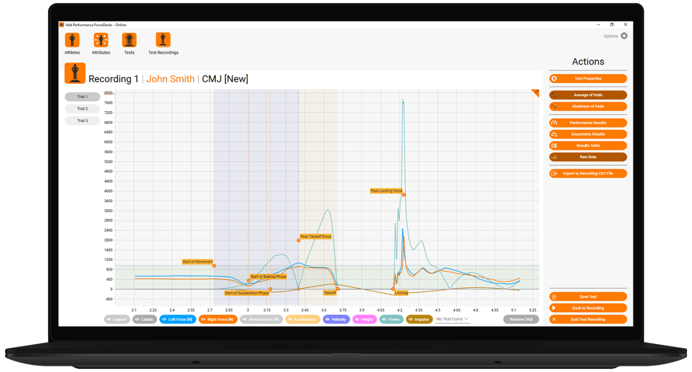
- Peak Force
- Rate of Force development

Squat Jump

- Jump Height
- Power
- Time to decel

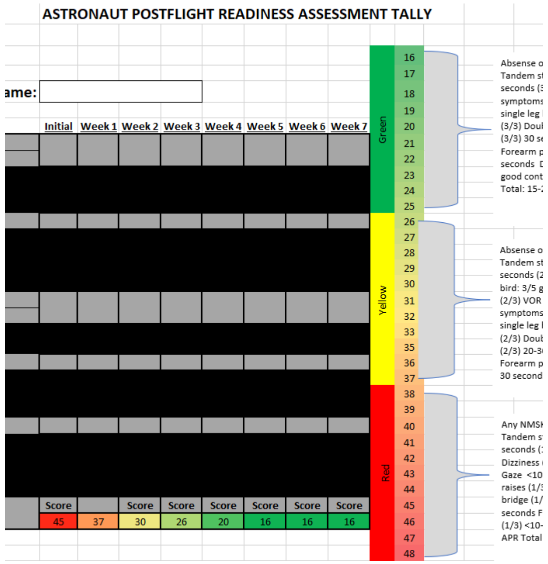
Countermovement Jump

- Jump height
- Power
- Time to decel



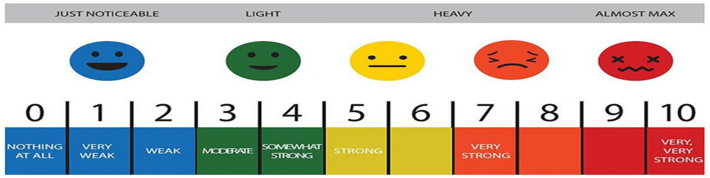
Post-flight Reconditioning- First Steps

- Assess / Monitor
- Develop Plan
- Train



*Primarily Subjective monitoring

”Scientists and coaches must acknowledge the exceptional ability of the human neurobiological system to integrate abundant amounts of personal and environmental data and convey it through a straightforward score.”



Post-flight Reconditioning: Developing the Plan

Needs

Priorities

- Evidence-based approach

Preference (potential conflict)

- Mostly lies in perceived ability vs true ability

Known Priorities for every Crew member

Neuromuscular Reeducation

Cardiovascular / Cardiorespiratory Fitness

Motor Learning and Neuromuscular Reeducation

Motor Learning

- Motor learning is defined as 'a change in a person's capability to perform a **skill** that must be inferred from a relatively permanent improvement in performance as a result of practice or experience' (Magill and Anderson, 2007).
- Motor learning involves learning a **skilled task** and practicing with a goal in mind until the skill is executed automatically **(Schmidt & Wrisberg 2007).**

Neuromuscular reeducation

- Deals with retraining the brain and spinal cord in voluntary and reflex motor activities.
- The primary aim is to restore the proper firing of spinal and peripheral nerves to improve the following: Range of Motion, Strength Expression, Strength Endurance, Power, and Coordination.

Skills

- A Skill is a learned ability that individuals acquire through training and practice. Skill may be defined as the ability to perform at a high standard effectively and efficiently.

Running in 3 different environments

Types of Skills

- **Gross Motor Skills** - Require the usage of our larger muscles located in the torso, legs, and arms to perform tasks (e.g., Running, Jumping).
- **Fine Motor Skills** - Our hands and wrists can execute intricate movements using the smaller muscles. **+ tasks that require timing** (e.g., Hitting a baseball, Pitching, Golf swing).

For example,

- Running barefoot needs to be practiced before proper execution.

Learned Skill / Disruption

Skill Execution / Expression

Poor Coaching or Practice

Pain or Injury

Spaceflight

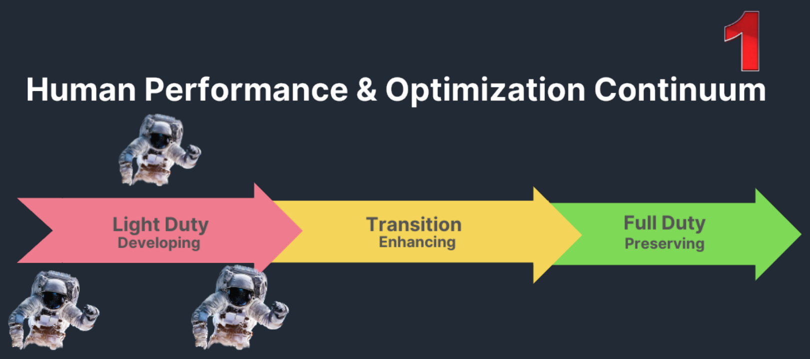
Anything that interrupts the dialogue within the neuromuscular system. More

**Typically, these skills are only impaired if they are hampered by discomfort, injury, inadequate coaching or practice, or spaceflight - essentially, anything that interferes with neuromuscular connections.*

Layne, Chuck & McDonald, P. & Bloomberg, Jacob. (1997). Neuromuscular activation patterns during locomotion after space flight. Experimental brain research. Experimentelle Hirnforschung. Expérimentation cérébrale. 113. 104-16

Neuromuscular Reeducation and Deconditioning Across 3 Pillars

- Resistance Training
- Cardiovascular / Cardiorespiratory
- Agility (as it applies)



Resistance Training - Phase 1

- Primary Focus: *Neuromuscular reeducation*
  - Isometric Exercise
    - Stabilization
    - Anti-Rotation
    - Low intensity 50% 1RM compound ground-based movements *(benefit of free weights)*

Restrictions

- Axial Loading
- Velocity-specific exercises that require timing (i.e., weightlifting)

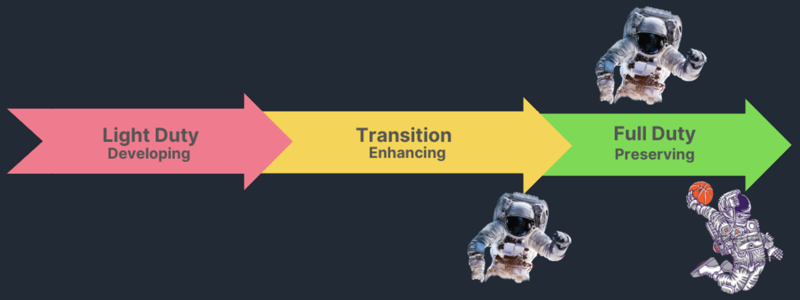
Resistance Training – Phase 2

- Phase 2 Primary Focus: Strength Expression, Power Expression
  - Basic Ground-based Muti-joint movements
    - Free weights are beneficial
      - Low intensity 50% 1RM compound ground-based movements *(benefit of free weights)*
    - Stability + Force Production
      - Still Learning

Restrictions

- Axial Loading

Human Performance & Optimization Continuum



Resistance Training Phase 3

- Power Expression - VBT
  - Lower Force / High Power output
    - Jump Squats
    - Med Ball Throws
    - Traditional VBT

Restrictions

- Individual, performance-dependent

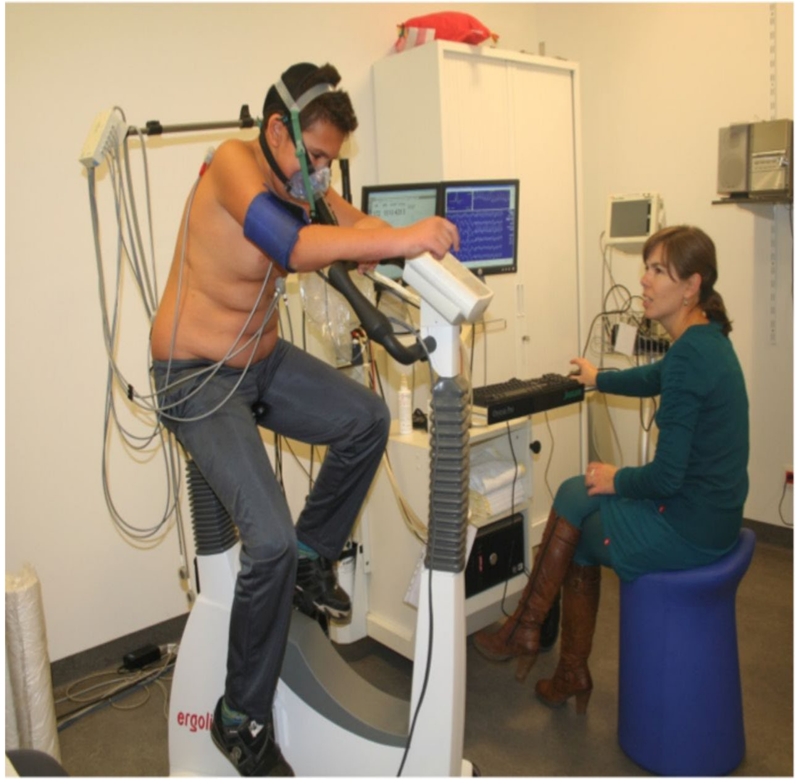
Cardiovascular Deconditioning

Monitoring of Cardiovascular fitness based on VO2max

- Maximal oxygen uptake (.VO(2,max)) is a physiological characteristic bounded by the parametric limits of the Fick equation: (left ventricular (LV) end-diastolic volume--LV end-systolic volume) x heart rate x arterio-venous oxygen difference.”   (Stroke Volume)
  - Stroke Volume - the volume of blood pumped out of the heart’s left ventricle during each systolic cardiac contraction.

Phycological and Biochemical changes

- Left Ventricular hypertrophy
- Decrease Plasma Volume
- Increased Heart Rate



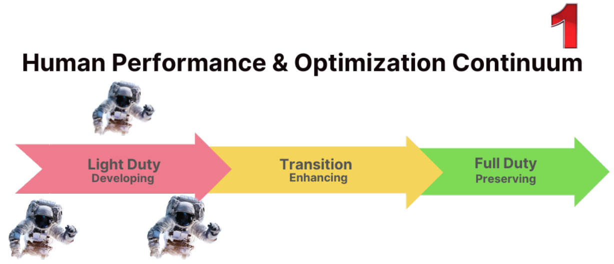
Levine BD. .VO2max: what do we know, and what do we still need to know? J Physiol. 2008 Jan 1;586(1):25-34. doi: 10.1113/jphysiol.2007.147629. Epub 2007 Nov 15. PMID: 18006574; PMCID: PMC2375567.

Cardiovascular Training Phase 1

- Primary Focus: Aerobic Exercise that does not cause issues
- Typical Modalities
  - Recumbent Bike
  - Hydroworks
  - AlterG Treadmill

Restrictions

- Calf Intensive Exercises
  - Incline Treadmill walking
  - Running at body weight
  - Any exercise that could require unexpected reaction.

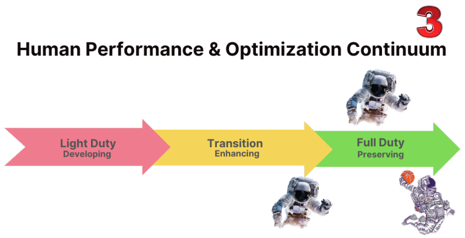


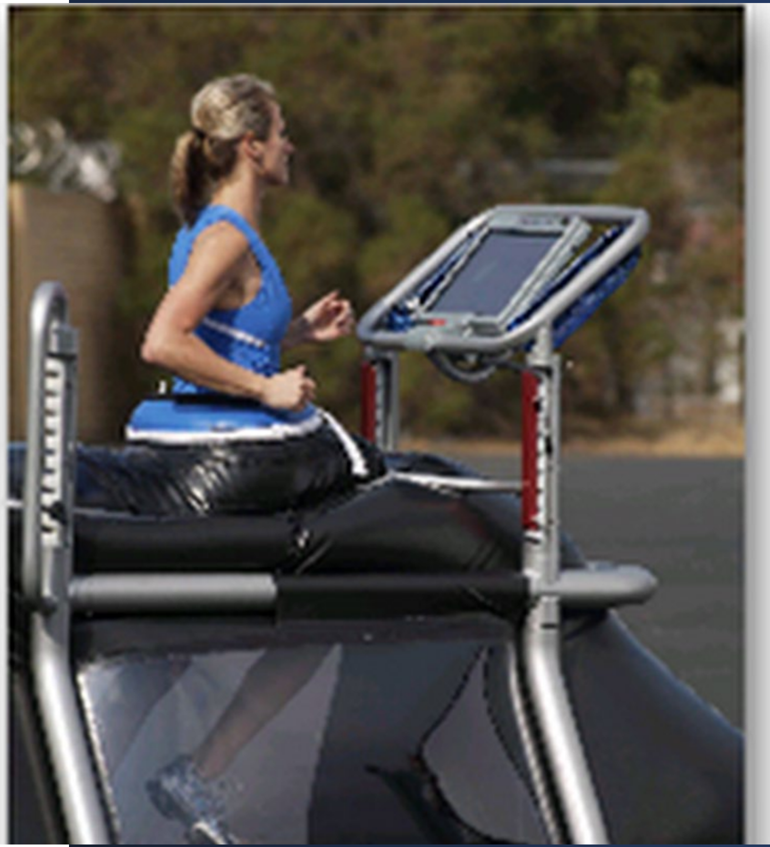
Cardiovascular Exercise Phase 2, 3

- Phase 2 + **Phase 3** Primary Focus: Aerobic / Anaerobic exercise that does not cause issues!
  - **Protocol**
    - Aerobic Exercise 60%-70% + about 20% of the allotment at the time spent in the 80% or above range
    - Running On a Treadmill is ideal (control of the environment and volume and intensity)
  - **Modalities**
    - Treadmill
    - Hydorworks
    - AlterG (progress in the percentage of body weight)

Restrictions

- Calf intensive
  - Incline Treadmill walking
  - Running at body weight
  - Any exercise that could require an unexpected reaction





" Recognizing the muscular endurance that naturally develops from living in a 1 G environment is crucial." Corey Twine

Agility as it applies

- Closed Skills - require an athlete to perform a pre-programmed pattern of movement(s) using cones or other implements.
  - (Successful demonstration of skill)
- Open Skills – Reactive, Decision making
- Phase 2 + **Phase 3** Primary Focus: Aerobic / Anaerobic exercise that does not cause issues!
  - AlterG (progress in the percentage of body weight)

Restrictions

- Speed
- Skill
- Load

Sample Post-Flight Reconditioning Template

Post Flight Reconditioning Calendar/Goals

Crew Member:							
Mission:							
Crew Member Goals:	Short Term (first week):						
	Short Term (by mid-point):						
	Long Term (by end of 45 days):						
Week 1: (R+1-R+7)	Conditioning/Agility	Resistance	Conditioning/Agility	Resistance	Active Recovery	Resistance	Conditioning/Agility
Week 2: (R+8-R+14)	Resistance	Conditioning/Agility	Active Recovery	Resistance	Conditioning/Agility	Resistance	Full Rest
Week 3: (R+15-R+21)	Resistance	Conditioning/Agility	Assessment Resistance	Conditioning/Agility	Resistance	Active Recovery	Full Rest
Week 4: (R+22-R+28)	Resistance	Conditioning/Agility	Assessment Resistance	Conditioning/Agility	Resistance	Active Recovery	Full Rest
Week 5: (R+29- R+35)	Resistance	Conditioning/Agility	Assessment Resistance	Conditioning/Agility	Resistance	Active Recovery	Full Rest
Week 6: (R+36-R+42)	Resistance	Conditioning/Agility	Resistance	Conditioning/Agility	Resistance	Active Recovery	Full Rest
Week 7: (R+43-R+45)	Resistance	Conditioning/Agility	Resistance	Conditioning/Agility	Resistance	Active Recovery	Full Rest

ASCR Group Led
ASCR Group Led
Crew Member Led

X Due to individual crewmembers' specific needs and or preference

Sample Post-Flight Reconditioning Weekly Template

Resistance Training Template

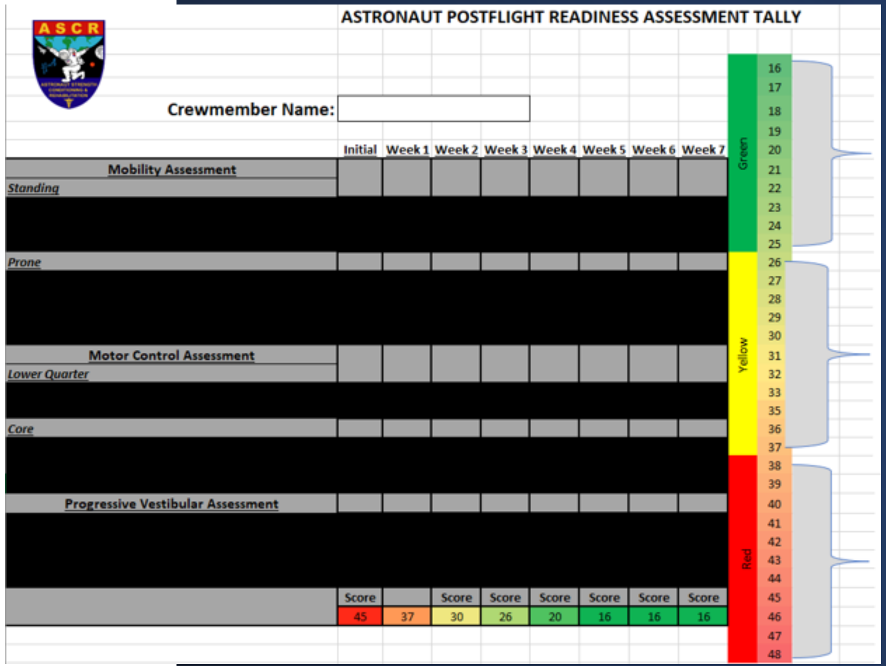
- **Vestibular**
- **Mobility**
  - Shoulder
  - Hip
  - Spine
- **Neuromuscular Re-education**
- **Progressive Vestibular / Balance**
- **Specific Warm-up**
- **Main Resistance Training Exercise**
  - Push
  - Pull
  - Primary Leg
- **Cool down / Recovery**

Agility and Conditioning Template

- **Vestibular**
- **Mobility**
  - Shoulder
  - Hip
  - Spine
- **Neuromuscular Re-education**
- Progressive Vestibular / **Balance**
- **Dynamic Warm-up**
  - A-skips
- **Main Agility Training Exercise**
- **Conditioning**
  - Bike, or
  - Running
- **Cool down / Recovery**

Active Recovery Template

- **Vestibular**
- **Mobility**
  - Shoulder
  - Hip
  - Spine
- **Neuromuscular Re-education**
- Progressive Vestibular / **Balance**
- **Specific Warm-up**
- **Light Cardio 20-25min**
- **Cool down / Recovery**



ASTRONAUT POSTFLIGHT READINESS ASSESSMENT TALLY

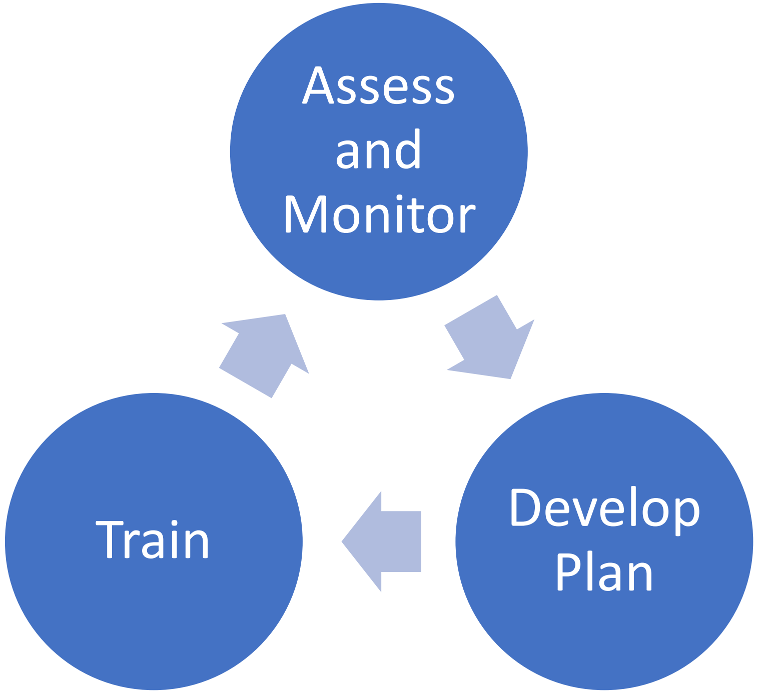
ASCR

Crewmember Name:

	Initial	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Mobility Assessment								
Standing								
[redacted]								
Prone								
[redacted]								
Motor Control Assessment								
Lower Quarter								
[redacted]								
Core								
[redacted]								
Progressive Vestibular Assessment								
[redacted]								
	Score		Score	Score	Score	Score	Score	Score
	45	37	30	26	20	16	16	16

Green	16, 17, 18, 19, 20, 21, 22, 23, 24, 25
Yellow	26, 27, 28, 29, 30, 31, 32, 33, 35, 36, 37
Red	38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48

Post-Flight Lessons Learned



Summary / Lessons Learned

Daily fatigue assessment and total volume understanding (only so much in the tank)

Pointed and clear guidance on activity outside of the post-flight reconditioning timeframe

Quality over quantity

Consider web-based platforms to train crew if on travel

Previous injury and prior functional status considerations

Creativity is a must during the entire 45 days...have fun!

Questions?

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