U.S. Countermeasure Operations

Jim Loehr MS, CSCS
Astronaut Strength, Conditioning & Rehabilitation Group
NASA – Johnson Space Center
Wyle Integrated Science and Engineering Group

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Preflight Exercise

• Goal
  – Maximize increases in muscle, bone and aerobic fitness
  – Familiarize astronauts with in-flight exercise prescription and hardware operation

• Schedule
  – Crewmember assigned about 2 yr before mission
  – Each crewmember is scheduled PT 4 hrs/wk
Preflight Exercise (con’t)

• Exercise Program
  – Aerobic Exercise Prescription
    • Crew performs on own
  – Resistance Exercise Prescription
    • Program written by ASCR
    • General fitness using free-weights
    • Emphasize in-flight exercises
Preflight Exercise (con’t)

• In-Flight Hardware
  – Crew receives 2 CMS Ops Classes
    • Covers hardware usage, maintenance, inspection, etc.
  – Our class focuses on usage, exercise technique, establishing exercise speeds/loads, and safe hardware operation
  – ARED: 16 training sessions over 2 yr (time taken out of PT)
    • Considered training class and is therefore hard scheduled and tracked
  – T2: encourage crew to come during PT time to practice T2 operations
Preflight Challenges

- Training schedule tight making pre-flight training inconsistent
  - Limit on number of work hours in a week
  - PT usually the first thing moved or deleted from training schedule based on priority
  - If moved usually placed extremely early or late

- International travel
  - Multiple facilities, different equipment, various times in country, time in training schedule while in that country
  - Difficult to establish a routine
In-flight Exercise

• Overall concept
  – Body adapts to the surrounding environment
  – Program variation key to mitigate adaptation to 0 G
  – If the body cannot predict the environmental stimuli, more likely to preserve functionality

• Goal
  – Minimize losses in muscle, bone and aerobic conditioning
  – Protect performance and functionality
  – Maximize hardware utilization

• Schedule
  – 2.5 hours exercise 6 d/wk
  – 1.5 hr Resistive
  – 1 hr Aerobic
  – Most exercise 7d/wk
In-flight Exercise (con’t)

• ARED:
  – Vary Load:
    • Lower body - Heavy (4x6), Light (4x12), Medium (4x8)
    • Upper Body - All 3x10
  – Vary Exercises: 3 distinct exercise routines/days
    • Primary exercises are lower body/triple extension movements
  – Vary Order: Each routine or day rotates so each gets a heavy, light, medium day.
  – Vary Exercise Techniques: Use a variety of squat and deadlift techniques and stances.
  – 2 distinct macrocycles; % of load lifted increases week to week
  – Loads determined using pre-flight ARED training sessions
  – Lower Body: Calculate 6, 8 and 12 RM using 10 RM
  – Add 75% BW to all squat and heel raise exercise
  – Next Step: Evaluate high velocity exercises
In-flight Exercise (con’t)

- **CEVIS/T2:**
  - Try to accommodate crew preference
    - Recommend 3/3
    - End of mission 2/4
  - For CEVIS and T2 we prescribe steady state and various interval protocols
  - Difficulty increases as increment progresses
    - CEVIS – Watts
    - T2 – Speed/Load
  - Recommend at least 5 min of passive walking/running as a warm-up
  - **Treadmill Load**
    - Starts at 50-60% of preflight body weight
    - Increase load throughout the mission
  - **CEVIS protocols based on preflight VO2 maximal cycle aerobic test**
In-flight Challenges

• Broken hardware/hardware not performing as expected
• In-flight operations can restrict exercise time
  – e.g. experiments sensitive to vibration, maintenance activities, EVA
• Communication
  – Takes time to adjust program through email
  – Limited individual talk time with crew
• Injury
• Schedule
  – 6 crew + 1.5 hr ARED time = 9 hr; crew work day = 8 hr
• Treadmill
  – Loading on treadmill dictated by harness comfort
  – Limited understanding of load x speed interaction
    • How to create prescriptions to maximize aerobic fitness
• Exercise program affects multiple systems
  – Limited exercise time
  – Maximize prescriptions to maximize use of crew time
• Crew preference/effort
  – Ground: Underestimate loads/speeds for in-flight prescription
  – In-flight: Crew adherence - may deviate or alter program due to preference
Postflight Reconditioning

• All crewmembers have issues to some degree
  – Neurovestibular, orthostatic, back/neck, coordination, balance/agility, aerobic, strength, endurance, power and flexibility
  – All crewmembers progress at different rates
• Goal
  – Return to preflight status as quickly as possible
• Schedule
  – Lasts 45 days starting R+1
  – 2 hr every day, including weekends
• Every day
  – Aerobic Exercise
  – Dynamic Stretching and Warm-up
  – Core Exercise
  – Static Stretching
• Every other day
  – Resistance Training
  – General Performance Skills
Postflight Reconitioning (con’t)

• Every day
  – Aerobic Exercise
    • 20–30 min
    • HR ≥ 75–80% age predicted max
    • Progression: Recumbent Bike → Upright Bike/Rower/Elliptical → Treadmill → Outdoor
  – Dynamic Stretching and Warm-up
    • Done everyday starting at R+0
    • Objectives
      – Primary – warm-up and dynamic stretching
      – Secondary benefits – balance, coordination, orthostatic and neurovestibular
  – Core Exercises
    • Done everyday starting at R+1 and progressing as needed
    • Objectives- develop and work core muscle strength and endurance in all planes of motion
      – Primary – muscle strength and muscle endurance
      – Secondary benefits – reduced back and neck stiffness and neurovestibular
  – Static Stretching
    • Done everyday starting at R+0
    • Objectives – increase flexibility around all joints
      – Primary – flexibility
• **Every Other Day**
  
  – **Resistance Exercise**
    - Perform exercises similar to those performed during flight
    - Progressively push load to preflight levels
  
  – **General Performance Skills**
    - **Mobialanception**
      - Start at R+1. As crewmember improves tasks become more challenging
      - Objectives
        - Primary – mobility, balance, proprioception
        - Secondary benefits – neurovestibular and orthostatic
    
    - **Medicine Ball**
      - Starts at R+1 and becomes progressively harder as the crewmember improves
      - Objectives – power in multiple planes of motion
        - Primary – power and back
        - Secondary benefits – muscle endurance, coordination, balance, strength, neurovestibular
    
    - **Ladder and Cone Drills**
      - Start around R+7; after our first functional fitness exam.
      - Objectives – agility, coordination and balance while moving in multiple planes of motion
        - Primary – agility, coordination and balance
        - Secondary benefits – neurovestibular, reduced foot and calf soreness
    
    - **Jumping Drills**
      - Start no sooner than R+21
      - Objectives – power, coordination and balance while moving in multiple planes of motion
        - Primary – power, agility, coordination and balance
        - Secondary benefits – reduced foot and calf soreness
Postflight Challenges

• Progression
  – Crew initial ability / functionality
    • In-flight program adherence
  – Adherence / attendance
    • Family obligations
  – Desire to return to normal activities
    • Crew push too hard, risking injury

• Schedule
  – Don’t always get 2 full hours

• Fatigue
  – Family / friends
  – Fighting gravity
  – Return to work / normal activities
Back-up Slides
## ARED Exercise Prescription

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National Aeronautics and Space Administration