Exercise Countermeasures Support

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Background

• ISS medical operations support
  – Requirements and implementation of medical operations support developed through consensus between International Partners

ISS MMOP Countermeasures Working Group Representatives

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Background

• First Canadian ISS Expedition crewmember – 2009

• CSA astronauts fly under ISS-US Operating System

• ISS medical operations support for CSA astronauts
  – in collaboration with NASA
  – in coordination with International Partners
Exercise Prescription
Pre-flight

• Launch-365 days to Launch

• Objectives:
  – Ensure general physical preparedness
    • adequate level of fitness to conduct mission operations safely and effectively
    • sufficient reserve to help offset the deconditioning effect of space flight.
  – Crewmembers are trained and familiar with in-flight equipment, exercise technique and protocols
Exercise Prescription
Pre-flight

• General Physical Preparedness - Fitness Guidelines
  – Cardiorespiratory:
    • maximum aerobic capacity (VO2max) at or above the mean for their age and gender (American College of Sports Medicine Guidelines)
      – based on NASA-STD-3001, Volume 1

  – Musculoskeletal:
    • Pre-flight musculoskeletal fitness within or above Very Good health benefit zone for age and gender matched norms (Canadian Physical Activity, Fitness and Lifestyle Approach (CPAFLA))
    • Hand grip, push-ups, partial curl-ups, sit and reach, vertical jump
Exercise Prescription

Pre-flight

Resistance training
- Phase 1 – Stabilization (muscular endurance, joint stability)
- Phase 2 – Strength (strength endurance, hypertrophy)
- Phase 3 – Undulating periodization – (alternate between stabilization, strength endurance, power)
- flexibility, balance and agility exercises in all phases
- 3 days/week
Exercise Prescription
Pre-flight

Cardiorespiratory conditioning
- Cycling; running; elliptical
- 3-5 days/week
- Steady and interval stimulus

• Include exercises that will be performed in-flight
  - squats, deadlifts, presses, CR protocols
  - Pre-flight resistance loads to estimate in-flight loads
Exercise Prescription

Pre-flight - Implementation

- CSA astronauts physically based in Houston but travel frequently

- Face-to-face sessions with crewmember on regular basis

- Exercise activity captured with heart rate monitor and electronic notes/journal

- Exercise prescriptions updated via email
Exercise Prescription

Pre-flight - Implementation

– In-flight countermeasures hardware training sessions performed at NASA-JSC
  • Capture in-flight hardware settings

– Pre-flight exercise related evaluations conducted at NASA-JSC
  • VO2, Isokinetic, DEXA, Functional fitness test
Exercise Prescription

In-flight

• Launch to Landing
• Objectives:
  – mitigate deleterious effects of microgravity to ensure operational effectiveness and decrease time required for post-flight reconditioning.
  • Muscular atrophy, bone loss, cardiovascular and neurosensory deconditioning

• Resistance and cardiorespiratory training
  – 6 days/week + 1 active rest day
  – Resistance: 1 hr/day
  – Cardiorespiratory: 30-45 min/day
Exercise Prescription
In-flight

Resistance
Phase 1 – Acclimatization
• 3 workouts
• Each workout composed of:
  – Warm-up set (1 x 15 reps; 1 x 8 reps)
  – 2-3 sets x 10 reps
  – Emphasis on lower body (squats, deadlifts, heel raises)
Exercise Prescription

In-flight

Resistance
Phase 2 –

• 3 workouts & 3 variations for reps/load
• 9 day cycle
  – Warm-up set (1 x 8 reps)
  – 4 sets of 6 reps or 3 sets x 8 or 12 reps
• Each workout composed of 6-7 exercises
  – Emphasis on lower body

• Progress load by 5% every third cycle, if first 2 cycles completed as prescribed.
Cardiorespiratory program:
- Aerobic fitness maintained at or above 75 percent of the pre-flight value (NASA-STD-3001, Volume 1)

Cycle ergometer (CEVIS)
- Set of individualized protocols developed by NASA Exercise Physiology Lab
  - steady state protocol (20 min @ 80% VO2max)
  - interval protocols (2 min stages, 40 or 50% VO2max rest; stimulus stages range from 60-90% VO2max)
Exercise Prescriptions

In-flight

Treadmill (TVIS & T2)

• Loading as high as feasible
• 75-90% HRmax (ground)
• At least one interval protocol/week
• Passive walking at end of session

• Cycle ergometer and treadmill data received weekly
• Periodic Fitness Evaluation
• Recommendations provided as needed
Exercise Prescriptions

Post-flight

- Landing to Landing + 45 days
- Objectives:
  - Crewmember obtains pre-flight physical fitness
- 2 hour reconditioning session, 6-7 days/week
- Based on NASA standardized post-flight protocol
  - Flexibility
  - Balance, agility, coordination
  - Muscular strength, endurance
  - Cardiorespiratory
- Progression based on crewmember’s condition & post-flight data
Exercise Hardware

• Pre-flight & Post-flight:
  – Commercially available
  – Heart rate monitors (with GPS)
  – Strength and conditioning equipment

• In-flight:
  – Resistance: ARED (iRED)
  – Cardiovascular: Treadmill - T2 (TVIS) and Cycle-ergometer – CEVIS (velo)

• At this time, CSA is not involved in the development of in-flight exercise countermeasures hardware.
Current Challenges

1) Minimum fitness standards to be maintained in-flight is unknown.
   – Impact on response to hardware contingency situations / availability.
   – Forward work at ISS Countermeasures Working Group
Operational Considerations

1) Pre-flight crewmembers have full training and travel schedule

2) Crewmember’s exercise technique may be different in micro-g

3) Hardware and software issues
Questions?