International Standardization of Bed Rest Standard Measures

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Purpose

• Present the complement of bed rest standard measures as developed for international use
  – Goal: to recommend a minimum set of standard measures to be used internationally with bed rest studies
Standard Measures

• Standard measures
  – assess all bed rest studies in a multidisciplinary manner
  – enhance interpretation of discipline specific measures
  – are valid, reliable and scientifically accepted
  – are typically “gold standard” measures used to assess changes in physiological function

• Standardization of measures
  – Allows for data sharing and comparison of data across bed rest studies completed at any location
Process

- Initial work was done through the International Countermeasures Research Working Group (ICM)
  - Agency leads for standardization of bed rest measures
    - ESA: Patrik Sundblad
    - IBMP: Irina Larina
    - NASA: Ronita Cromwell
  - Standard measures used by ESA, IBMP and NASA were reviewed by discipline experts
  - Experts provided recommendations for the minimum set of standard measures to be used internationally
  - Recommendations were reviewed by the agency leads and categorized as required or recommended measures
  - A standard measures document was drafted and merged with the standard conditions document

- Complete document is under review by the IAA study group
International Standard Measures

• Sensorimotor
  – Required
    • Postural Equilibrium Control
    • Treadmill test
  – Recommended
    • Dynamic Gait Index
    • Seat Egress and Walk
    • Gaze Control
    • Force Control
    • T-Reflex Function
International Standard Measures

• Cardiovascular
  – Required
    • Tilt test
    • Maximal Aerobic Capacity ($VO_{2max}$)
  – Recommended
    • Electrocardiogram (ECG)
    • Holter Monitor
    • Plasma Volume
    • Echocardiography
International Standard Measures

• Muscle
  – Required
    • Muscle Strength (isokinetic testing)
    • Neuromuscular Power (Vertical Jump)
  – Recommended
    • Muscle Size (MRI)
    • Muscle Biopsy
International Standard Measures

**Bone**

- **Required**
  - Bone Mineral Density (DXA)
  - Serum Chemistry
    - Calcium Homeostasis
    - Gonadal Hormones
    - Calcitropic Hormones
    - Endocrine Regulators
    - Bone Turnover Markers (bone formation)
  - Urinary Measures
    - Bone Turnover Markers (bone resorption)
    - Minerals (calcium)

- **Recommended**
  - Peripheral QCT
  - Blood
    - Cytokines and Cell Signaling/Mediators
  - Urine
    - Renal Stone Risk
International Standard Measures

Nutrition/Hematology

Required

• Blood Measures
  – Serum Chemistry
  – Whole Blood Analysis (CBC/differential/Platelets)
  – Coagulation Test
  – Finger-Stick Tests (whole blood)
  – Hematologic and Iron Status Indicators
  – Ionized Calcium Profile
  – Hormones
  – Mineral Status
  – Protein Status
  – Water & Fat Soluble Vitamin Status

• Urinary Measures
  – Urinanalysis
  – Minerals
  – Protein Status
  – Renal Stone Risk

• Other Measures
  – Body Mass
  – Body Composition (DXA)
  – Dietary Intake
International Standard Measures

Nutrition/Hematology Recommended

- Blood Measures
  - Antioxidants/Oxidative damage
  - Bone Markers
  - Cytokines

- Urinary Measures
  - Antioxidants/Oxidative damage
  - Bone Markers

- Other Measures
  - Resting metabolic rate
International Standard Measures

- **Immunology**
  - Complete Blood Count (CBC)
  - Basic leukocyte subsets
  - Stress hormone levels
  - Plasma IgG levels
  - Viral antibody levels
  - Alpha 1 globulin, alpha 2 globulin, beta globulin, gamma globulin
International Standard Measures

• Psychology
  – Required
    • Positive and Negative Affect Scale (PANAS)
    • General Health Questionnaire
  – Recommended
    • Log of Critical Incidents
    • Subject Diary
    • Personal Self-Perception and Attitudes Survey (PSPA)
    • Cognitive Test Battery
# Testing Schedule

<table>
<thead>
<tr>
<th>Standard Measure</th>
<th>Baseline Data Collection (BDC)</th>
<th>Head-Down Tilt (HDT)</th>
<th>Recovery (R)</th>
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<tbody>
<tr>
<td>Postural Equilibrium Control</td>
<td>BDC-1</td>
<td></td>
<td>R+0</td>
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<tr>
<td>Treadmill Test</td>
<td>BDC-2</td>
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<td>R+0</td>
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<tr>
<td>Tilt test</td>
<td>BDC-5</td>
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<td>Maximal Aerobic Capacity</td>
<td>BDC-4</td>
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<tr>
<td>Muscle strength</td>
<td>BDC-5</td>
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<td>R+2</td>
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<tr>
<td>Bone mineral density</td>
<td>BDC-13</td>
<td></td>
<td>R+13</td>
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<tr>
<td>Bone markers</td>
<td>BDC-3</td>
<td></td>
<td>R+0</td>
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<tr>
<td>Nutrition/Hematology</td>
<td>BDC-3</td>
<td></td>
<td>R+0</td>
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<tr>
<td>Immunology</td>
<td>BDC-3</td>
<td></td>
<td>R+0</td>
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<tr>
<td>Positive and Negative Affect Scale</td>
<td>BDC-13, BDC-1</td>
<td>HDT14, HDT28, HDT42, HDT56</td>
<td>R+1, R+13</td>
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<tr>
<td>General Health Questionnaire</td>
<td>BDC-13, BDC-1</td>
<td>HDT14, HDT28, HDT42, HDT56</td>
<td>R+1, R+13</td>
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# Discipline Experts

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<tr>
<th>Discipline</th>
<th>ESA</th>
<th>IBMP</th>
<th>NASA</th>
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<tbody>
<tr>
<td>Bone</td>
<td>Joern Rittweger</td>
<td>Victor Oganov</td>
<td>Jean Sibonga</td>
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<td>Cardiovascular</td>
<td>Richard Hughson</td>
<td>Olga Vinogradova</td>
<td>Steve Platts</td>
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<td>Hematology</td>
<td>Alexander Chouker</td>
<td>Marina Rykova</td>
<td>Scott Smith</td>
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<td>Immunology</td>
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<td>Brian Crucian</td>
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<tr>
<td>Muscle</td>
<td>Joern Rittweger</td>
<td>Boris Shenkman</td>
<td>Lori Ploutz-Snyder</td>
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<td>Nutrition</td>
<td>Petra Frings-</td>
<td>Irina Larina</td>
<td>Scott Smith</td>
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<td>Psychology</td>
<td>Elisabeth Rosnet</td>
<td>Vadim Gushin</td>
<td>Walt Sipes</td>
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<td>Sensorimotor</td>
<td>Gilles Clement</td>
<td>Inessa Kozlovskaya</td>
<td>Jacob Bloomberg</td>
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14
Thank you for your attention.