“SPACE MEDICINE”
Shuttle – Space Station
Crew Health and Safety
Challenges for Exploration

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The first word from the Moon
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Objective

To ensure the health, safety, and well-being of the astronaut corps and ground support team during all phases of space flight.
Mission Support

On-orbit Flight Control Room (FCR) Staffing

Surgeon Console - FCR
Physiological Issues

- Space Motion Sickness (SMS)
- Cardiovascular
- Neurovestibular
- Musculoskeletal
- Behavioral/Psycho-social
Human Response to Spaceflight

Astronauts experience a spectrum of adaptations in flight and postflight.

- Balance disorders
- Cardiovascular deconditioning
- Decreased immune function
- Muscle atrophy
- Bone loss

- Neurovestibular
- Cardiovascular
- Bone
- Muscle
- Immunology
- Nutrition
- Behavior
Space Motion Sickness (SMS)

- **Incidence**
  - Affects approximately 70% of crewmembers
  - 10% of cases severe

- **Symptoms** - From loss of appetite to nausea and vomiting

- **Time course** - Onset from MECO to 24 hours; peak symptoms 24 to 48 hours; symptoms resolve by 72 to 96 hours

- **Causes**
  - Neurovestibular - otolith mismatch, sensory conflicts
  - Fluid shift

- **Treatment**
  - Decreased activity
  - 1-G orientation
  - Medication (Phenergan IM)
Cardiovascular

Changes in redistribution of body fluids cause inability of the body to adapt to rapid circulatory changes, producing orthostatic symptoms postflight.

- **Symptoms** - Dizziness, lightheadedness,

- **Time course** - From reentry to several hours postlanding

- **Causes**
  - Fluid shifts
  - Baroreceptor

- **Treatment**
  - Fluid loading
  - On-orbit exercise benefit
  - Liquid cooling garment
  - Medications
Behavioral/Psycho-Social

Changes in crew mood, morale, and circadian rhythm

- **Incidence** - Affects all crewmembers to some degree
- **Symptoms** - Fatigue and irritability, performance
- **Time course** - Depends on flight plan
- **Causes**
  - Work load
  - Sleep habits and facilities
  - Crew personalities, “crew space”, and cultural differences
  - Temperature
  - Noise
  - Odors
  - Atmosphere
  - Diet
  - Lack of family contact
- **Treatment** - Treat causes
Space Flight Environmental Issues

- Radiation
- Toxic products and propellants
- Habitability
- Atmosphere
- Medical events
Medical events in U.S. Space Program

• Apollo 8 crew – 1st Americans to report space motion sickness
• Apollo 9 - space motion sickness caused EVA to be rescheduled (1st timeline change due to medical cause)
• Apollo 11 – Type 1 DCS in command module pilot
• Apollo 13 – Kidney infection during mission
• Apollo 15 – Cardiac dysrhythmia (PVC, PAC, bigeminy) during lunar EVA
• Apollo Soyuz Test Project – Nitrogen Tetroxide chemical pneumonitis on reentry
Medical Events in Russian Space Program

• Events not resulting in mission termination or early return
  – Kidney Stone - 1982
  – Hypothermia during EVA - 1985
  – Psychological stress reaction - 1988
  – Spacecraft depressurization - 1997
  – Toxic atmosphere - 1997
The Space Radiation Environment

Representation of the major sources of ionizing radiation of importance to manned missions in low-Earth orbit. Note the spatial distribution of the trapped radiation belts.
Systems & Crew Training

KC-135
“Weightless Wonder, Vomit Comet”

Hardware Testing and Procedure Validation
Developing ACLS algorithms for on-orbit use and training
Systems & Crew Training

Shuttle Orbiter Medical System (SOMS)
Systems & Crew Training

Health Maintenance System (HMS)
Defibrillator & Respiratory Support Pack (RSP)
Crew Medical Restraint System (CMRS)
Crew Contamination Protection Kit (CCPK)
Mission Support

- Extravehicular Activity (EVA) Monitoring
Upright dual arm and leg cycle exercise (ALE)

Semi-recumbent intermittent light exercise simulating astronaut tasks (ILE)
Vertical Pursuit Tracking With Head and Eye

L - 10

EYE
HEAD

GAZE
TARGET

R + 0

EYE
HEAD
GAZE
TARGET

20°

1 Sec
Astronaut Health

Physical training and rehabilitation
Perspective

Earth

Venus

Mars

Mercury

Pluto
Jupiter is about 1 pixel in size
Earth is invisible at this scale
Morbidity Associated With Shift Workers\textsuperscript{1-4}

- Gastrointestinal disorders (e.g., peptic ulcer disease)
- Hypertension/cardiovascular disease
- Psychological distress
- Work-related strain
- Drug/alcohol dependency
- Disruption in social/family life

High Performance Environments in Medical Care
HOUSTON

FIRST WORD FROM THE MOON
Medical Care in High Performance Environments
Really High Performance Environments
Neurovestibular

In-flight changes in neural feedback function that produce postural imbalance and loss of coordination postflight

- **Incidence** - All crewmembers are affected to some degree
- **Symptoms** - From vertigo and unstable gait to nausea and vomiting
- **Time course** - From landing to 48 - 72 hours postlanding
- **Causes** - Neurovestibular-otolith and proprioception readaptation
- **Treatment**
  - Avoid rapid head movements
  - Slow but progressive increase in activity
  - Medication (Phenergan, Antivert)