Medical Needs for Mars

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• The Challenges ( = Key Questions that need to be answered before we can embark on a mission to Mars, with a specific focus on cross-disciplinary considerations)

• The Essentials (= Key Design Drivers)

• Cross Disciplinary Focus
The Challenges

LEO Mission Planning Assumptions:

- Real Time Communications
- Medical Evacuation Capability
- Consumables Resupply
Getting to Mars

Deep Space Gateway
2024

Deep Space Transport
2027

Precursor
2029

Mars
2033

Human System Requirements

- Test System Data Management
- Ground Optimize for 42 Day Mission
- Deploy System Data Handling
- Initial Ground Operations Changes
- Exercise Deep Space Comm, Autonomy, and Decision Paths
- Deploy Revised Ground Ops
- Optimally Autonomous Crew
- Redefined Ground Operations Paradigm

Ground System Requirements

Pre-Decisional
The Challenges

• What is likely to go wrong?

• How do we prevent those things?

• If they happen, how do we plan to deal with them?

• How do all those things fit into the limited resource space we have from the vehicle and mission architecture?

• How do we show that the resources, knowledge, skills, and abilities that we include reduce the risk to those who go?
Changing Mission Risk

Mission Duration (Days)

- Launch: 730 days
- Transit Hardware: 365 days
- Deep Space Hab: 128 days
- Shuttle/ISS: 42 days
- Gateway: 21 days
- EM2: 14 days
- Transit Medical - LOCL: 1/25 to 1/22
- EDL: Mars Transit

Mission Risk (LOC)
• Conception of Medical Operations
• Quantification of Medical Risk
• Data Systems Development
• Human Systems Engineering for Vehicle and Mission Integration
Human System Performance

- Cognition
- Sleep
- Team Cohesion
- Team Dynamics
- Training Capabilities
- Mood
- Physical Strength
- Stamina
- Exercise Equipment
- CO2 Levels
- Oxygen
- Water Quality
- Air Quality
- Radiation Monitoring
- Waste Management
- Food and Nutrition
- Pharmacy
- Medical Equipment
- Medical Skills Maintenance
- Emergency response
- Biomonitoring
- Ground Support
System Performance Threatened by Sleep Deficit
Sleep Deficit Affects Other System Aspects
Cross Collaboration Priorities

• How do we monitor the human system state to enable prediction and prevention of medical issues?

• How do we model Human Performance so that we can plan for systems that optimize that?

• How do we balance medical specific training/understanding with the larger mission training needs?

Medical is a small part of the Crew Health and Performance System
The Essentials

- **Protect from environmental hazards**
  - Radiation protection
  - Noise, vibration, CO$_2$, etc.

- **Keep healthy crew well**
  - Exercise
  - Other physiological countermeasures
  - Food
  - Behavioral health

- **Prevent, diagnose, treat, manage long-term health care**
  - Data system
  - Medical devices
  - Medical supplies

- **Support crew to accomplish mission tasks**
  - Procedures
  - Training
  - User interfaces
In the end, a single system has to work.
From Conclusion 6:

“The human being must be integrated into the space mission in the same way in which all other aspects of the mission are integrated.”