

# ***Medical Care in Space:***

***The Challenges and Risks  
Space Travel and Colonization  
Pose for Medical Care, and  
How Life on Earth  
Can Benefit***

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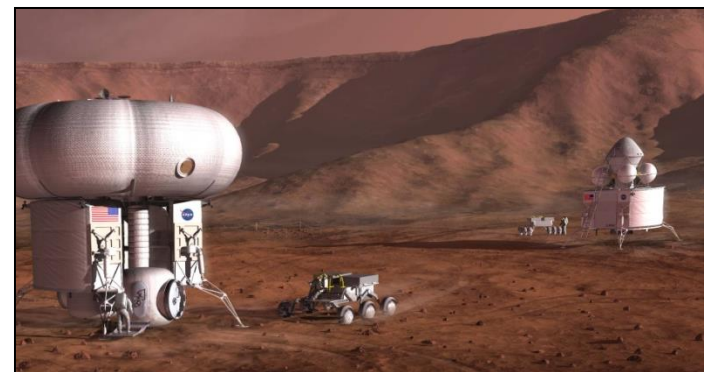
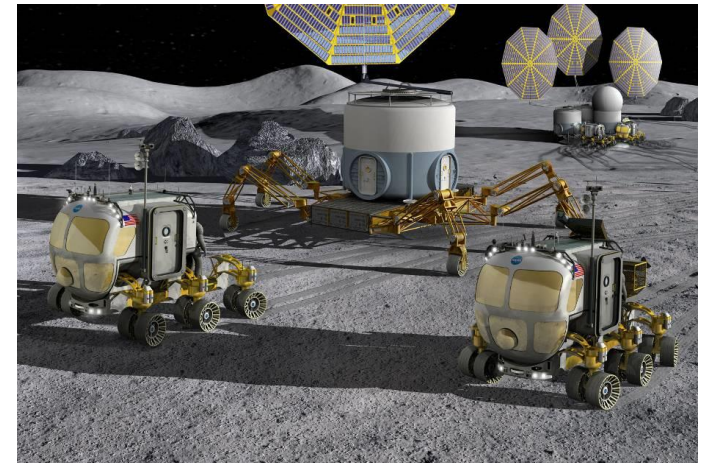


# ***Space is a Dangerous Place for Your Health***

- **Reduced Exposure Potential for Infectious Diseases, But Immune System is Weakened**
- **Radiation Hazards are Much Worse**
- **Lower Gravity Wreaks Havoc on the Body, e.g.,**
  - **Osteoporosis, Bone Mineral Density Loss**
  - **Muscular Degeneration and Atrophy**
  - **Renal Stones**
  - **Congestive Heart Failure**
  - **Motion Sickness, Sensory-Motor, Cognitive**
  - **Behavioral, Psycho-social, Job Performance**
- **Constrained Environment Also Contributes to Additional Behavioral, Psycho-social, and Job Performance Risks**

# ***Now Embarking on Exciting New Missions***

- **Extended International Space Station Crews and Stays**
- **Lunar Sortie Missions**
- **Permanent Lunar Habitation**
- **Mars Missions**
- **Health Risks will be Much Greater than Ever Before**



# ***In Space Medical Care Options***

- **Return Home**
- **Limited Clinical Care**
  - **Only Ancillary Medical Training for Astronauts**
  - **Limited Medical Equipment**
  - **Reduced Pharmacological Efficacies**
- **Mitigations**
  - **Treadmill, Ergometer**
  - **Preventative Drugs**



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# ***How Engineers Helped Assess the Health Risks***

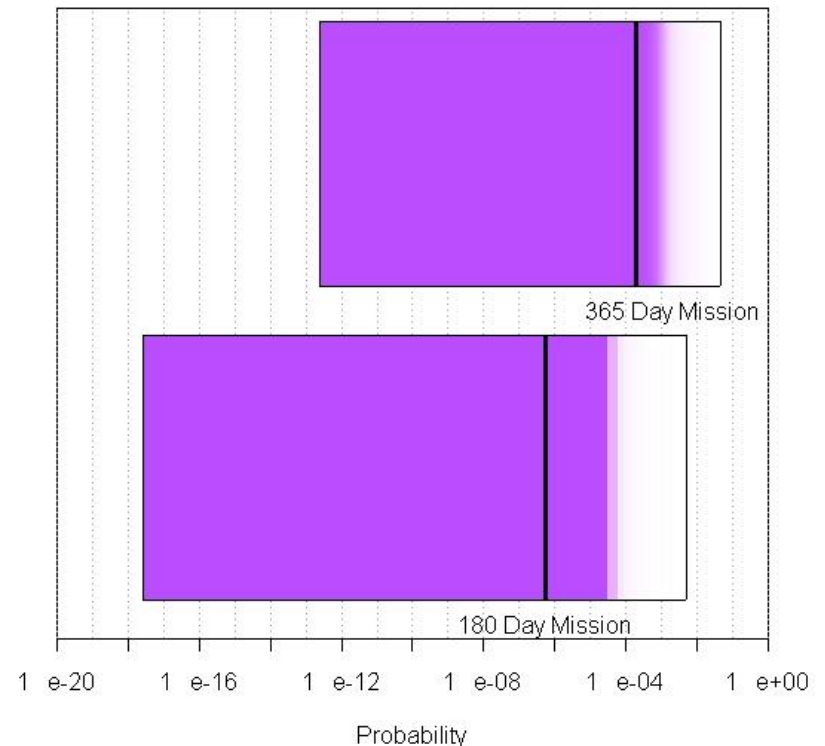
- **The Problem:**
  - **Astronauts Selected for Health**
  - **Very Few if Any Health Events**
  - **Many, Many Astronaut Flights with No Health Event**
- **The Solution**
  - **Use Bayesian Approach**
  - **Incorporate Data from Entire Human Spaceflight History**
  - **Develop Complete Risk Distributions**



# *Example:* *Bone Fracture Risk*

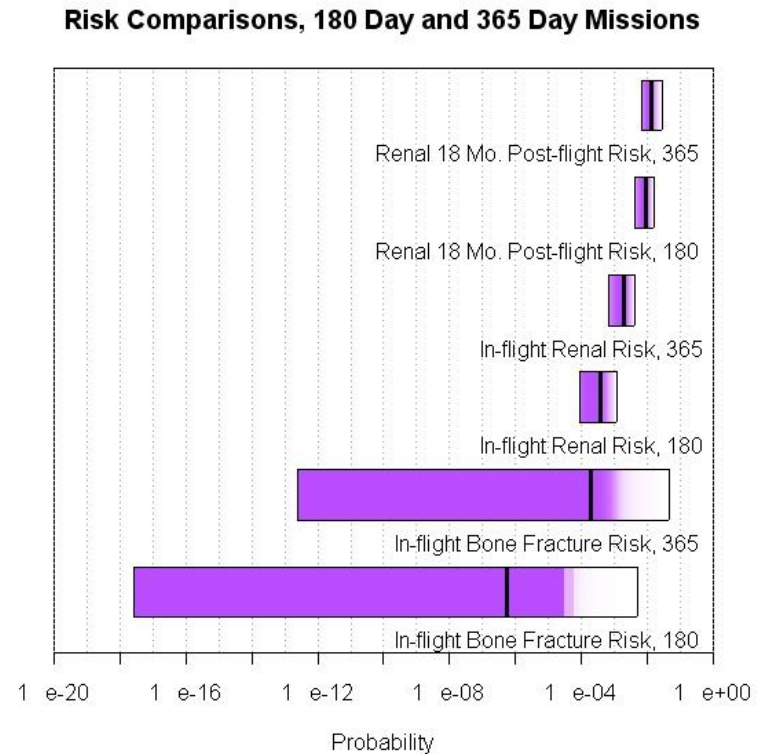
- **The Data**
  - **977 Astronaut Missions up to 434 Days**
  - **No Bone Fractures Ever Observed**
- **Risk Results for 180 vs. 365 Day ISS Mission**

**In-flight Bone Fracture Risk, 180 vs 365 Day Missions**



# Fracture vs. Renal Risks

- **Renal Data:**
  - One Event on-orbit
  - Few Post Mission
- **Risk Results for 180 vs. 365 Day ISS Mission**
  - Fracture
  - Renal During Mission
  - Renal Post-mission



# ***Space Medical Applied to the Earthbound***

- **Remember the Treadmill for Mitigating Fracture Risk?**
- **Once, it Broke on the ISS**
  - **Astronaut Merely Stood on Treadmill Strapped In for Exercise Period and Read**
  - **Astronaut Had No BMD Loss**
- **Mitigation Action Previously Believed to be Result of Working the Muscles**
- **Apparently, Static Stress on Bone Prevents BMD Loss Also**
- **May Lead to New Treatments for the Earthbound with BMD Loss**



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**Slide #8**



# *Summary*

- **Space Medical Care Can Accelerate Innovations in Understanding Health Problems on Earth, as well as in Medical Care on Earth**
- **Systems Engineers Can Play a Significant Role in Advancing these Innovations**



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