Medical Research in Microgravity: Challenges for Future Long-Term Space Missions & the Moon

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UNOOSA - Accessibility in Space
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Agenda

- Human Spaceflight and Health Risks
- Challenges for Medical Research
- Bio-Monitor Astroskin System
- Current Research
- Future Challenges and Opportunities
- Q&A
Human Spaceflight - History

- Yuri Gagarin: 1961
- 600+ astronauts reached orbit in past 60 years
- Less than 100 women
- 12 walked on the Moon
- 10 people in space right now (7 ISS, 3 Tiangong SS)
- Person-days in space/years increasing ↑
- Private spaceflights → more diverse astronauts
Human Spaceflight - Environmental Conditions

- Isolated
- Confined
- Extreme
- Weightlessness
  - Radiation
- No day/night

➡ Crew Safety
➡ Mission Risk Management
Human Spaceflight - Common Health Issues

- Upper respiratory congestion
- Circadian rhythm - loss of sleep
- Skin rash
- Bone and muscle loss
- Cardiovascular stiffness
- Infections - immunity dysregulation
- Intracranial hypertension
- Vision deterioration

46% of crew members reported an event deemed “notable”.
3.40 events per flight year

Low Earth Orbit propice to telemedicine
Mars, not so much...

Human Spaceflight - Countermeasures and Health Risk Management

- Cardiac and strength training
- Health monitoring
- Psychological self-assessments
- Medical decision support systems
- Medication
- Air filtration

Data Driven ⇒ Need Medical Research
Constraints on study design:

- Few subjects available
- Crew member time limited
- Crew members selected for good health
- Long mission planning cycle
- Volume/weight of equipment
- Space qualified medical devices
- Limited resupply opportunities

"Demands for answers to medical questions widely exceeds our capacity to do trials."
Astroskin - Monitors Five Vital Signs Simultaneously

3-Lead ECG
- 250 Hz, 1uV Resolution
- Heart rate: 30-220 BPM, 1Hz, 16 bits resolution
- QRS event detection: 4ms resolution
- RR intervals: 4ms resolution

Dual Channel Breathing Sensors
- RIP 125 Hz
- Breathing rate: 2-90 RPM, 1 Hz, 0.1 RPM resolution
- Minute Ventilation: 3-90 L/min, 1 Hz
- Tidal Volume (last inspiration): 80-10000 mL, 1 Hz, 20 mL resolution
- Inspiration & Expiration Events: 8ms resolution

Pulse Oximetry
- Oxygen Saturation (SpO2 %): 1 Hz, resolution 1%
- Photoplethysmography (PPG): 75 Hz
- Heart rate: 1 Hz

Systolic Blood Pressure (BP)
- Systolic pressure: 60-260 mmHg, 1 Hz, 1 mmHg resolution
- Pulse Transit Time Computation

3-axis Accelerometer
- 50 Hz, +/-16g range
- Actigraphy: 1Hz, 3.9 mG resolution
- Step count: reported at each step
- Cadence: 30-240 rpm, calculated on 8 last steps, 1 Hz

Skin Temperature
- 1 Hz, 0.1 Celsius resolution
An End-to-End System

Astroskin Vital Signs Monitoring Platform

- iOS App - iPhone & iPad
- Data Synchronization
- Dashboard
- Open API & Free Hosting
- Licensing options for Developers & Organizations
Astroskin - Vascular Aging Study

Dr Richard Hughson, Waterloo University - CSA
9 astronauts
Data collection 2019-2024

- Identify the specific cause of increased arterial stiffness in astronauts
- Confirm if and when insulin resistance develops during a space mission
- Clarify the effect of radiation exposure on cardiovascular health
- Track the recovery process after return

After 6 months in space, astronauts’ arteries stiffen by 17% to 30%, which could be compared to 10 to 20 years of normal aging on Earth.

Dr Andrew Blaber, Simon Fraser University - CSA
14 astronauts
Data collection started in 2022

• Investigate how astronauts' cardiovascular and respiratory systems interact with their blood pressure control systems
• Track these interactions in space to show the deconditioning that weightlessness can cause
• Compare data from male and female astronauts to shed light on whether their cardiorespiratory systems adapt to space flight in different ways

Astroskin - Space Health Study

Dr Carolyn McGregor, Ontario Tech University - CSA
10 astronauts
Data collection started in 2022

- Study deconditioning during space flight
- Collect data for AI medical system
- Develop live streaming communication system for health data

American Astronautical Society
2022 International Space Station
Research Innovation Award for
Human Health in Space
Astroskin - Future Challenges and Opportunities

More research needed!

Prepare long-term missions:
- Artemis Lunar Base Camp
- Orbital industry
- Mars

Research Opportunities:
- ISS well equipped with medical devices
- Private orbital missions
- Suborbital flights
- New opportunity to study short term microgravity decompensation
- Diverse, less fit astronauts.
They Are Using Astroskin for Medical Research In Space and on Earth
Let’s Stay In Touch:

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