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

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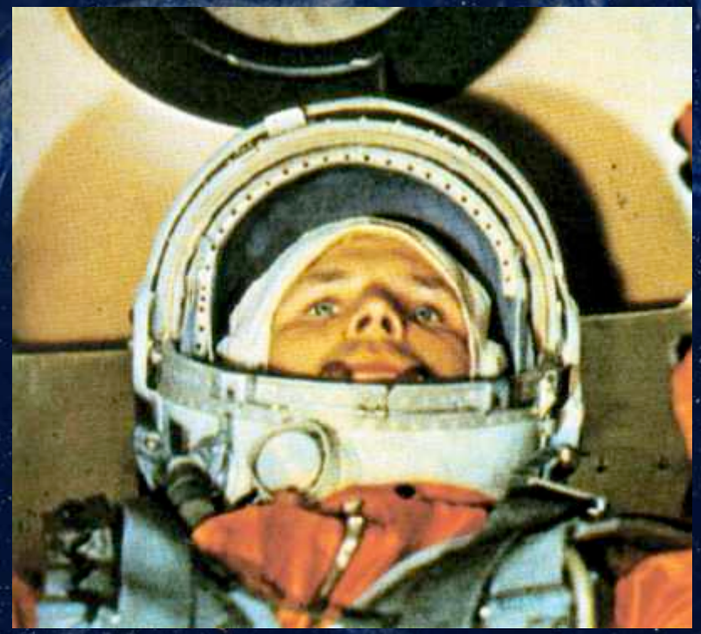
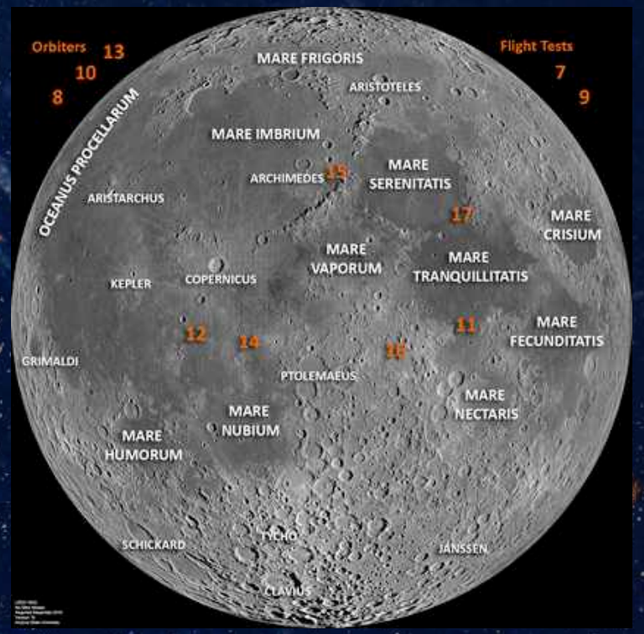
UNOOSA - Accessibility in Space
November 9th, 2023

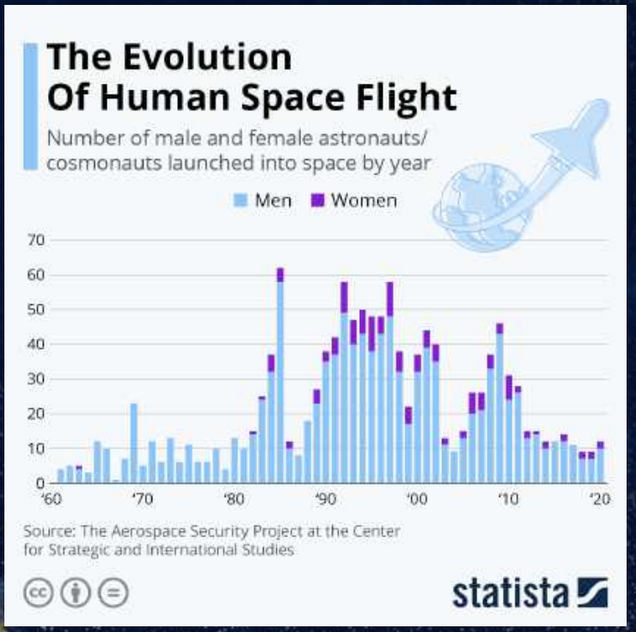
Agenda

- 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

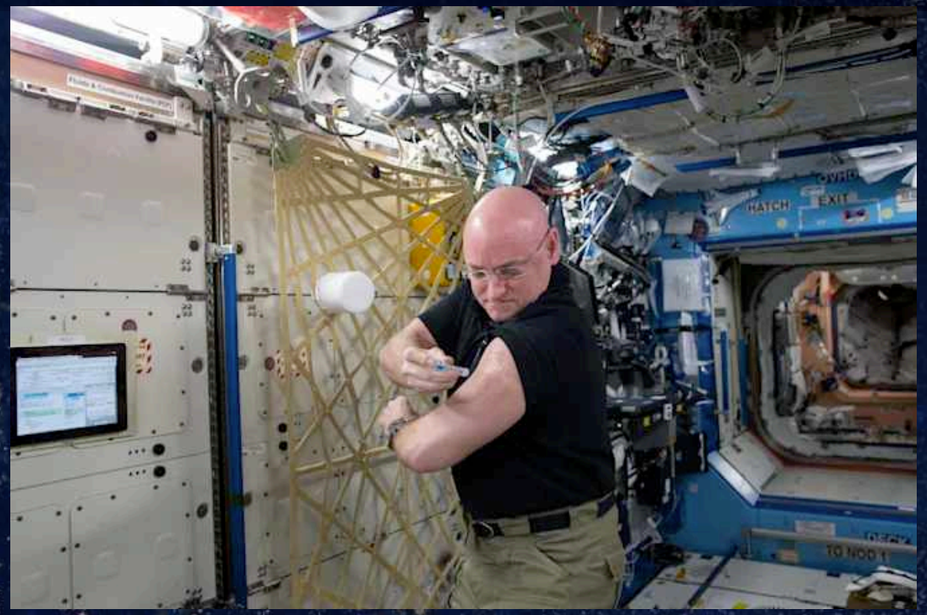
Human Spaceflight - Environmental Conditions

- 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…

See also “Incidence of clinical symptoms during long-duration orbital spaceflight”, Crucian et al, NASA, International Journal of General Medicine, 2016.

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

Human Spaceflight - Challenges for Medical Research in Space

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

ASTROSKIN
VITAL SIGNS MONITORING PLATFORM

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

Astroskin Vital Signs Monitoring Platform

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

Astroskin In Space

ASTROSKIN
VITAL SIGNS MONITORING PLATFORM

Astroskin - Vascular Aging Study

ASTROSKIN
VITAL SIGNS MONITORING PLATFORM

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.

Akihiko Hoshide

https://www.asc-csa.gc.ca/eng/sciences/vascular.asp

Astroskin - Cardiobreath Study

ASTROSKIN
VITAL SIGNS MONITORING PLATFORM

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**

David Saint-Jacques

https://www.asc-csa.gc.ca/eng/sciences/cardiobreath.asp

Astroskin - Space Health Study

ASTROSKIN
VITAL SIGNS MONITORING PLATFORM

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**

https://www.asc-csa.gc.ca/eng/sciences/space-flight-improve-monitor-health-earth.asp

Astroskin - 2022 ISS Research Innovation Award

ASTROSKIN
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American Astronautical Society 2022 International Space Station Research Innovation Award for Human Health in Space

Astroskin - 1st suborbital flight - Virgin Galactic 05 Mission (Nov 2nd, 2023)

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Astroskin - Future Challenges and Opportunities

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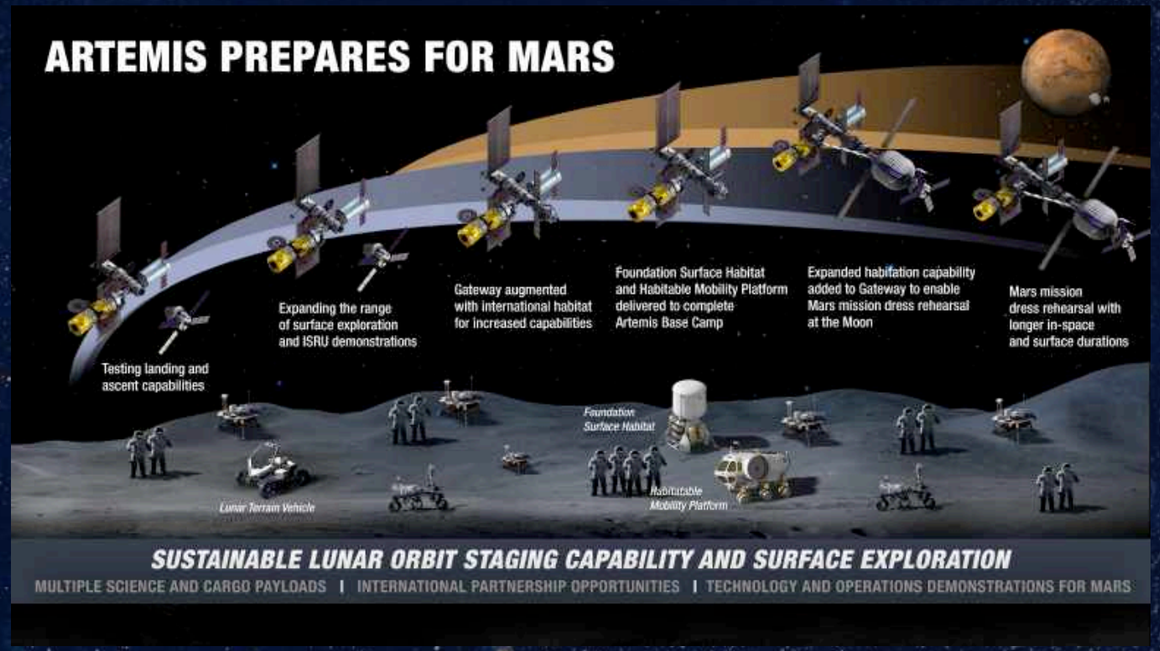
More research needed!

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

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NASA
CSA ASC
Ames Research Center
IIAS
INTERNATIONAL INSTITUTE FOR ASTRONAUTICAL SCIENCES
Virgin GALACTIC
THALES
NOKIA
AIRBUS DEFENCE & SPACE
UNIVERSITY OF ALBERTA
東北大学 TOHOKU UNIVERSITY
UTS UNIVERSITY OF TECHNOLOGY SYDNEY
UT DALLAS
Griffith UNIVERSITY
McGill
The Open University
UNIVERSITY OF IOWA HEALTH CARE
University of CINCINNATI
Canadian Blood Services
Société canadienne du sang
KISSEI
GU ENERGY
GOVERNMENT OF DUBAI
OntarioTech UNIVERSITY
UNIVERSITY OF WATERLOO
ENERGIO
Children's Hospital of Philadelphia
SFU SIMON FRASER UNIVERSITY

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