Planning Committee Members

Dr. Stephen Wetmore

Dr. Scott McKay

Dr. Richard Pawliszyn

Sheena Blasing, Program Coordinator
Program Learning Objectives

1. To transmit pertinent and relevant clinical practice knowledge and guidelines to primary care physicians including a forum for discussion and critical appraisal;

2. Identify and discuss current evidence supporting treatment of common conditions in primary care; and

3. Discuss challenges family medicine physicians face in their current practices.
Disclosure of Financial Support

- This program has received no financial support from any organization or sponsor.
- This program has received no in-kind support from any organization or sponsor.
Mitigating Potential Bias

- Presenters received a detailed letter from the Organizing Committee outlining the learning objectives and content expectations for each presentation.

- *Conflict of Interest* disclosure forms have been completed by all presenters and reviewed by the Organizing Committee.
Mitigating Potential Bias

• Presentations have been reviewed by a member of the Organizing Committee to ensure balance in content and the absence of bias.
Faculty/Presenter Disclosure

- Planning Committee Member: Dr. Scott McKay
  - Financial compensation:
    - London Health Sciences Centre
      - Stipend for Medical Advisory Committee Chair & Associate Chief of Family Medicine
    - Associate Chief of Family Medicine
    - Western University, Department of Family Medicine
      - Stipend for Undergraduate Education Director
Faculty/Presenter Disclosure

Presenter: Dr. Adam Sirek

- Financial compensation
  - Director, Leap Biosystems Inc.
Outline
1. What is Aerospace Medicine?
2. Space Missions & Architecture
3. Human Health Hazards of Spaceflight
4. You’re the Flight Surgeon

Learning Objectives
1. Identify the differences between traditional terrestrial medicine and aerospace medicine environments
2. Identify the five hazards to human spaceflight
3. Relate space medicine to corollary terrestrial environments
What is Aerospace Medicine?
### Traditional Aerospace Medicine Paradigms

<table>
<thead>
<tr>
<th>Medical Discipline</th>
<th>Physiology</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Medicine</td>
<td>Abnormal</td>
<td>Normal</td>
</tr>
<tr>
<td>Aerospace Medicine</td>
<td>Normal/Abnormal</td>
<td>Abnormal</td>
</tr>
</tbody>
</table>
Modern Commercial Aerospace Medicine Paradigms

<table>
<thead>
<tr>
<th>Medical Discipline</th>
<th>Physiology</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace Medicine</td>
<td>Abnormal</td>
<td>Abnormal</td>
</tr>
</tbody>
</table>

Abnormal → Abnormal
Space Missions
MISSION DURATION

**ISS/LEO**
Duration: 3-6 mo
Crew: 3-6
Transit Time: 6 hrs - 2 d
Communication Delay: 0.001 sec
Distance from Earth: 408 Km

**CIS-LUNAR**
Duration: 3 mo
Crew: 4-6
Transit Time: 3 d
Communication Delay: 1.25 sec
Distance from Earth: 384,400 Km

**DEEP SPACE**
Duration: 3 yrs
Crew: 4-6
Transit Time: 150-300 d
Communication Delay: 14 min
Distance from Earth: 54.6M Km
ARTEMIS II
Crewed Hybrid Free Return Trajectory, demonstrating crewed flight and spacecraft systems performance beyond Low Earth Orbit (LEO)

1. LAUNCH

2. ENTER EARTH ORBIT
Perigee Raise Maneuver (PRM) by Interim Cryogenic Propulsion Stage (ICPS) into 100x1545 nmi orbit

3. APOGEE RAISE BURN TO HIGH EARTH ORBIT
Followed by ICPS separation and Orion systems checkout

4. ORION TRANS-LUNAR INJECTION (TLI) BY ORION’S MAIN ENGINE

5. TRANS-LUNAR OUTBOUND
4 days with Outbound Trajectory Correction (RTC) Burns by Orion Aux Engines

6. LUNAR FLYBY
4,000 nmi (mean)

7. TRANS-EARTH RETURN
4 days Return Trajectory Correction (RTC) Burns by Orion Aux Engines

8. CREW MODULE/ SERVICE MODULE SEPARATION

9. ENTRY, DESCENT, AND LANDING

10. CREW AND ORION CAPSULE RECOVERY

Additional Information:
SLS Configuration (Block 1) with Human Rated ICPS | 15x1200 nmi (27.8x2222.4 km) insertion orbit | 28.5 deg inclination
4 astronauts | Mission duration: 10 Days | Re-entry speed: 24,500 mph (Mach 32)
LIVING, LEARNING AND WORKING ON THE MOON

International habitat delivered to Gateway

Artemis IV: First lunar surface expedition through Gateway

Sustainable operations with lander

Airlock arrives at Gateway; with surface habitat and pressurized rover

Exploration Command Module delivered to Gateway

SUSTAINABLE LUNAR ORBIT STAGING CAPABILITY AND SURFACE EXPLORATION

Lunar Terrain Vehicle (LTV)

Surface Habitat

Pressurized Rover

Surface Fission Power

ISRU Pilot Plant
Human Health Hazards in Spaceflight
Space has tremendous effects on the human body! As we prepare for journeys to more distant destinations like Mars, humankind must tackle these risks to ensure safe travel for our modern explorers.

The impacts of microgravity mirror aging and the complications of a sedentary lifestyle. By studying astronauts’ health, we also help people on Earth.

**BLOOD**

Blood cell production in the bone marrow is affected. Reduced red blood cells can cause anemia. Low white blood cell count leaves the body vulnerable to infection and is also linked with increased sensitivity to radiation.

**RADIATION**

Radiation doses are much higher. Overexposure can cause cataracts in the eyes, damage DNA, and increase the risk of cancer.

**HEART & BLOOD VESSELS**

Blood vessels stiffen and age faster, and astronauts can develop insulin resistance, which may lead to Type 2 diabetes. These factors increase the risk of cardiovascular disease.

**MUSCLES & NERVOUS SYSTEM**

Muscles lose mass and strength. Reflexes slow down and exercise tends to be less effective in space.

**BONES**

When they don’t bear weight, bones lose density and strength. While adults past age 50 typically lose about 1% each year, astronauts in space can lose up to 1.5% of their bone mass each month.
5 Hazards of Human Spaceflight

- Radiation
- Isolation
- Distance from Earth
- Gravity Fields
- Hostile Closed Environments
<table>
<thead>
<tr>
<th>Origin</th>
<th>Particle or wave type</th>
<th>Energy range</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Particles/continually streaming solar wind</td>
<td>Protons, Electrons</td>
<td>100 eV - 3.5 KeV</td>
<td>Moderate flux, low energy; effectively shielded by minimal structure</td>
</tr>
<tr>
<td>Solar particle events (solar flares, CME)</td>
<td>Protons, Electrons</td>
<td>100 eV - 3.5 KeV</td>
<td>Large flux, high energies; potentially very dangerous to crew</td>
</tr>
<tr>
<td>Solar wave radiation</td>
<td>Xray, Gamma Ray</td>
<td>KeV range - MeV range</td>
<td>Energy varies inversely with wavelength</td>
</tr>
<tr>
<td>Geomagnetically trapped particles</td>
<td>Protons, Electrons</td>
<td>600 MeV - 5-7 MeV</td>
<td>Flux increases with altitude and inclination for LEO</td>
</tr>
<tr>
<td>Galactic cosmic rays (GCR)</td>
<td>98% Baryons (mass &gt; proton)</td>
<td>Wide range of energies dependent on mass up to 10 GeV</td>
<td>Smaller flux, larger energy; isotropic distribution, significant source of IR to crew</td>
</tr>
<tr>
<td>Secondaries for particle collision with structure</td>
<td>Neutrons</td>
<td>1 – several 10s MeV</td>
<td>Short lived, 11-min half-life; deep-tissue penetration</td>
</tr>
<tr>
<td>Age (years)</td>
<td>Female</td>
<td>Male</td>
<td></td>
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<tr>
<td>25</td>
<td>0.4</td>
<td>0.7</td>
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<td>35</td>
<td>0.6</td>
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<td>35</td>
<td>0.9</td>
<td>1.5</td>
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<tr>
<td>55</td>
<td>1.7</td>
<td>3.0</td>
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</tbody>
</table>

- Daily ISS dose rates range from 0.4 - 0.6 mSv (80% GCR)
- A 6-month tour on ISS = 0.11 Sv
- Mars transit (outbound and inbound) (360 days) = 0.662 Sv
- Mars surface stay (500 days) = 1.01 Sv
- Mars transit + surface (3 year) = 1.67 Sv
**ISS/LEO**
- Duration: 3-6 mo
- Crew: 3-6
- Transit Time: 6 hrs - 2 d
- Communication Delay: 0.001 sec
- Distance from Earth: 408 Km

**CIS-LUNAR**
- Duration: 3 mo
- Crew: 4-6
- Transit Time: 3 d
- Communication Delay: 1.25 sec
- Minimum Distance from Earth: 356,700 Km

**DEEP SPACE**
- Duration: 3 yrs
- Crew: 4-6
- Transit Time: 150-300 d
- Communication Delay: 14 min
- Minimum Distance from Earth: 54.6M Km
Gravity Fields

1 g
50 Kg = 50 Kg

≈ 1/6 g
50 Kg ≈ 8.3 Kg

≈ 1/3 g
50 Kg ≈ 16.7 Kg
Gravity Fields

3 Noteworthy phenomena

- Sensorimotor effects
- Anthropomorphic response
- Fluid shifts
Hostile Closed Environments

ISS Data

Download ISS Data

Impact of CO₂ on Human Decision Making Performance

- Superior
- Very Good
- Average
- Marginal
- Dysfunctional

Basic Activity
Applied Activity
Facial Activity
Task Orientation
Initiative
Information Orientation
Information Utilization
Breath of Approach
Basic Strategy

- 600 ppm CO₂
- 1000 ppm CO₂
- 2500 ppm CO₂
Hostile Closed Environments

Dextre robot

Sunlight
+121°C

Shade
-151°C
Clinical Scenarios AKA “You’re the Flight Surgeon”
Scenario 1

“A Mutiny in Space”

• 43 year old previously healthy male calls the flight surgeon with symptoms of stuffy nose, dry nostrils, and nasal congestion.
  • No relief with blowing nose
  • Refusing to eat
• Reduced voiding and stool due to difficulty using plastic bags to collect waste and smell from bags (crew of 3 used 12 bags in 11 days)
Scenario 2

“I Can’t See”

- 6 months following long duration (6 month) spaceflight, 7 astronauts demonstrated:
  - consisting of disc edema in 5 astronauts
  - globe flattening in 5 astronauts
  - choroidal folds in 5 astronauts
  - cotton wool spots in 3 astronauts
  - nerve fiber layer thickening by OCT in 6 astronauts
  - decreased near vision in 6 astronauts
Scenario 2

“I Can’t See”

Scenario 3

“My Hand Hurts”

- 32 year old male reports hand edema, severe pain, parasthesias following a parachute jump.
- Reports that his right glove pressure seal failed during a balloon ascent to 102,800 ft (31,333 m) taking 1 hour and 31 minutes.
Scenario 4

“What’s That?”

- 42-year-old female astronaut was found to have an incidental obstructive left internal jugular venous thrombosis during an ultrasound examination that was performed as part of a vascular research study.
- The individual reported no headache or worsening of the facial plethora that is common in conditions of weightlessness.
- There was no personal or family history of venous thromboembolism.
- The physical examination revealed a prominent ipsilateral external jugular vein.

### Scenario 4

"What’s That?"

<table>
<thead>
<tr>
<th>Launch</th>
<th>Approximately 6-mo mission in weightless environment</th>
<th>Landing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Enoxaparin, once daily</td>
<td>On Earth</td>
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<tr>
<td>1.5 mg/kg</td>
<td>Apixaban, twice daily</td>
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<tr>
<td>1.0 mg/kg</td>
<td>5.0 mg</td>
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<tr>
<td>2.5 mg</td>
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<table>
<thead>
<tr>
<th>Ultrasound Examination</th>
<th>1</th>
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<tbody>
<tr>
<td>Treatment Day</td>
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<td>Thrombosis suspected</td>
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<td>on research ultrasound examination</td>
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<tr>
<td>Thrombosis diagnosed after clinical ultrasound examination</td>
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<td>Treatment started</td>
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<td>&lt;24 hr after diagnosis</td>
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<tr>
<td>Apixaban delivered to the space station</td>
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<td>Decision made to continue therapy beyond 90 days</td>
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<td>Anticoagulation stopped 4 days before landing</td>
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<tr>
<td>Spontaneous flow shown on landing; no further treatment necessary</td>
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Questions?

asirek2@uwo.ca