Thrombosis in Space & Clotting Risk in COVID-19

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CANEUS INTERNATIONAL

“Gravitational Physiology, Aging and Medicine” Research Unit
Medical University of Graz, Austria

European Innovative Partnership Active & Healthy Aging
Falls Prevention Task Force
Human Evolution and Gravity

Venous pressure (mm Hg)

<table>
<thead>
<tr>
<th>Position</th>
<th>Recumbent</th>
<th>Standing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+6</td>
<td>-39</td>
</tr>
<tr>
<td></td>
<td>+4</td>
<td>-15</td>
</tr>
<tr>
<td></td>
<td>+3</td>
<td>0</td>
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</tr>
<tr>
<td></td>
<td>+10</td>
<td>+90</td>
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</tbody>
</table>
Changing Gravity during Space Missions

Launch (3g) → Space (μg) → Earth (1g) → Re-entry (1.6g)
Fluid Shifts in the Body

1. On Earth, blood tends to pool in the lower body.
2. Promptly upon entering weightlessness, fluids shift toward the head.
3. After a time, the body adapts to weightlessness. The kidneys reduce the volume of fluid, relieving pressure in the head and chest.
4. The body reacts immediately upon reentering Earth's gravity; fluids are shifted from the head toward the feet.
Deconditioning Time Course

Each physiological system acclimates to microgravity at a different rate
After over 50 years of spaceflight, a **new risk** with the **potential to derail missions and seriously harm astronauts** appeared, 

*clot in neck vein*

- with little forewarning.

ESA Topical Team on Thrombosis

- Started in 2020 January
- Nandu Goswami, Medical University of Graz (Co-Ordinator)
- 22 Members:
  - Austria
  - Belgium
  - Canada
  - France
  - Germany
  - Norway
  - Slovenia
  - UK
  - USA
COVID-19

SEQUENCING VARIANTS
Brazilian SARS-Cov-2 lineage
B.1.1.28 known as P.1
(S01YV3)
B.1.1.7 (S01YV1) reported in the UK
South Africa B.1.351
(S01YV2)

• Many open questions
• Inadequate current knowledge
• Need for openness, more research & international collaborations

SARS-Cov2 ORIGIN?
Zoonosis
Laboratory virus leak
Synthetic particle

THERAPEUTIC SOLUTIONS to COVID-19
1. Antiviral drugs and drug repurposing
2. Monocolonal antibodies
3. Antibiotics and corticosteroids
4. Medical devices

PREVENTION – IMMUNOSTIMULATION
• Natural immunity support
• Vaccination

Endothelium

Regulation of:
- Coagulation
- Fibrinolysis
- Vascular tone

Pathogenesis:
- Atherosclerosis
- Hypertension
- Heart failure

Heart Attack

Atherosclerosis
Coronary Artery Disease
Thrombosis

- Pro-coagulatory parameters
- Anti-coagulatory parameters

Goswami et al. (2020) *J Clin Med.* 9(10)
Goswami et al. (2020) *J Clin Med.* 9(11)

**ESA project: Thromboembolism risk during Dry Immersion (PI)**
6 degree Head Down Tilt


ESA bedrest project: “Coagulation and bed rest” (PI)
European Developing Countries Trial Partnership (EDCTP) project: “EndoCOVID” (2021-2023)

Risk of Coagulation in COVID-19 patients with HIV and receiving Anti-Retroviral Therapy

- Nandu Goswami, Medical University of Graz, Austria (Co-Ordinator)
- Benedicta Nkeh Chungag, Walger Sisulu University, S. Africa
- Simiat Elias, Lagos State Univ College of Medicine, Nigeria
- Knut Lundin, University of Oslo, Norway
Bedrest in Older Persons
Frailty: A Vicious Cycle

Bedrest → further → De-conditioning

Falls / Fear of falling

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Spaceflight studies support geriatric health on Earth

Exploring the parallels between microgravity and the consequences of aging

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Amal Eseeddine
Senior Director Government and Corporate Affairs, Thuraya Telecommunications Company, Dubai

Understanding the links between spaceflight physiology and the aging process can lead to improvements in human health not only for astronauts living in microgravity but also for older people living on Earth. This article provides a general overview of important physiological consequences of spaceflight, the aging process in humans on Earth, and important connections between these physiological states.

Ever since our ancestors started walking upright, the human body has adapted to the effects of gravity. For example, during standing, the human heart – despite being located below the brain – is able to pump enough blood to the brain against the force of gravity to maintain proper brain function. The pooling of blood in the legs – which occurs due to gravitational forces – is counteracted by the muscle pump in the lower limbs by one-way leg venous valves as well as by the action of breathing. Additionally, the weight-bearing bones and anti-gravity muscles have adapted during evolution to ensure adequate support during standing. Thus humans can stand up without any real problems.

The real importance of gravity on physiological systems is, however, seen when gravity is reduced or taken away, as in the microgravity environment...
“Gravitational Physiology, Aging and Medicine” Unit

Geriatric Institutions

Space Agencies

Expertise

- Cardiovascular regulation
  - Hemodynamics
  - Hormones
  - Autonomic function

- Orthostatic intolerance

- Vascular health & function

Geriatric care institution
Universities
Research Centers
Communication Platforms
Companies

NASA
ESA
IBMP, Russia
DLR, Germany
MEDES, France
Simon Fraser University
Selected International Collaborators

- Daniel Devigo, Ciudad Autónoma de Buenos Aires, **Argentina**
- Patrick DeBoever, VITO, Mol, **Belgium**
- Paul Dendale, University of Hasselt, **Belgium**
- Andrew Blaber, Simon Fraser Univ., Vancouver, **Canada**
- Yunfang Gao, Northwest Univ., Xian, **China**
- Ines Drenjancevic, Univ. Josip Juraj, Osijek, **Croatia**
- Jörn Rittwegger, German Space Agency (DLR), **Germany**
- Laszlo Simon, Semmelweis Univ., Budapest, **Hungary**
- Giovanna Valenti, Univ. of Bari, **Italy**
- Satoshi Iwase, Aichi Medical Univ., **Japan**
- Inessa Kozlovskaya, IBMP, Moscow, **Russia**
- Rado Pisot, Univ. of Primorska, **Slovenia**
- Hans Strijdom, Univ. of Stellenbosch, Cape Town, **South Africa**
- Benedicta Chungag, Walter Sisulu University, Mthatha, **South Africa**
- Jean-Pierre Montani, University of Fribourg, **Switzerland**
- Simiat Elias, Lagos State Univ. College of Medicine, **Nigeria**
- Voyko Kavacic, Institute of Gerontology, Wayne State University, Michigan, **USA**
- Germaine Cornillessen, Halsberg Chronobiology Center, Minnesota, **USA**
“International Co-operation for Space Life Sciences Knowledge Sharing & Development in Africa”

International Academy of Astronautics (IAA):
Commission 2 – Space Life Sciences Study Group Report