New Bed Rest Paradigm: Strict adherence of -6°-Head Down Tilt Bed Rest

– An Improvement to the Ground-Based Microgravity Analogue? –

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The VaPER-Study

The recent “Medium-term Bed Rest Study - VIP and Psychological environ Research Study (VaPER)” was conducted in 2017 as joint project between NASA and DLR in Cologne, Germany.

The primary aim of this comprehensive study was to test influences of the novel paradigm for microgravity simulation combining -6° head down tilt (HDT) with increased ambient CO2 (0.5%) on cerebral and ocular anatomy and physiology. The study focused on the Spaceflight Associated Neuro-ocular Syndrome (SANS, formerly the visual impairment and intracranial pressure, or VIP) syndrome.

Test Subjects – Important Factor

Adherence of test subjects is of central importance for successful completion of bed rest studies.

- Careful screening before study inclusion with an emphasis on psychological aspects.
- Information in advance about all important aspects of the study.

Recruitment Steps (VaPER-Study)

- > 4500 Contacts after Announcement of the Study
- First Questionnaire via Email: 670 Persons
- Detailed Subject Information via Email: 378 Persons
- Information Sessions (+Psychological Questionnaire): 107 Participants
- First Medical Screening: 67 Participants
- Psychological Interview: 34 Participants
- DXA scan: 26 Participants
- 12 Test Subjects + 4 Back ups

Why to obey rules?

Bed rest study – it’s a mission!

Test subjects are team members within this mission and have to feel like that.

The: environ facility and the experienced staff at the DLR-Institute of Aerospace Medicine create an atmosphere of best possible well-being during confinement.

Motivation of all team members lead to successful performance of experiments and daily life.

- Information exchange: e.g. Briefings, daily ward round
- Physical well-being: e.g. Medical care, Physiotherapy
- Psychological well-being: e.g. Psychological care, Special events

Results

Fluid shift was more obvious than in previous studies
- Puffy face
- Retinal thickness was measured via optical coherence tomography (OCT).
- In 5 of 11 test subjects OCT reveals thickened retinal nerve fiber layer

Future studies have to show whether strict -6° HDT bed rest, hypercapnia, or both in combination are required to achieve SANS-like findings.

# Challenge 3: Feasibility

<table>
<thead>
<tr>
<th>Study</th>
<th>Camp.</th>
<th>Research Groups</th>
<th>Subj.</th>
<th>Experiments</th>
<th>Intervention</th>
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</thead>
<tbody>
<tr>
<td>SAG (2010/11)</td>
<td>3</td>
<td>8</td>
<td>~ 30</td>
<td>+ BCD</td>
<td>Training (daily)</td>
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<td>MEP (2012/13)</td>
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<td>18</td>
<td>&gt; 30</td>
<td>+ BCD</td>
<td>Nitrate</td>
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<tr>
<td>RSL (2015/16)</td>
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<td>&gt; 30 (2nd BCD)</td>
<td>+ BCD</td>
<td>Training (4x weekly)</td>
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<td>VaPER (2017)</td>
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<td>4</td>
<td>n.a.</td>
<td>+ ISM</td>
<td>0,5% CO2</td>
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<td>AGBRESA (2019)</td>
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<td>19</td>
<td>&gt; 100</td>
<td>+ ISM</td>
<td>BCD</td>
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</table>

Where is the limit in terms of:
- Duration of the entire study (stationary part, follow ups)?
- Individuals are able and willing to participate
- Performance of the experiments by test subjects?
- Tolerable number and time effort?
- Availability of rooms?
- Parallel performance of experiments
- Well-trained, flexible and motivated staff?
- Overall coordination?
- Funding?

Acknowledgments

Many thanks to NASA.

KIBI Wyle all the scientists involved, all the staff involved, and a special thanks to our test persons!

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January 22nd-25th, 2019

Limits of Bed Rest as Microgravity Analogue

HDT bed rest has been used as one of the microgravity analogues for decades.

Unlike in microgravity where all hydrostatic gradients are abolished the gravity vector is still present in HDT bed rest.

- Different physiological responses
- -6°-HDT studies cerebral or ophthalmic findings as observed in astronauts (SANS) could not be reproduced so far

-6° HDT alone may not be sufficient to induce head-wad fluid shifts as in microgravity, however, steeper HDT tilt angles are unrealistic for long-duration bed rest studies.

As a consequence we investigate whether the bed rest model for SANS-related research can be improved by combining a hypercapnic environment similar to that on board the ISS with a stricter controlled head position during -6° HDT bed rest.

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Limitations of Bed Rest

As Microgravity Analogue

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