### 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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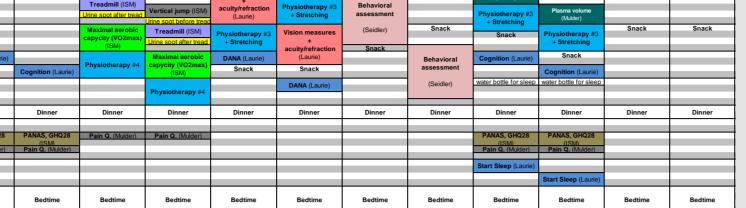


#### **Evolution of Bed Rest Studies at DLR**

#### SAG-Study (2010/11)



# VaPER-Study (2017)



#### **AGBRESA-Study (2019)**



## 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 ⇒ in -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-ward 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.

#### **The VaPER-Study**

The recent "Medium-term Bed Rest Study - VIIP and Psychological :envihab 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  $CO_2$  (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 VIIP syndrome).

BDC-Phase normal atmosphere normal activity	HDT-Phase Atmosphere with increased CO <sub>2</sub> (0.5%) Bed rest in -6° Head Down Tilt	R-Phase normal atmosphere normal activity				
BDC: Baseline Data Collection (14 days)						

#### **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** 

#### 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 :envihab 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

HDT: Head Down Tilt (-6°) Bed rest (30 days)

Recovery (14 days) **R**:

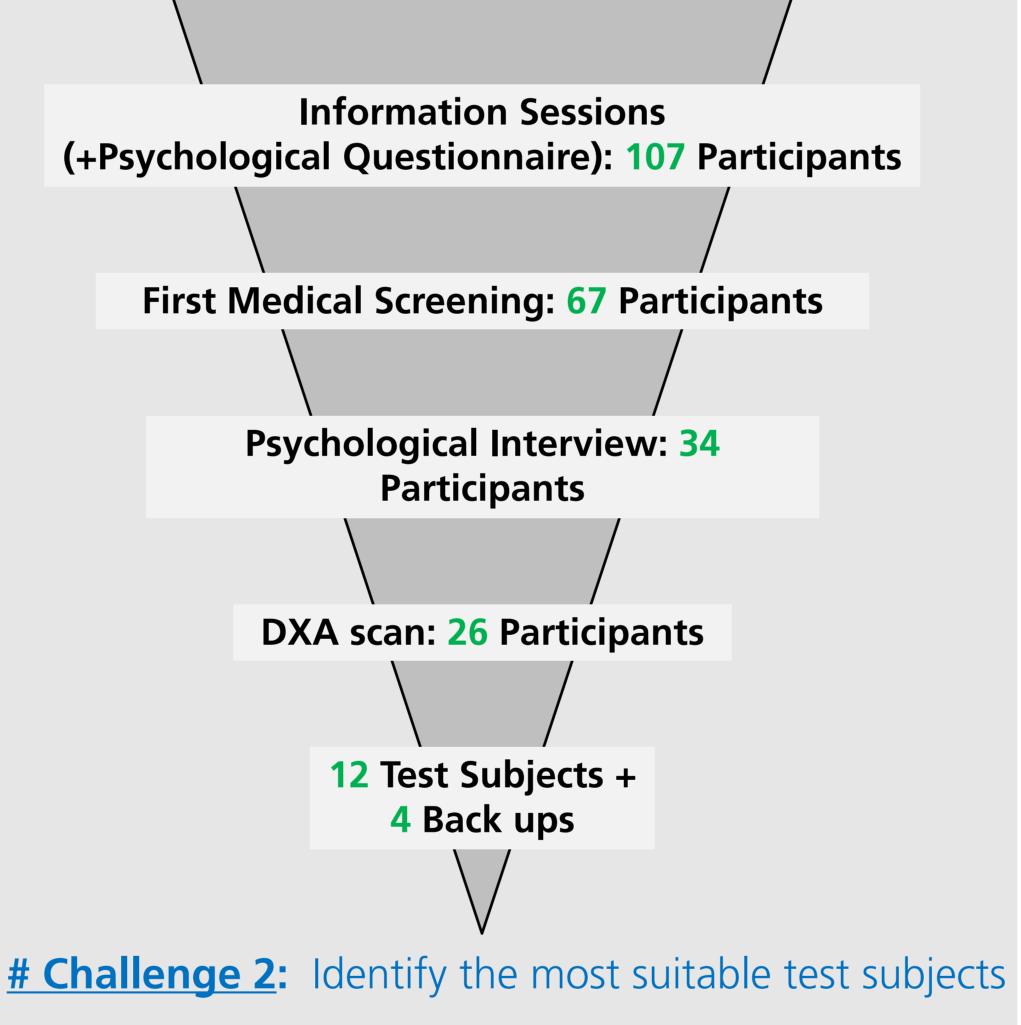
RSL-Study (2015/16)

#### **Improvement of Bed Rest**

In addition to the approximation of atmospheric conditions to those on the ISS, the head position of the test subjects was more strictly controlled compared to previous bed rest studies.

VaPER-Study (2017)





During the VaPER-Study all test subjects showed an excellent adherence and maintained strict -6° HDT throughout the study.

Pillows were no longer allowed except a small pillow for lying on the side.

#### Results

Fluid shift was more obvious than in previous studies  $\Rightarrow$  Puffy face

Retinal thickness was measured via optical coherence tomography (OCT).

 $\Rightarrow$  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.

#### <u>**# Challenge 3: Feasibility</u></u></u>**

Study (Year)	Camp.	Research Groups	Scientists	Experiments	Intervention
SAG (2010/11)	3	8	~ 30	> 8 + BCD	Training (daily)
MEP (2012/13)	2	18	> 60	> 18 + BCD	Nutrition
RSL (2015/16)	2	11	70	~ 50 (incl. BCD)	Training (5-6/week)
VaPER (2017)	1	4	n.a.	9 + ISM	0,5% CO <sub>2</sub>
AGBRESA (2019)	2	19	> 100	> 19 + ISM + BCD	AG (daily)

Where is the limit in terms of:

- Duration of the entire study (stationary part, follow ups)?  $\succ$  Individuals are able and willing to participate
- Performance of the experiments by test subjects? > Tolerable number and time effort?



24h-Camera-monitoring combined with onlinecoaching whenever needed led to an accurate lying position in all situations.

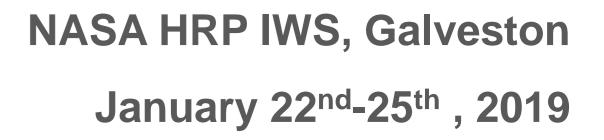
- Availability of rooms?
  - > Parallel performance of experiments
- Well-trained, flexible and motivated staff?
- Overall coordination?
- Funding?

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#### **Study Team**

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