Objective: Define successive bed rest campaigns leading to a potential VIIP countermeasure

To determine if the analog is successful, changes need to occur in following **outcome measures** (dependent variables):

- Intracranial pressure
- Retinal nerve fiber layer
- Choroidal engorgement
- Globe flattening
- Axial biometry
- Optic nerve sheath diameter distention
- Cycloplegic refraction
- Visual acuity

**Study parameters (independent variables) to include:**

- CO₂
- Sodium
- Exercise (resistive & aerobic)
- Strict tilt angle

What information can the currently defined studies provide?

- Karina/Joerne enVIIP: \(\angle 6^\circ, 12^\circ, 18^\circ\) + eye changes; \(\angle 12^\circ\) w/ 1% CO₂; \(\angle 12^\circ\) + LBNP
- Vascular Compliance: Compares effects of more and less compliance
  - VIIP strongly prefers to add CO₂ to Vascular Compliance
- Vizzeri/Laurie: 1 hour with 1% CO₂ at \(\angle 6^\circ\)
  - VIIP prefers to add 2 compliance groups and longer duration
- Scott: Effects of exercise modalities at \(\angle 15^\circ\)
- NSBRI Pilot – Confirms facility capabilities for CO₂ administration, etc. Defines tilt \(\angle\).
  - VIIP prefers to do multiple tilts \(\angle 6^\circ, 9^\circ, 12^\circ\) with 2 compliance groups (unless another study identifies optimum angle e.g. 9 degrees)
Pilot CO2

Expected study parameters:
• 24 hours at $\angle 6^\circ$ Head Down Tilt (HDT)
• CO$_2$ at 0.5% - 1%
• Data collection mirrors ISS Ocular Health
• Prefer 2 Compliance groups
• Sodium levels ??
• N = ??

Assumptions:
• NSBRI sponsored
• Studies completed before this campaign begins:
  • Karina/Joern enVIIP: 5 hrs. at enviHab
  • Location: enviHab
Acute CO₂

Preferred Study parameters:
• 5 - 7 days at \( \angle 12^\circ \) HDT or 7 - 10 days at \( \angle 9^\circ \) HDT or 10 - 14 days at \( \angle 6^\circ \) HDT
  (the tilt angle and duration should be defined by previous studies and what elicits VIIP related change)
• CO₂ at 0.5% - 1% depending on duration and safety
• 2 compliance groups – high (females) and low
• Sodium levels similar to ISS (fixed/constrained)
• N = ?

Assumptions:
• Studies completed before this campaign begins:
  • Karina Bowman / Joern Rittweger 5 hrs. at enviHab
  • NSBRI Pilot 24-hour with CO₂ at enviHab
  • Vascular Compliance bedrest at UTMB
  • J. Scott Exercise at JSC
• Location: enviHab
• Year 1 – planning, definition, approvals, pilot.
• Year 2 - Implementation
### Chronic CO₂

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#### Study parameters:
- $\angle$ tbd° Head Down Tilt (HDT) depending on results of Acute study
- Duration: Extended from Acute CO₂ study to ~ 1 month
- CO₂ at 0.5% - 1.0% depending on duration and safety
- 2 compliance groups – high (females) and low
- Sodium levels similar to ISS (fixed/constrained)
- Exercise – resistive (or resistive AND aerobic like ISS)
- $N = \mathit{?}$

#### Assumptions:
- Studies completed before this campaign begins:
  - Acute CO₂ at enviHab
  - Mechanical Countermeasures NRA14
  - J. Scott - Exercise
- Location: enviHab
- Year 1 – planning, definition, approvals, pilot.
- Year 2 - Implementation
**Countermeasures Validation**

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### Study parameters:
- $\text{CO}_2$ (fixed)
- Tilt (fixed)
- Sodium similar to ISS (fixed)

### Countermeasures to be tested
- Mechanical device
- Exercise modalities
- Pharm (only if no mechanical CM has proven effective)

### Assumptions:
- Studies completed before this campaign begins:
  - Acute & Chronic CO2 at enviHab
  - Mechanical Countermeasures NRA14
  - J. Scott – Exercise
  - Location: enviHab