70 DAYS OF 6 DEGREES-HEAD DOWN TILT BED REST AND ITS IMPACT ON OCULAR PARAMETERS

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BACKGROUND

- Ocular changes such as visual impairment and intracranial pressure (VIIP) have been observed in astronauts returning from long-duration spaceflight.
- Changes may be attributed to the shift in body fluids due to microgravity.
- It remains to be determined whether 6° head-down bed rest is a good analog for VIIP.

Visual Impairment and Intracranial Pressure (VIIP) Syndrome:

May include the following symptoms:

- Hyperopic shift
- Cotton wool spots
- Edema of the Optic disc (papilledema)
- Choroidal folds
- Optic nerve sheath distention
- Globe flattening

Bed Rest Platform:

- 6° head down-tilt (HDT) bed rest

- Nomenclature
  - o *Pre-bedrest phase*: BR -14 to BR -1 for control subjects, BR -21 to BR -1 for exercisers
  - o *In-bedrest phase*: BR1 to BR70
  - o *Post-bedrest phase*: BR+0 to BR+13

NASA Flight Analogs Research Unit (FARU) Standardized Conditions:

- During in-bed phase: subject reclined and monitored 24 hours/day
- Vitals, body weight, fluid intake/output measured daily
- Awake time: 6:00 am – 10:00 pm
- Standardized diet to maintain weight within 3% of initial weight

PURPOSE

- Investigate the effects of 6° head-down bed rest on ocular structures and function.
- Determine if 6° head-down bed rest is a suitable ground-based analog for modeling and studying the VIIP Syndrome.

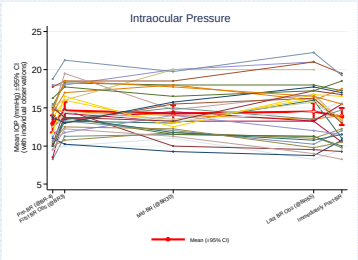
METHODS

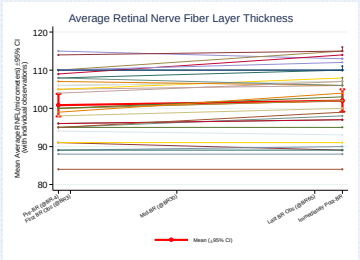
- 16 subjects (15M, 1F, age range 29-54 years): healthy, normotensive, non-smoker, normal weight
- Participated in 70 days of 6° HDT bed rest
- Control group and exercise group
- Measurements used in this study:
  - o Best corrected visual acuity (BCVA)
  - o Spherical equivalent
  - o Intraocular pressure (IOP)
  - o Retinal nerve fiber layer (RNFL) thickness by OCT
- Statistical methods:
  - o Completely repeated measures experimental design
  - o Data collected longitudinally at several time points before, during and after bedrest, and for subjects' left and right eyes at each time point.
  - o Repeated measures data submitted to a mixed-effects linear regression with a-priori contrasts comparing subjects' closest pre-bedrest observation to each subsequent observation available per outcome.

RESULTS

For the following variables, "Pre/Post" was defined as the CLOSEST Pre and Post observations to bedrest. Other in-bed time points were also utilized:

- Subjects' closest pre-bedrest observations were between 3 and 6 days pre-bedrest.
- Subjects' first bedrest observation was usually day 3 of bedrest (BR3).
- Subjects' mid-bedrest observation was usually day 30 of bedrest (BR30).
- Subjects' last bedrest observation was usually day 65 of bedrest (BR65).
- Subjects' closest post-bedrest observations were between 2-3 days post.



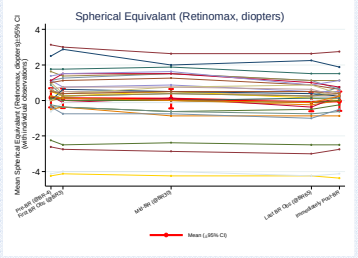


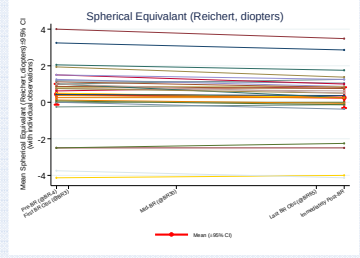
	IOP (mmHg)				
Day	Pre-BR	BR3	BR30	BR65	Post-BR
Mean	12.90	14.66	14.25	14.52	13.86
CI (+/- 95%)	(61.76, 64.24)	(62.86, 65.33)	(64.20, 66.67)	(64.80, 67.27)	(63.73, 66.20)
p (vs. pre-BR)	-	<0.001	<0.001	<0.001	<0.009

Fig. 1. IOP changes during pre-/in-/post-bedrest.

- IOP significantly increased from a mean of 12.90 mmHg in pre-BR to 13.86 mmHg in post-BR.
- IOP in pre-BR is significantly different from all the in-BR and post-BR time points.

- Mean Average RNFL Thickness by Spectralis optical coherence tomography (OCT) significantly increased from a mean of 100.84µm in pre-BR to 102.03 µm in post-BR ($p < 0.001$).
- No in-bed measurements were taken for RNFL Thickness.



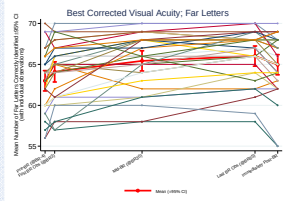


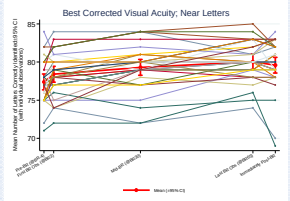
	Spherical Equivalent Retinomax (diopters)				
Day	Pre-BR	BR3	BR30	BR65	Post-BR
Mean	0.15	0.11	0.09	-0.07	-0.04
CI (+/- 95%)	(-0.39, 0.70)	(-0.43, 0.66)	(-0.45, 0.64)	(-0.61, 0.47)	(-0.59, 0.50)
p (vs. pre-BR)	-	0.496	0.289	<0.001	<0.001

Fig. 2. Spherical Equivalent changes during pre-/in-/post-bedrest with the Retinomax device.

- Mean Spherical Equivalent significantly decreased from pre-BR to post-BR ($p<0.001$) with both the Retinomax and Reichert devices.
- Spherical Equivalent Retinomax was significantly different from the last BR day and post-BR, but not from the first or middle BR days.
- No in-bed measurements were taken for Spherical Equivalent Reichert.

RESULTS





	BCVA Far (# of letters correctly identified)		BCVA Near (# of letters correctly identified)	
Day	Pre-BR	Post-BR	Pre-BR	Post-BR
Mean	63.00	64.96	77.40	79.59
CI (+/- 95%)	(61.76, 64.23)	(63.73, 66.20)	(76.37, 78.43)	(78.56, 81.09)
p (vs. pre-BR)	-	<0.001	-	<0.001

Fig. 3. BCVA Far and Near changes during pre-/post-bedrest.

- Mean BCVA far and near significantly increased from pre-BR to post-BR ($p < 0.001$).
- BCVA FAR and NEAR are significantly different from all of the in-BR and post-BR time points.

DISCUSSION

Although statistically significant changes were found, none were clinically significant.

- Both far and near best corrected visual acuity (BCVA) improved from pre-BR to post-BR. We speculate that this may be due to the learning effect of using the visual chart weekly during the study.
- Spherical equivalent decreased significantly from pre-BR to post-BR with both the Retinomax and Reichert device, which indicates a slight shift to myopic biometrics, which might be due to adjustment to near-vision activities during bed rest confinement.
  - o Reichert device is non-handheld and only used pre- and post-BR.
- There was a significant increase in IOP from pre-BR to all in-BR and post-BR time points.
  - o This increase in IOP associated with the positional change may be reversible with more time in the post-bed rest phase.
- Average retinal nerve fiber layer (RNFL) thickness by Spectralis OCT increased significantly from pre-BR to post-BR.
  - o Possibly due to interstitial edema from fluid redistribution.

CONCLUSION

- Although no clinically significant changes have been observed, IOP increase, spherical equivalent decrease, and thickening of the retina due to fluid redistribution in bed rest justify further investigation of HDT bed rest as an analog to model and study the VIIP syndrome.

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DISCLOSURE

Taibbi, G None; **Cromwell, RL** None; **Zanello, SB** None; **Yarbough, PO** None; **Vizzeri, G** None