Vittamed Two Depth Transcranial Doppler for Non-invasive Assessment of Intracranial Pressure Final Results of Phase 2 study

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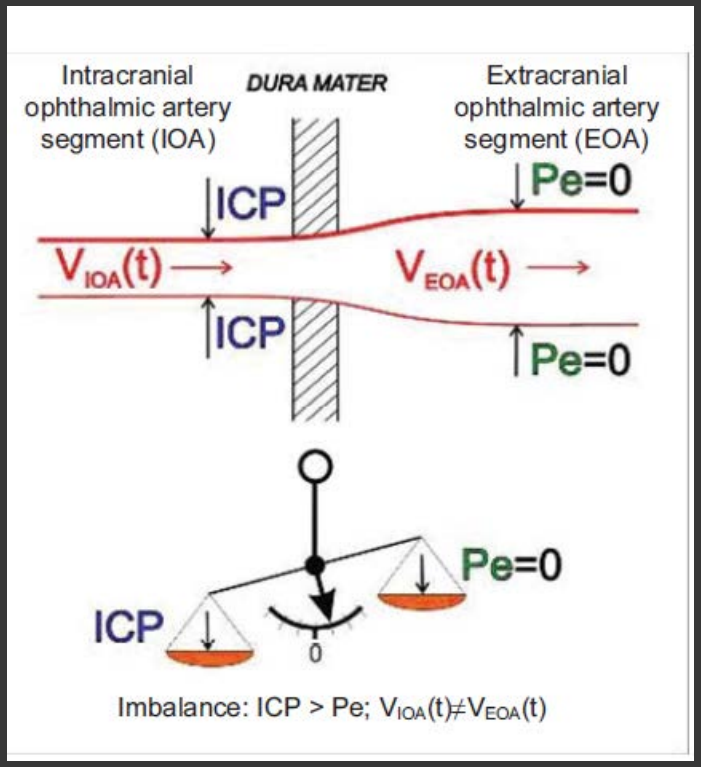
Disclosures

- Study was supported by funding from National Space Biomedical Research Institute through NASA NCC 9-58, and Center for Space Medicine
- Vittamed provided technical support and training on device operation, but had no role in study design, funding, data analysis or interpretation.

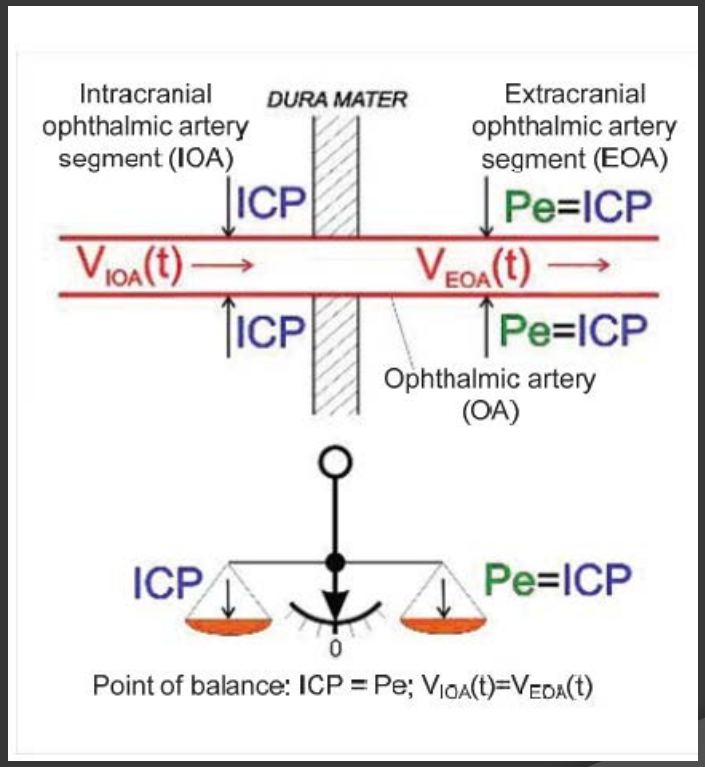
Specific Aims

- Compare accuracy of Vittamed device compared to simultaneously invasively measured ICP
- Include patients with normal and elevated ICP, as previous study with Vittamed device was mostly in patients with normal ICP (5 to 15 mmHg)

Vittamed Two Depth Transcranial Doppler uses Ophthalmic Artery as ICP sensor



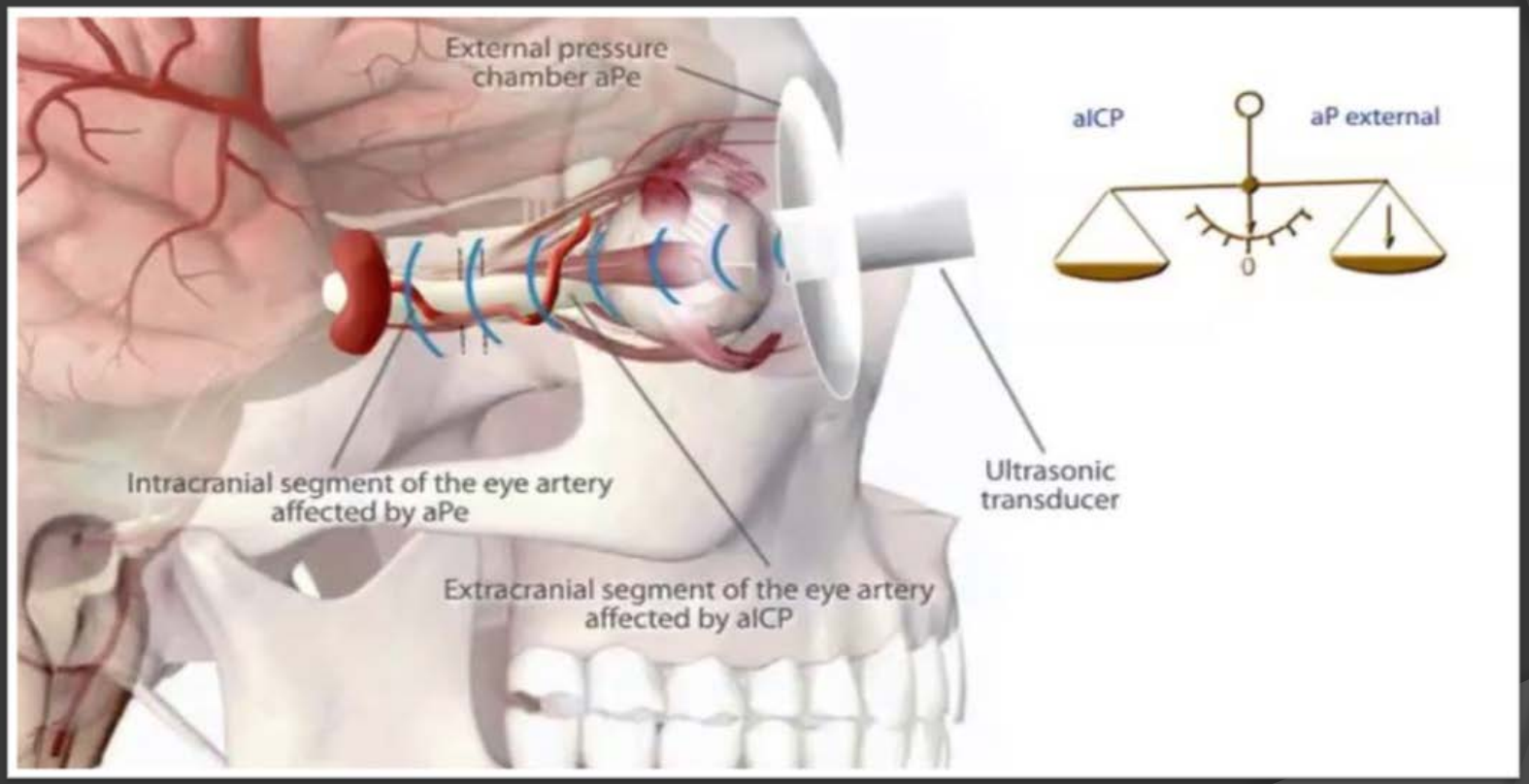
Baseline



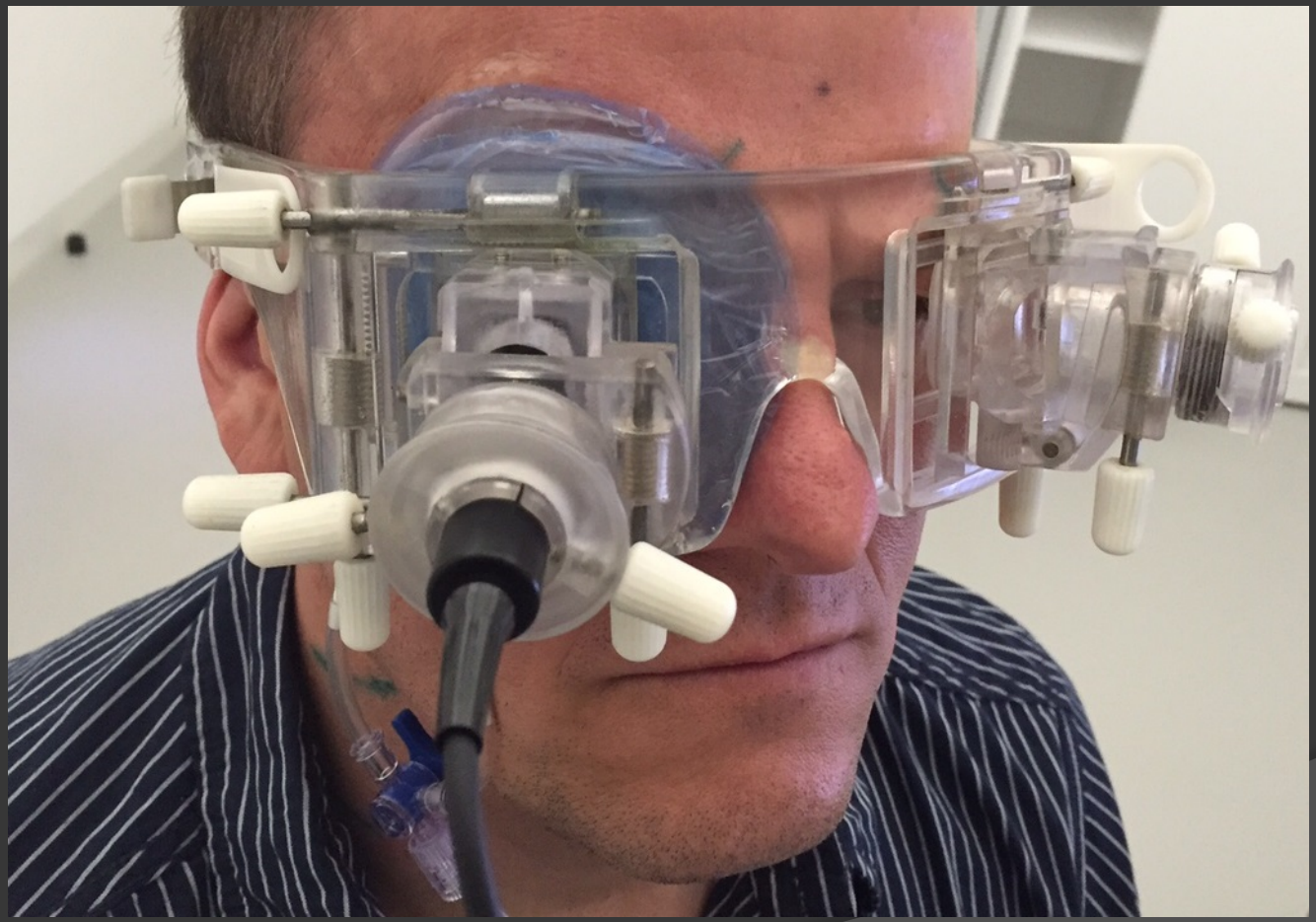
Balance point

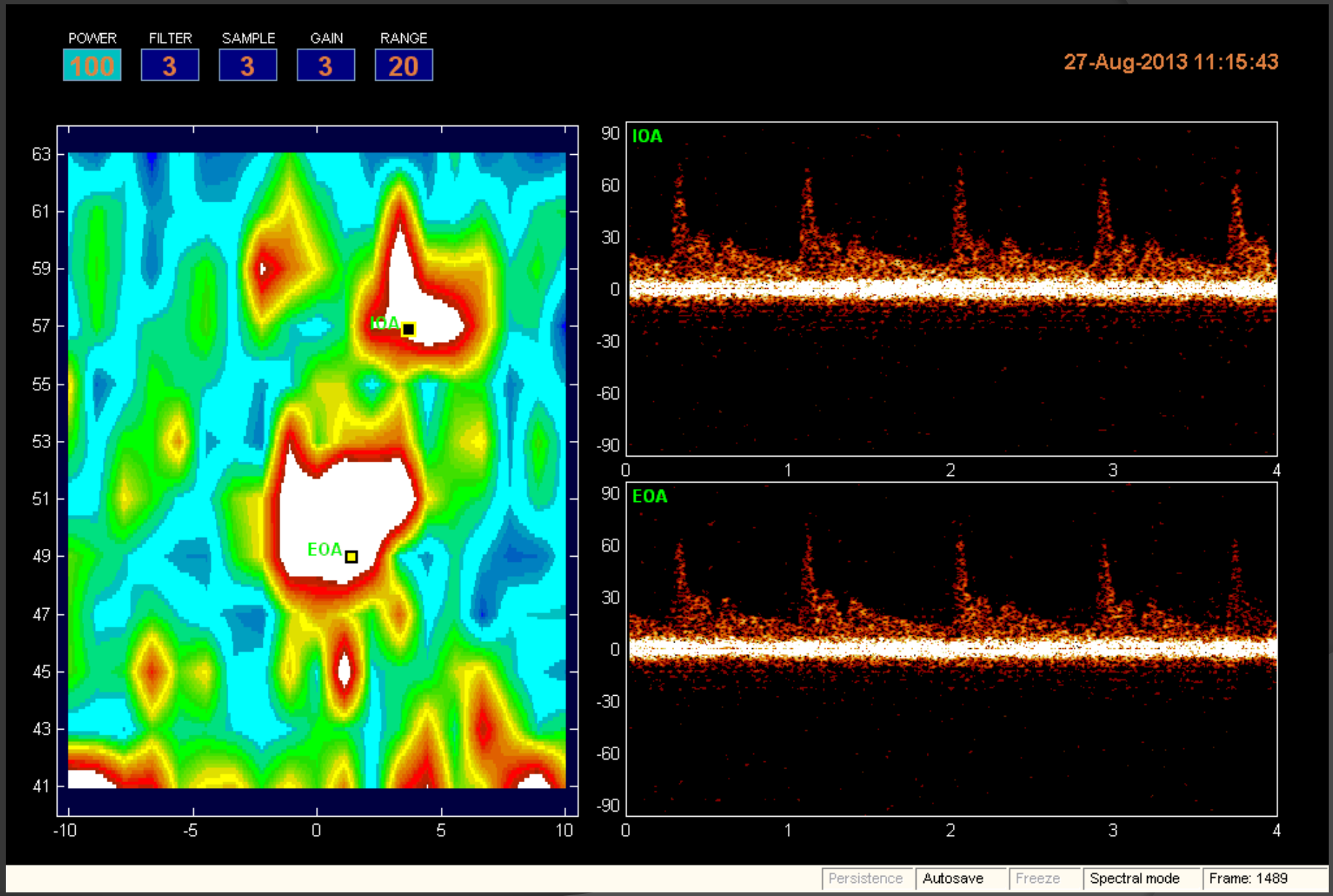
Ragauskas A et al. Neurology 2012;78;1684

Diagram of Vittamed ICP meter



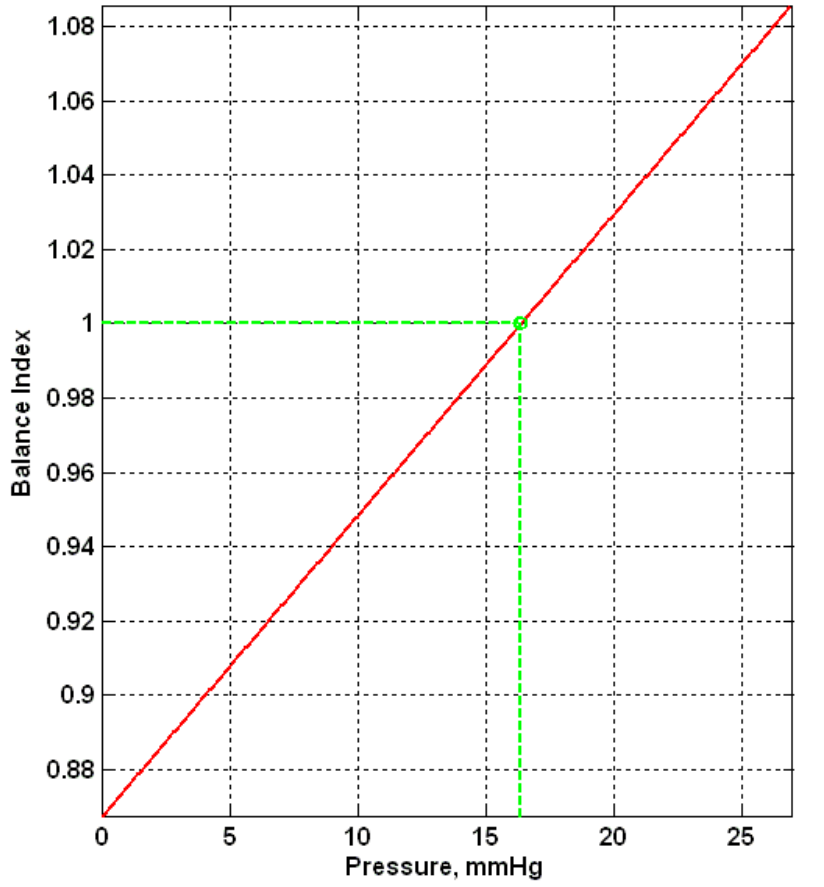
Headframe and Orbital Cuff




POWER
100
FILTER
3
SAMPLE
3
GAIN
3
RANGE
20
27-Aug-2013 11:15:43
IOA
EOA
IOA
EOA
Persistence
Autosave
Freeze
Spectral mode
Frame: 1489

Absolute ICP= 16.38 mmHg

100% completed



Start | Export | Continue | Close

P.I.(ext)/P.I.(int):

No. of pulses : 154

File index : 18

P(ext) :

Chamber turned off

Vs(ext):

Vd(ext):

P.I.(ext):

Vs(int):

Vd(int):

P.I.(int):

CorrCoef:

S/N(ext): 0.0

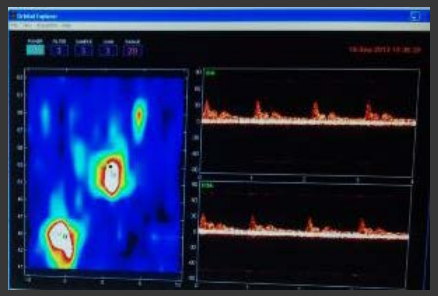
S/N(int): 0.0

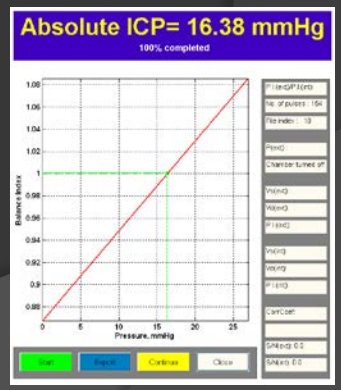
Study criteria - Phase 2

- Inclusion criteria
  - Age 18 to 70
  - Need lumbar CSF pressure measurement for clinical purposes
- Exclusion criteria
  - Focal cerebral mass lesions
  - Eye conditions that would preclude application of pressure to orbital tissues

Procedure Diagram

57/61 (93%)	42/57 (74%)	24/42 (57%)
Step 1	Step 2	Step 3
Enrolled	Found OA segments	ICP obtained





World Neurosurg. 2015 Dec 24. pii: S1878-8750(15)01725-8. doi: 10.1016/j.wneu.2015.11.102. [Epub ahead of print]

Clinical Validation of a Transcranial Doppler Based Non-Invasive ICP Meter: A Prospective Cross-Sectional Study.

Bershad EM[1], Anand A[2], DeSantis SM[3], Yang M[3], Tang RA[4], Calvillo E[2], Malkin-Gosdin L[2], Foroozan R[5], Damani R[2], Maldonado N[2], Gupta P[2], Tan B[2], Venkatasubba Rao CP[6], Suarez JI[6], Clark JB[6], Sutton JP[7], Donoviel D[8].

Author information

KEYWORDS:

Intracranial pressure; Transcranial Doppler ultrasound; Vittamed; neurocritical care; non-invasive

PMID:26724629

[PubMed - as supplied by publisher]

Results: Demographics (n=24)

- Sex: Women 96%
- Race: White 54%, Hispanic 25%, Black 21%
- Age (mean): 31 (20-55)
- Weight: 98 kg (64-151)
- Indication for ICP:
  - Suspect IIH (n=19)
  - Other headache (n=2)
  - Optic neuritis (n=2)
  - Seizure (n=1)

Subject	Age	Race	Gender	Weight (Kg)	Height (Inch)	Condition
1	45	White	Female	92.5	61	Suspected IIH
2	22	White	Female	104.3	65	Suspected IIH
3	44	White	Female	89.8	66	Suspected IIH
4	29	White	Female	116.6	69	Suspected IIH
5	33	Hispanic	Male	127.5	67	Optic neuritis
6	24	Hispanic	Female	97.1	61	Suspected IIH
7	20	Black	Female	72.6	64	Suspected IIH
8	20	Hispanic	Female	81.6	62	Suspected IIH
9	31	Hispanic	Female	131.5	66	Optic neuritis
10	34	White	Female	109.8	63	Suspected IIH
11	49	Black	Female	88.5	66	Suspected IIH
12	22	White	Female	145.1	68	Seizure
13	24	Black	Female	79.4	63	Headache
14	25	Hispanic	Female	68.0	62	Suspected IIH
15	29	Hispanic	Female	136.1	67	Suspected IIH
16	29	Black	Female	66.7	70	Suspected IIH
17	55	White	Female	151.0	65	Headache
18	27	White	Female	104.3	61	Suspected IIH
19	28	White	Female	81.6	66	Suspected IIH
20	29	White	Female	73.5	63	Suspected IIH
21	25	White	Female	63.5	65	Suspected IIH
22	33	Black	Female	98.0	65	Suspected IIH
23	20	White	Female	88.7	67	Suspected IIH
24	43	White	Female	74.8	65	Suspected IIH

Summary of ICP data

Mean and range of non-invasive ICP in mmHg

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
6.00	15.20	19.50	18.98	22.10	35.70

Mean and range of invasive ICP in mmHg

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
9.80	17.72	19.75	21.17	24.42	37.40

Note: 1 mmHg = 1.34 cmH_20

Bland-Altman Analysis

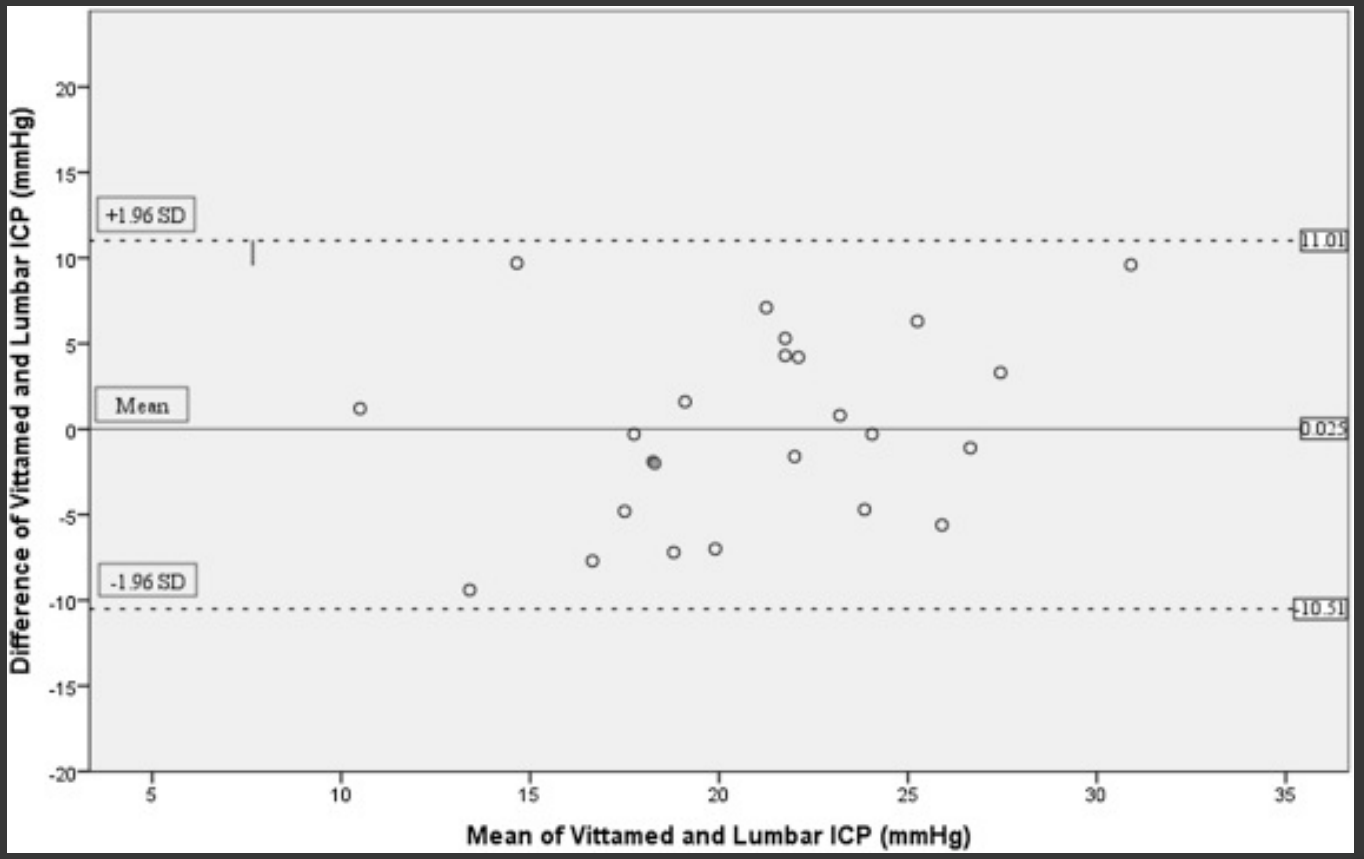


Figure 1. Bland-Altman plot of Vittamed intracranial pressure (ICP) meter versus lumbar cerebrospinal fluid (CSF) pressure measurements. The X and Y axes display the mean and difference for each independent paired measure for Vittamed versus lumbar CSF pressure

Eric M. Bershad, Aashish Anand, Stacia M. DeSantis, Ming Yang, Rosa A. Tang, Eusebia Calvillo, Leslie Malkin-Gosdin, Rod Foroozan, Rahul Damani, Nelson Maldonado, Pramod Gupta, Benedict Tan, Chethan P. Venkatasubba Rao, Jose I. Suarez, Jonathan B. Clark, Jeffrey P. Sutton, Dorit B. Donoviel

World Neurosurgery, 2015, Available online 25 December 2015

http://dx.doi.org/10.1016/j.wneu.2015.11.102

Vittamed Vs Lumbar ICP Scatterplot

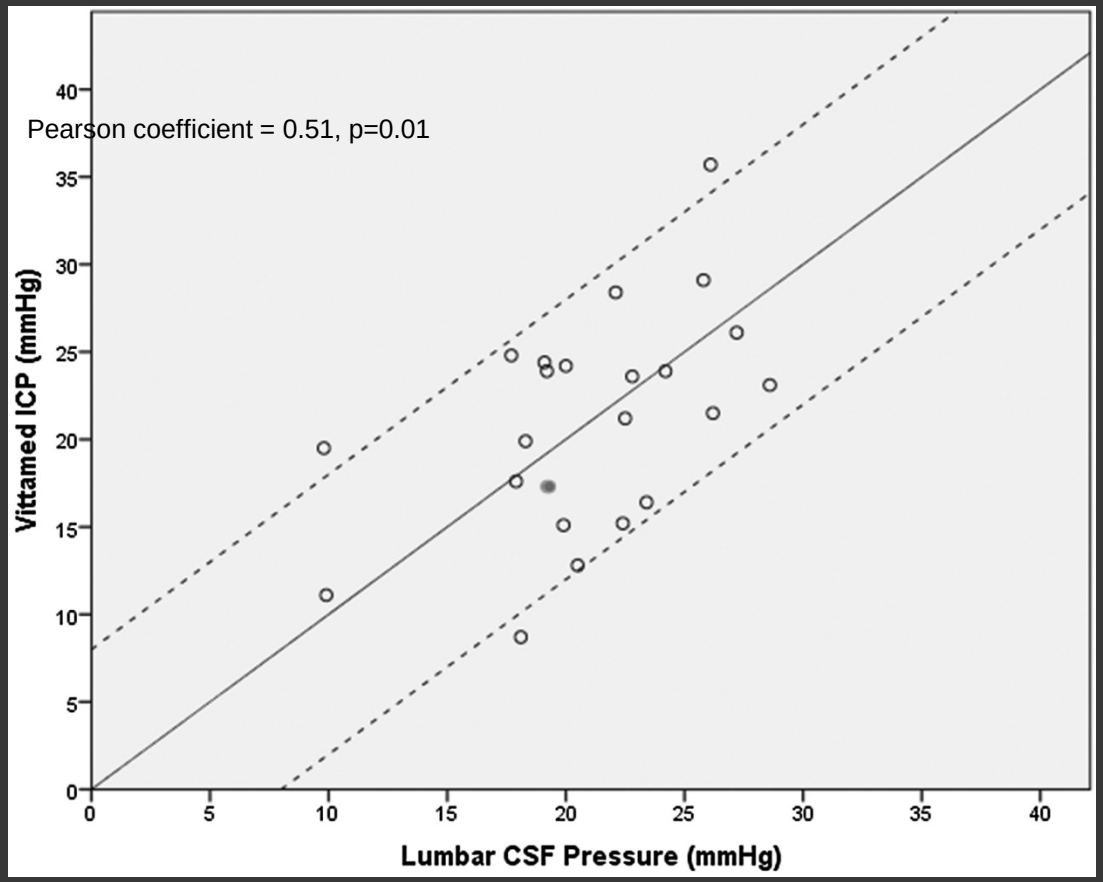


Figure 2. Scatterplot of Vittamed intracranial pressure (ICP) versus lumbar cerebrospinal fluid (CSF) pressure measurement. Each point represents an independent paired measurement plotted by lumbar (X-axis) and Vittamed (Y-axis). The solid diagonal line (y = x + 0) represents zero difference between measures. The dashed lines mark the limits of an error corridor of ± 8 mmHg.

Bershad et al. World Neurosurgery, 2015

Subject tolerability - summary

- No major adverse events
- Minor adverse events
  - Vasovagal response during LP (n=1)
  - Backache
  - Head or eye pressure
  - Transient blurry vision (n=2), resolved with saline eye flush

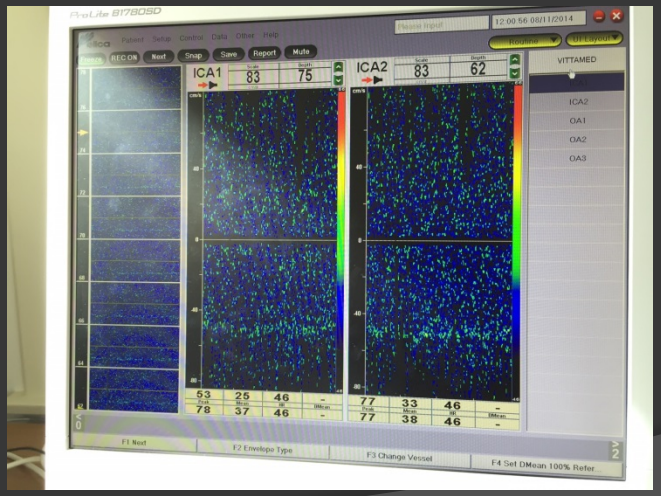
Issues which precluded reliable paired (LP and Vittamed) measurements

- Headframe issues
  - Poorly fitting (n=11)
  - Movement of during cuff inflation (n=3)
  - Subject intolerance (n=1)
- Non-reliable result (n=4)
- Software issues (n=2)
- Excessive eye movement (n=2)
- Poor OA signals (n=1)
- Doppler artifact (n=1)
- Lumbar puncture unsuccessful (n=1)

Summary of results

- Overall fair agreement between invasive lumbar CSF pressure and Vittamed ICP. Average difference between measures was 4.5 mmHg (SD 3.1)
- Technical factors precluded measurement in some subjects
- Improvements in headframe design, hardware durability, and doppler beam may improve ability to obtain ICP measurements

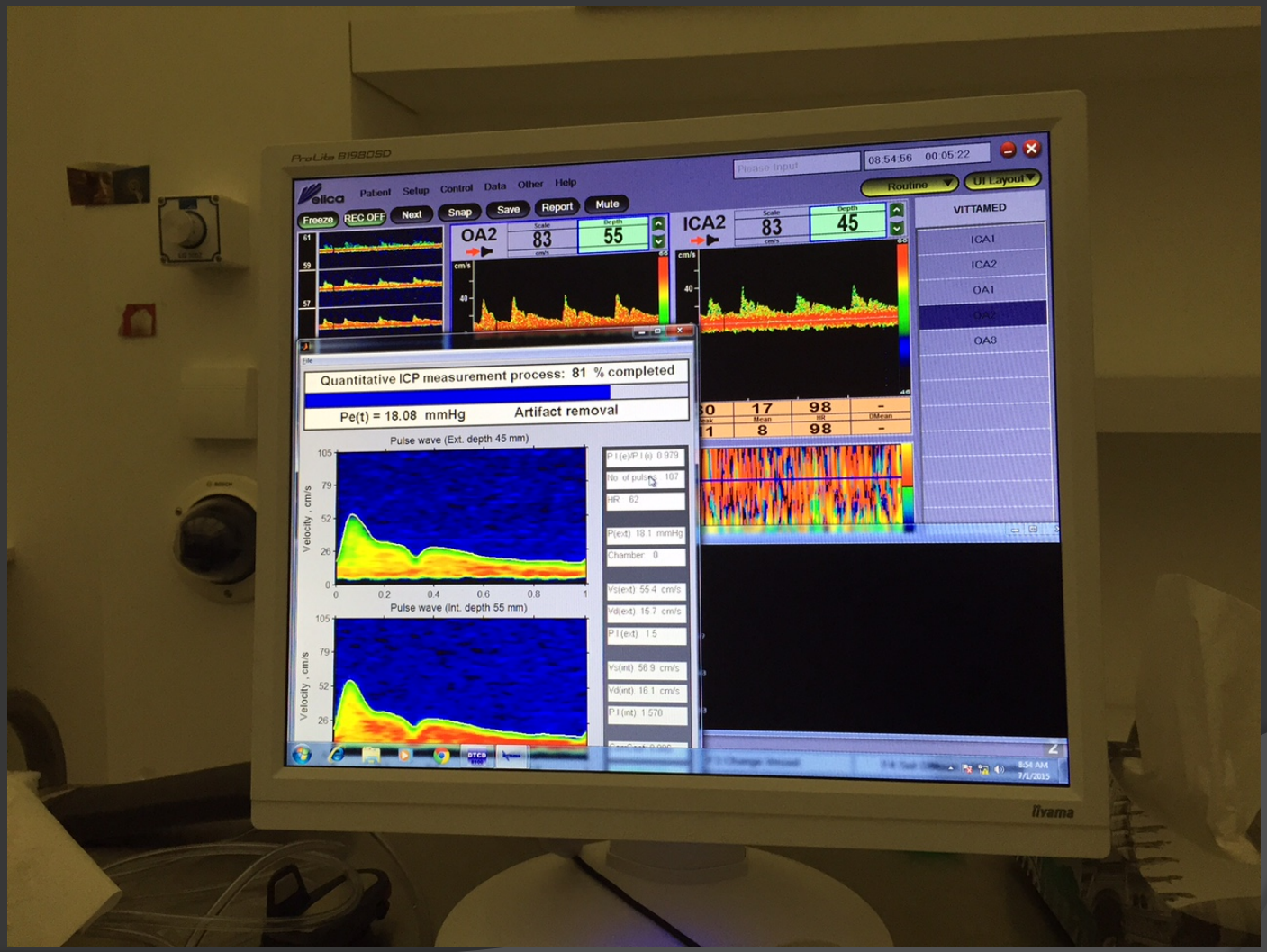
CE Mark 3rd Generation model



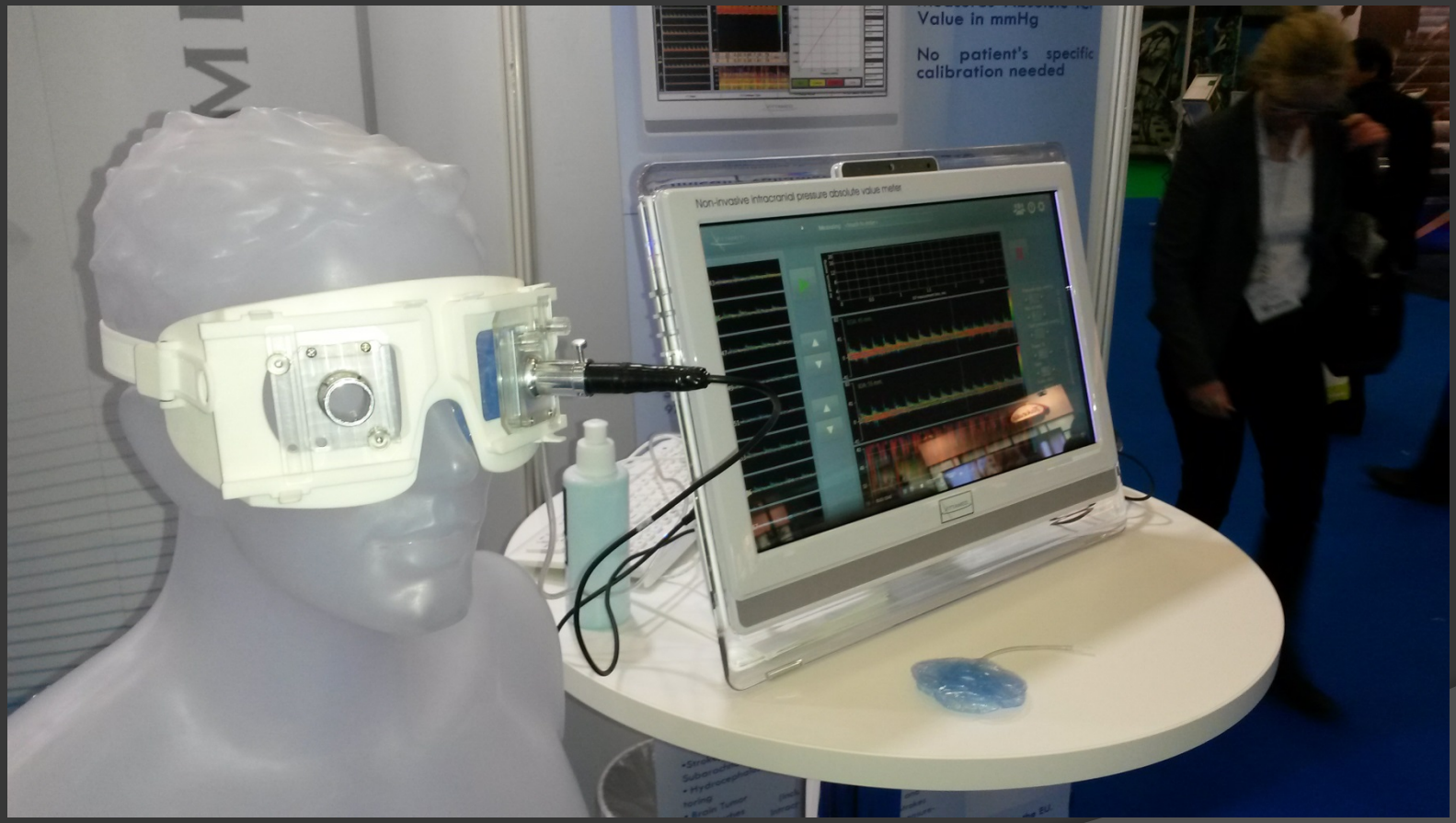
Vittamed operability in SPACE-COT

- Two experienced operators (Eric Bershad and Karina Marshall-Goebel)
- 112 measurements in 6 subjects during 54 sessions (2.1 measures/session)
- Obtained at least 1 reliable ICP measure in 53/54 sessions (98%)
- Completed within allotted time frame in 100% of sessions

Screen display



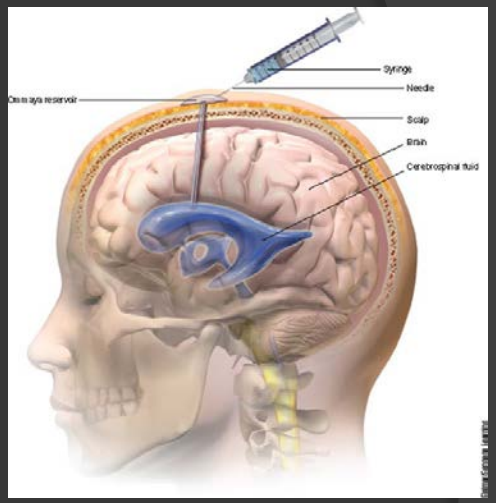
4th Generation fully integrated model

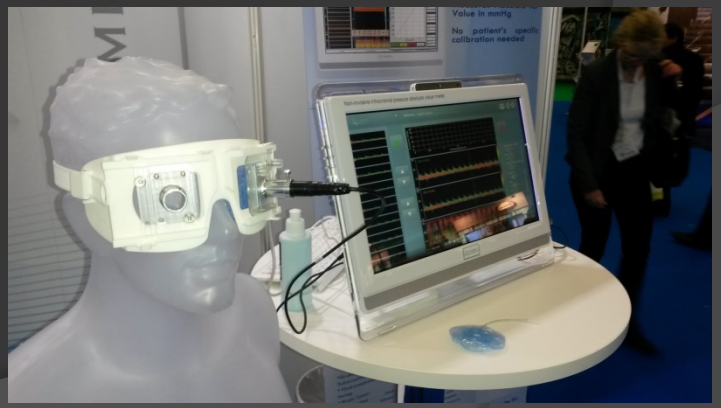


Picture courtesy of Arminas Ragauskas

Future Plans

- Clinical validation study of the newest (4th generation ICP meter)
- Sites: Baylor College of Medicine, UT Southwestern (Dallas), and UT MD Anderson (Houston).
  - Specific aims
    - Paired measures of ICP (Ommaya reservoir) and Vittamed
    - Paired measures of lumbar CSF pressure and Vittamed (IIH/neurological patients)
    - Assess the change in ICP in the same subject in different body tilt angles (Ommaya) or pre to post CSF drainage (IIH)





Acknowledgements

- Baylor College of Medicine
  - Eusebia Calvillo, RN
  - Leslie Malkin-Gosdin
  - Jose Suarez, MD
  - Rod Foroozan, MD
  - Aashish Anand, MD
  - Richard Dunham, MD
  - Rahul Damani, MD
  - Nelson Maldonado, MD
  - Pramod Gupta, MD
  - Benedict Tan, MD
- UT Houston
  - Stacia DeSantis, PhD
  - Ming Yang, MS
- Houston Methodist
  - Andrew Lee, MD
- CHI-Saint Luke‘s
  - Imitiaz Chaudry, MD, PhD
- University of Houston
  - Rosa Tang, MD
  - Anastas Pass, OD, JD
  - Christian Cajavilca, MD
- NSBRI (NCC-9-58) and Center for Space Medicine
  - Dorit Donoviel, PhD
  - Jonathan Clark, MD, MPH
  - Graham Scott, PhD
  - Julie Do, MBA
  - Nancy Gibbins
  - Jeffrey Sutton, MD, PhD
- Kaunas University Technology, Lithuania
  - Arminas Ragauskas, Sc.D
  - Rolandas Zakelis, PhD
  - Vytautas Petkus, MS
  - Laimonas Bartusis, MS

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