Team 01

Enhancing Neurocritical Care Through Multimodal Monitoring with Novel Contextual Sensors

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1 – Need

30,000 patients with severe TBI require intensive care in US each year [1]

Intense lighting, loud sounds, and temperature fluctuations can contribute to disturbed sleep and impact rate of recovery as well as overall patient outcome [3]

Sensory sensitivities are common sequelae of brain injury, yet current multimodal monitoring does not include these environmental factors [2]

Changes in external ventricular drain (EVD) stopcock position are not tracked, which limits the use of intracranial pressure data for physiological event detection or prediction during retroactive analysis

Objective

To design a turn-key system that measures and collects temperature, light, sound, and stopcock position data to provide contextual factors further enhancing multimodal monitoring surrounding neurocritical patient care

2 – Design Inputs

Constraints:

- Disinfection by EPA certified wipes/sprays, UV light, and bleach
- Must not generate emissions detectable above background level
- *MR unsafe* labeling as the EVD may be subjected to MRI

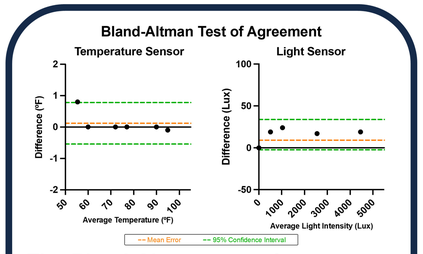
Requirements:

Light	Measure 0 to 5000 lux at 1 Hz
Sound	Measure 20 Hz to 16 Hz at 32 kHz
Temperature	Measure 60 to 90 degrees F at 5 Hz
SPS	Measure 3 unique stopcock positions at 1 Hz
Power	Minimum of 18 days continuous operation

4 – Verification

Sensor Characterization

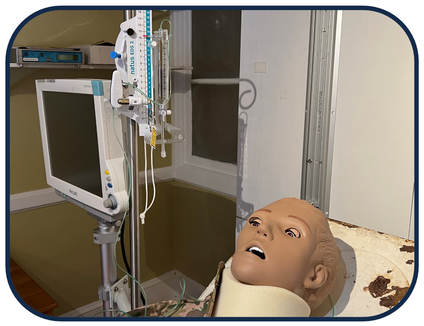
- Characterize all sensors utilizing calibrated reference sensors
- Design custom testing apparatuses to minimize noise
- Sensors must agree with reference sensor within 95% confidence interval in requirement range



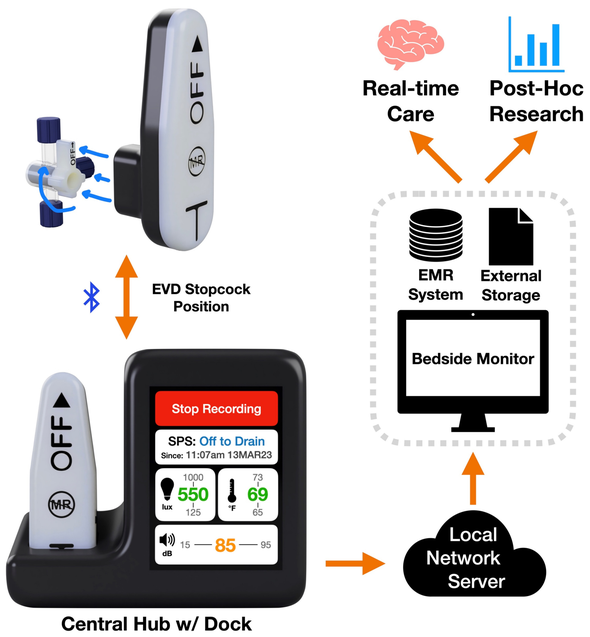
The Bland-Altman test of agreement assesses the degree of agreement between two measurements

Mock ICU Test

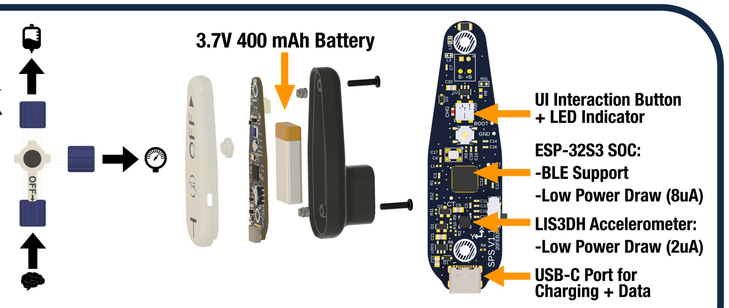
Will evaluate performance of entire system in a simulated NeuroICU environment and ensure the SPS battery life requirement is fulfilled



3 – Solution Intended Use + Component Details



Stopcock Position Sensor (SPS)



SPS mounts to stopcock and relays status of EVD to central hub

Data log example:
`SPS OFF TO PATIENT - 11:39:24`

Central Hub

- Light Sensor: VEML7700
- Sound Sensor: MAX4466
- Temperature Sensor: AHT20
- Touchscreen UI:
  - Live data readout
  - System control
  - Can add alerts in the future

SPS designed to charge when docked in mounted hub.

Data log example:
`50 lux, 23.89 C, 60dB - 11:39:24`

5 – Conclusion

Progress

- Current work is focused on central hub development
- Beta-testing to occur at UT Southwestern Medical Center

Innovation

- Our system enables automated logging of contextual factors without impacting current care practices

Impact

- Tracking contextual factors gives clinicians additional information to potentially improve patient outcomes
- Annotated temporally accurate data will expand and improve research in multimodal brain monitoring and TBI
- Future updates can enable improvements to real-time care

References + Acknowledgements

1. Foreman et al., (2021) ***Curr Neurol Neurosci Rep*** 21, 6 .https://doi.org/10.1007/s11910-021-01098-y
2. Thielen et al., (2022). ***Journal of Neuropsychology***. https://doi.org/10.1111/jnp.12284.
3. Kamdar et al., (2016). ***Ann Am Thorac Soc***, 13(8), 1370-1377. https://doi.org/10.1513/AnnalsATS.201601-087OC

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