NON-INVASIVE PROTEIN MEASUREMENT BY TRANSCUTANEOUS SENSOR

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Background

Advancements in terrestrial technology can have impactful applications for medical systems onboard space vehicles and stations. Finite resource allocation often filters what is admissible for spaceflight. Therefore, selection of technology that provides the most utility with maximum resource efficiency becomes increasingly important as NASA sets its sights towards deep space exploration. Limitations of resupply and less than real-time communications drives a strategy shift towards more crew autonomy and self-reliance. Reusable point-of-care (POC) diagnostic medical equipment may have a beneficial role onboard future spaceflights.

Current Process

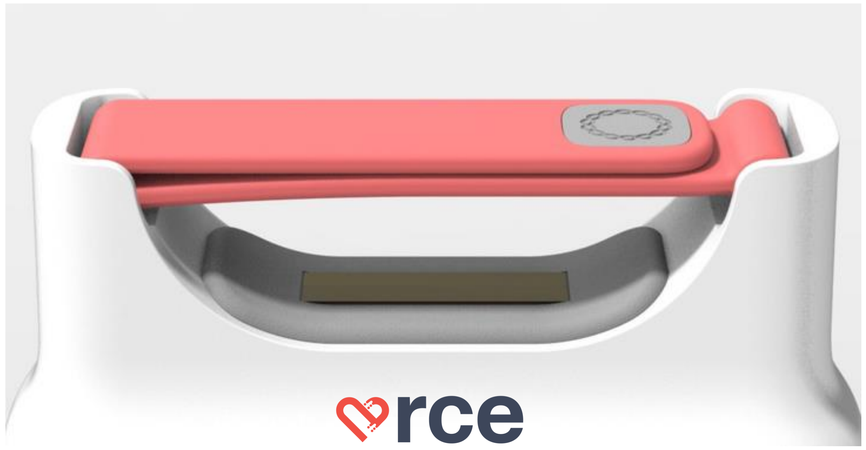
Current blood analysis of astronauts is based on biochemical and immunoassay testing, retrieved via phlebotomy. With the lack of comprehensive blood analyzers onboard spacecraft and the ISS, samples are refrigerated, stored, and returned to Earth to be analyzed weeks to months after blood extraction.

NASA recognizes the need for in-situ real-time measurements and has tested blood-based POC analyzers. [1] NASA also highlights **"*new advances in noninvasive technologies may be needed, especially in long-term missions, due to shelf life concerns*"**. [2]

Methods

Remote Cardiac Enablement (RCE) has developed a transcutaneous sensor capable of detecting troponin, a cardiac protein widely-accepted in its use to assess for myocardial infarction (MI) and injury.

The sensor, incorporated into an acute MI rule-out model, is undergoing clinical validation studies in comparison with phlebotomy-derived biochemical tests throughout the United States. It can be characterized at a technology readiness level (TRL) 6.



- Non-invasive
- Compact
- Point-of-care
- No consumable materials
- Result in ~3 mins
- Utilizes infrared spectroscopy [3][4]
- Allows for longitudinal frequent testing

Standard Consumables & Equipment for Phlebotomy & Blood Analysis

Tourniquet	Gauze	Storage refrigerator
Alcohol swab	Non-sterile gloves	Analyzer
Barrel / vacutainer	Bandage	Test strips *
Needle +/- tubing	Biohazard container	Lancet *
Specimen tubes	Analyte-specific assay	* POC Devices

Discussion

<u>Expansion of Analytes & Diagnostic Value</u>

The intention of this technology goes beyond a single-purpose diagnostic instrument, with the acute MI rule-out model serving as the initial proof-of-concept. Transcutaneous sensing could allow for detection of innumerable other proteins.

D-dimer, NT-proBNP, cystatin C, and procalcitonin have been proposed as the next proteins of interest to be measured – respectively serving as markers for thrombotic events, further characterize cardiac stress, function as a proxy for renal function, and suggest an inflammatory state stemming from an infection.

Expanding the sensor and the catalog of analytes will require additional modifications of the device optics, filters, and detector (TRL 3).

<u>Resource Savings</u>

The sensor reduces the amount of consumables used when compared with traditional biochemical tests via phlebotomy. In turn, this helps to reduce the need for resupply, unnecessary evacuations, crew training time, procedural time spent on phlebotomy, turnaround time for results, and discomfort with blood draws. Its reusability allows for more frequent testing and improved longitudinal monitoring.

References

[1] Spaceflight validation of technology for point-of-care monitoring of peripheral blood WBC and differential in astronauts during space missions

[2] Portable Diagnostics Technology Assessment for Space Missions. Part 1; General Technology Capabilities for NASA Exploration Missions

[3] A novel breakthrough in wrist-worn transdermal troponin-I-sensor assessment for acute myocardial infarction

[4] Development and preliminary validation of infrared spectroscopic device for transdermal assessment of elevated cardiac troponin