

# Bioelectronics and Data Science for Precision Health

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Assistant Professor  
Fall 2023



**LEHIGH**  
UNIVERSITY

**Department of Bioengineering**

# PI Background



- **Education**

- Case Western Reserve University, Cleveland, OH. B.S. in Polymers Science and Engineering (2014)
- Case Western Reserve University, Cleveland, OH. M.S. in Biomedical Engineering (2018)
- Case Western Reserve University, Cleveland, OH. Ph.D. in Biomedical Engineering (2021)

- **Experience** (abbreviated)

- Research Engineer, Louis Stokes Cleveland Veterans Affairs Medical Center (2019-2021)
- Engineering Project Manager, Sibel Health, Chicago, IL (2021-2023)
- Lehigh University, Assistant Professor Biomedical Engineering (2023 – present)

- **Research:** Broadly in *Bioelectronics for health and performance monitoring and treatment*

- **Keywords:** Wearable sensors, bioelectronics, biomaterials, human performance, generative AI

- **Selected Publications**

- Wong JN, Walter JR, Conrad EC, **Seshadri DR**, Lee JY, Gonzalez H, et al. (2023) A comprehensive wireless neurological and cardiopulmonary monitoring platform for pediatrics. PLOS Digit Health 2(7): e0000291
- **Seshadri DR**, et al. (2020) Wearable Sensors for COVID-19: A Call to Action to Harness Our Digital Infrastructure for Remote Patient Monitoring and Virtual Assessments. Front. Digit. Health 2:8.
- **Seshadri, D.R.**, Li, R.T., Voos, J.E. et al. Wearable sensors for monitoring the physiological and biochemical profile of the athlete. npj Digit. Med. 2, 72 (2019).

# Seshadri Laboratory at Lehigh University

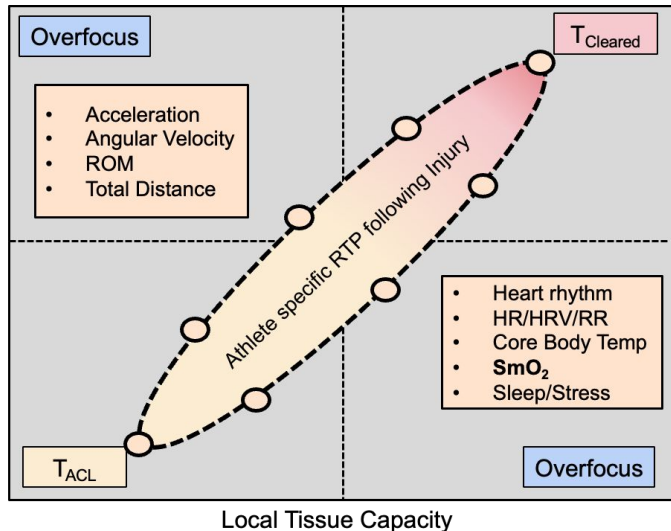
**Goal:** Value-drive engineering in wearable technology to address unmet medical needs

- 1) Assessing the **efficacy** of wearable technology in clinical trials
- 2) Musculoskeletal and physiological **modeling** from wearables data to answer a clinical question
- 3) **Engineering** medical devices with emphasis on scalability, translation, and commercialization



*Research disseminating from the Seshadri Laboratory will enable the development, validation, and deployment of biomedical devices to monitor advanced digital biomarkers to address unmet clinical needs*

# Thrust 1: Human Performance and Data Science



**Keywords:** Clinical trials, human performance, wearable technology, artificial intelligence,

## What is the technology being studied?

- High fidelity, low powered predictive algorithms for monitoring human health and performance
- Measure biophysical, biomechanical, and biochemical markers that are onerous to quantify and that require obtrusive detection modalities and integrate those detection and analytical capabilities into existing wearable systems

## Why is this topic significant?

- Measurement of markers alone is not sufficient; there lacks actionable insight from digital health technologies today to guide users
- Disseminate algorithms via an open-access platform to overcome “black box” understanding of AI-based analytics

## What are potential developmental pathways?

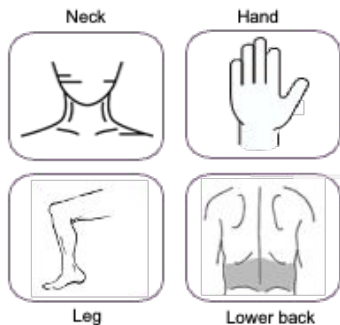
- Optimization of athlete workload programs to guide training and return to play
- Advanced digital biomarkers for health monitoring (cuffless blood pressure)
- Non-invasive detection of core body temperature or frostbite in athletes, warfighters, patients in critical care
- Integration of biomechanics and physiology for holistic health assessment into athlete management systems and hospital monitoring equipment (interoperability of data)

## What are the future directions of this research?

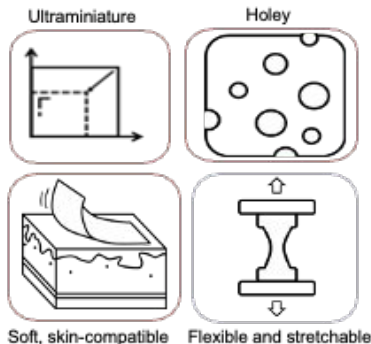
- Provide objective means to quantify efficacy (e.g. therapeutics)
- Machine learning tools to predict health outcomes (e.g. injury, health status)

# Thrust 2: Smart Hospital (Acute, Critical Care, and Remote Monitoring)

## Mounting locations



## Form Factors



**Keywords:** Embedded systems, flexible electronics, polymers, edge computing, clinical trials

## What is the technology being studied?

- Assessment of technologies on healthy and compromised individuals
- Development of digital diagnostics and therapeutics to quantify efficacy

## Why is this topic significant?

- COVID-19 has necessitated and galvanized society to harness our digital infrastructure for remote and self monitoring
- Growing adoption of digital health technologies necessitates innovations to maximize efficacy and further adoption across varied income and social levels

## What are potential developmental pathways?

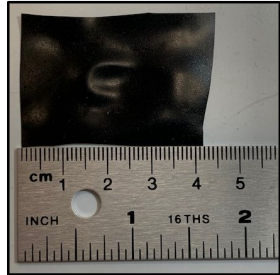
- Independent or company sponsored validation of digital health technologies
- Integration of predictive analytics and advanced materials science

## What are the future directions of this research?

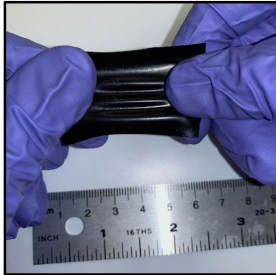
- Create pipeline for clinical validation and translation of medical device technologies for athletes and patients
- Low-cost wearable technology for health monitoring in low-income communities (e.g. social determinants of health)
- Wireless intensive care units to recapitulate vitals non-invasively

# Thrust 3: Diagnostic and Electroceutical Devices

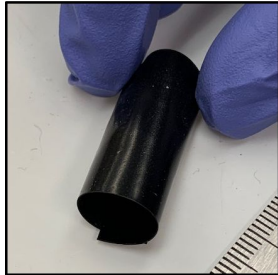
a) Unstrained



b) Stretched



c) Rolled



d) Compressed



**Keywords:** Biomaterials, electroceutics, tissue engineering, polymers, embedded systems

## What is the technology being studied?

- Epidermal or implantable devices for monitoring health conditions
- Development of novel materials, material chemistries, and material platforms

## Why is this topic significant?

- Need for quantifiable data to assess efficacy post surgery to complement patient reported outcome measures.
- Technology has applications in orthopedics, wound care, and cardiology
- Adoption of sensor technologies by medical device companies will enable academic-industry partnerships and licensing opportunities

## What are potential developmental pathways?

- Flexible electrodes, novel material platforms (collaborations with biomaterials, chemistry, materials science, electrical engineering)
- Implantable or epidermal devices for post-surgical monitoring

## What are the future directions of this research?

- Wound Healing
- Post-surgical monitoring
- Orthopedics: knee/hip arthroplasty, spine fusion, fracture fixation, ACL reconstruction, pressure distributions in foot (e.g. Lisfranc/Jones fractures) detection of biomarkers (e.g. muscle oxygen saturation, creatine kinase, hemoglobin, nitric oxide for tissue perfusion)
- Cardiology: cardiovascular implantable electronic devices, heart failure, AFIB management following

# From Platform Technology to Product: Long-Term Vision

## Engineering



## Clinical Grade

### Core Parameters

Skin Temperature

Heart Rate

pH

Impedance

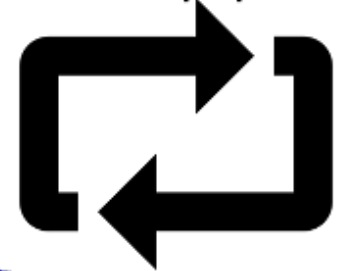
## AI/ML Support

Interoperability  
Health Prediction



## Full Automation

Closed Loop Operation



## Health Monitoring

Reepithelization

Infection

Vitals

## Edge Computing



Sensors  
+  
Therapeutics

Phase I

Phase II

Phase III

Phase IV

# Contact

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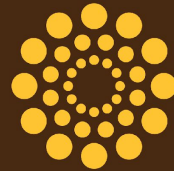


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**Google Scholar:**  
<https://scholar.google.com/citations?user=jVOCHjAAAAAJ&hl=en>



**SESHADRI LAB**

*Innovating to improve patient outcomes*