

# N.I.C.O.L.A.S. Oral Exam

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Jude Franklin, Anthony Frederick, Chet Friday, Justin Mollison, Gregory Ridgel

Faculty Advisor: Dr. Franz Baudenbacher

Clinical Advisor: Dr. Susan Eagle

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Non-invasive

Continuous

Optical

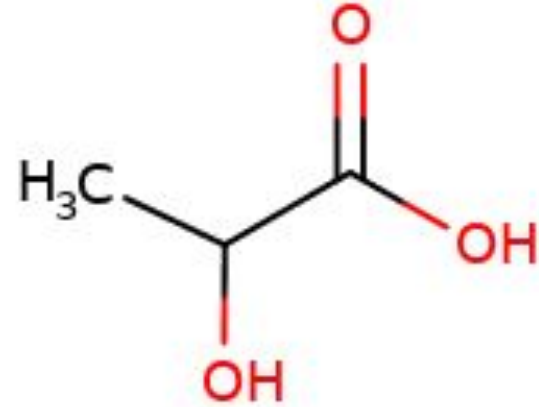
Lactic Acid

Sensor

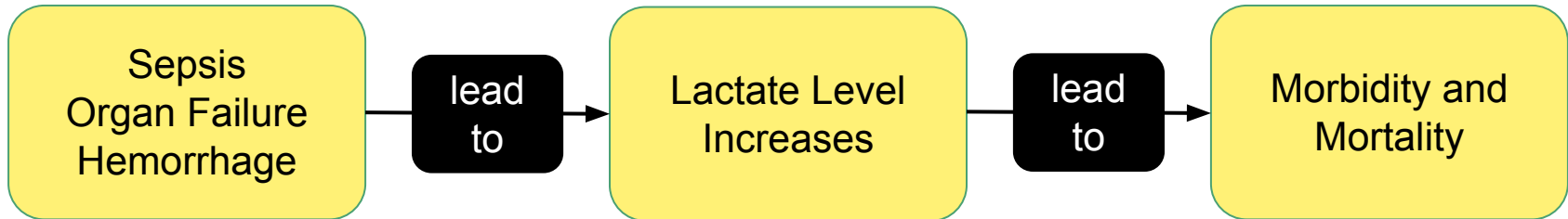
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# Background

- Clinical biomarker used to measure tissue degradation
- Normal levels  $\sim 1$  mM.
  - Relative > Absolute measurements



Lactic Acid  
(2-hydroxypropanoic acid)



# Problem Statement

- Currently, blood lactate levels are undersampled in clinical settings, leading to undetected spikes in lactate concentration which indicate the onset of sepsis, organ failure, and hemorrhage

# Needs Assessment

## **Patient**

Insulated Device  
Intermittent Pulses  
Non-invasive

## **Practitioner**

Continuous Sampling  
Ease of Use  
Clinical Application

## **System**

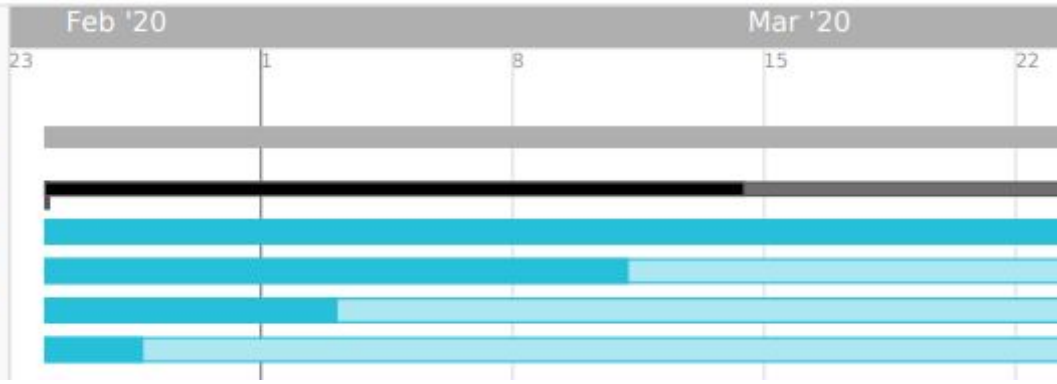
Simplest Modality  
Cost Effective & Portable  
Integrate with Hospital Systems

NICOLAS

Current Tasks

- Circuit Development
- Lactic Acid Absorbance
- Research into Alternate Modalities
- IRB Application / Process

0h	36%
0h	36%
0	95%
0	30%
0	15%
0	5%



# Anticipated Failures

- Loose Connections between circuit connections and microcontroller
- Microcontroller issues
  - Turning on and off system
    - Indicating power is flowing through the system
  - Healthcare providers not knowing when system is on, off and recording
  - Microcontroller failure
    - Incorrect modulation of circuitry
    - Disconnection of microcontroller to display
- Calibrating Signal across
  - Correcting patient signal across finger orientation and other irregularities
    - Finger thickness
    - Weird growths in fingers that will disrupt signal transduction

# Design Modifications

- Circuit Modifications
  - Addition of a manual on/off switch; initial design only controlled power from via microcontroller
  - Add LED that signals that photodetector/ LED is receiving power
  - Add LED battery level indicator
- Software Modifications
  - Use built in temperature sensor to monitor circuit temperature and automatically shut off power when temperature exceeds set maximum
  - Set up warning message to be broadcast if device reads null values (i.e. no reading because device has fallen off)
- Hardware modifications
  - Although we didn't get to fully mock-up what our final circuit mounting platform would look like, the finger clip and accompanying hardware platform must be able to adapt to patients of all sizes (excluding infants)



# Safety Concerns

- Tissue damage by absorption -- microwaving
  - Finding optimal pulse rate to be able to measure lactic acid, while preventing tissue damage
  - Prevent pulse-rate from being too high to reduce short-term damage to skin
  - Prevent long-term overexposure by limiting frequency of measurement periods
- Packaging -- Overheating circuitry
  - Incorporating all of the specialized circuit components in a specific orientation, as well as packaging them into a small enough space for a finger clip
  - Ensure proper ventilation / prevent system overheating that could burn patient while wearing
- Sanitization / Sterilization capabilities
  - Designed in a way that enables routine cleaning, between patient usage