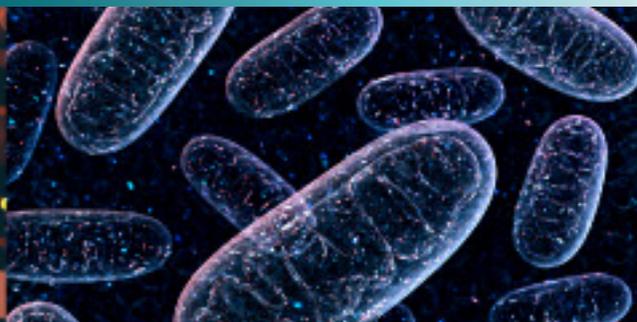




A New Look at Vital Signs

Jay Pandit, MD, Director of Digital Medicine

Assistant Professor of Molecular Medicine, SRTI



Road Map

- Introduction
- Temperature
- Heart Rate
- Respiratory Rate
- Blood Pressure
- Remote Monitoring
- Future Outlook
- Final Case



PULSE



70 BPM

mmHg



100
65
(90)

%SpO₂



100

RESPIRATORY
SYSTEM



12 RPM

TEMPERATURE



37.2 °C

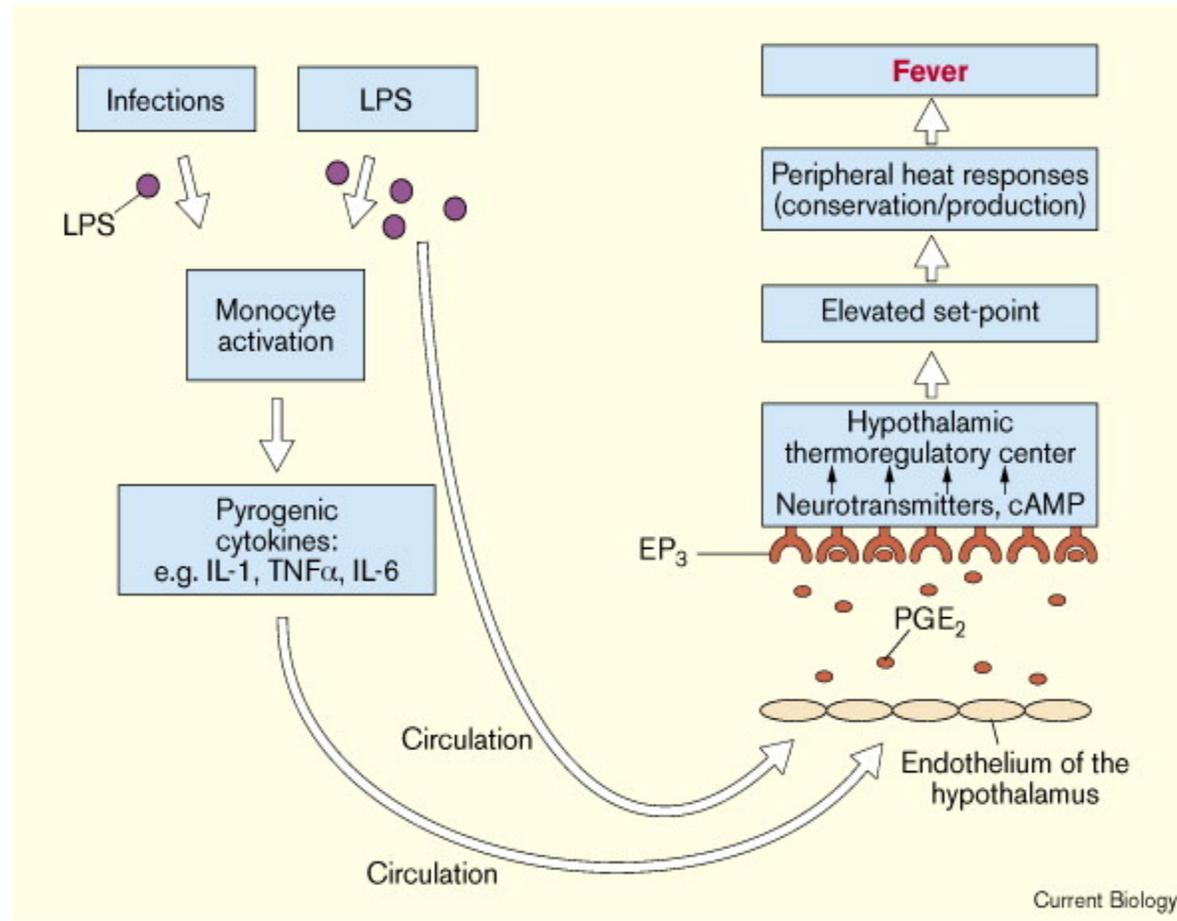


Temperature

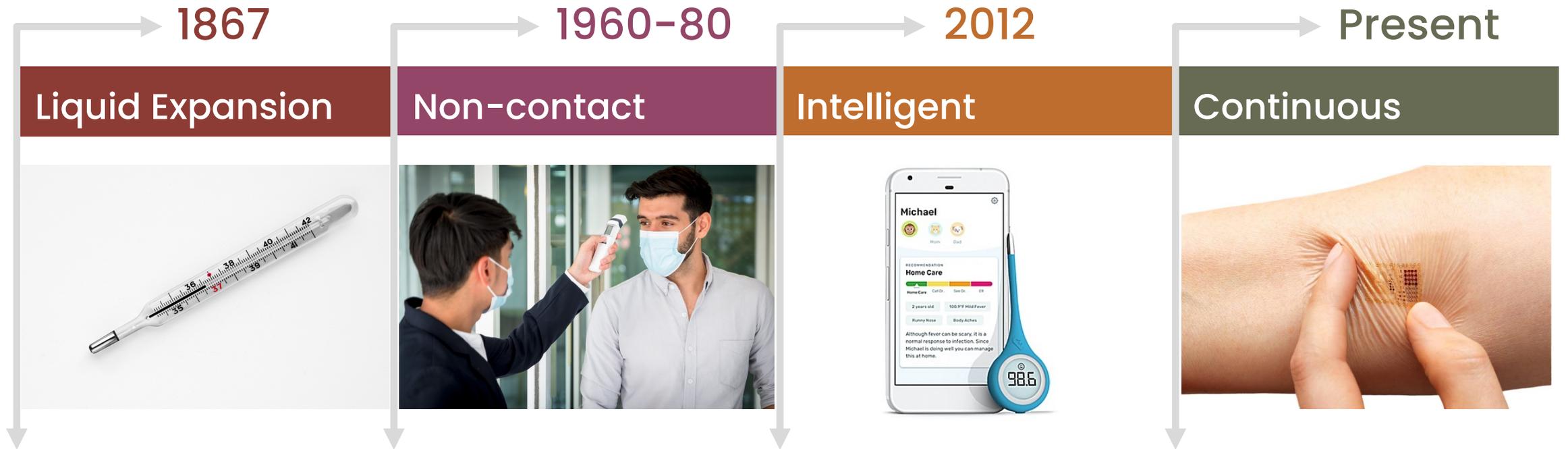
“Calor, Dolor, Rubor, Tumor” – 98.6°F or 37°C



Temperature Physiology

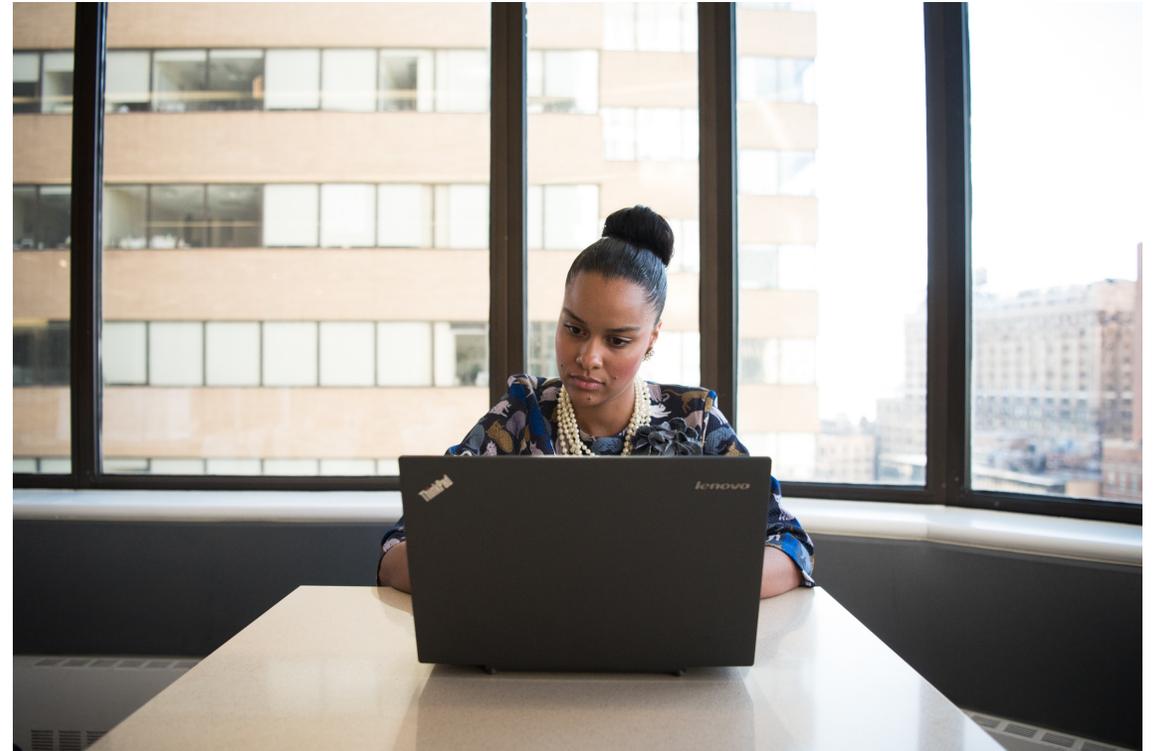


Temperature Measurement

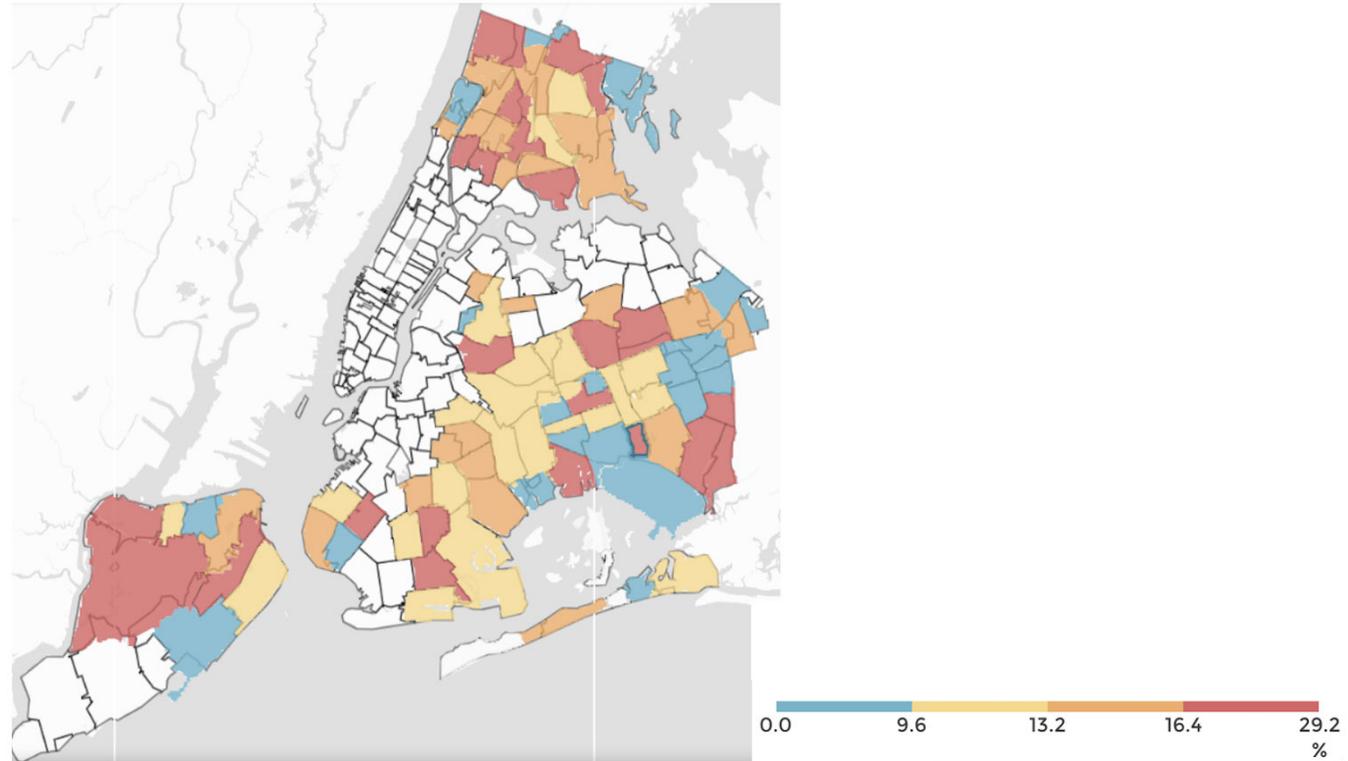


Jane

- 35-year-old female with hx of asthma living in NYC. She wants to know what her risk of getting a viral infection is by returning back to work in person.
- 98.6°F



Temperature Potential

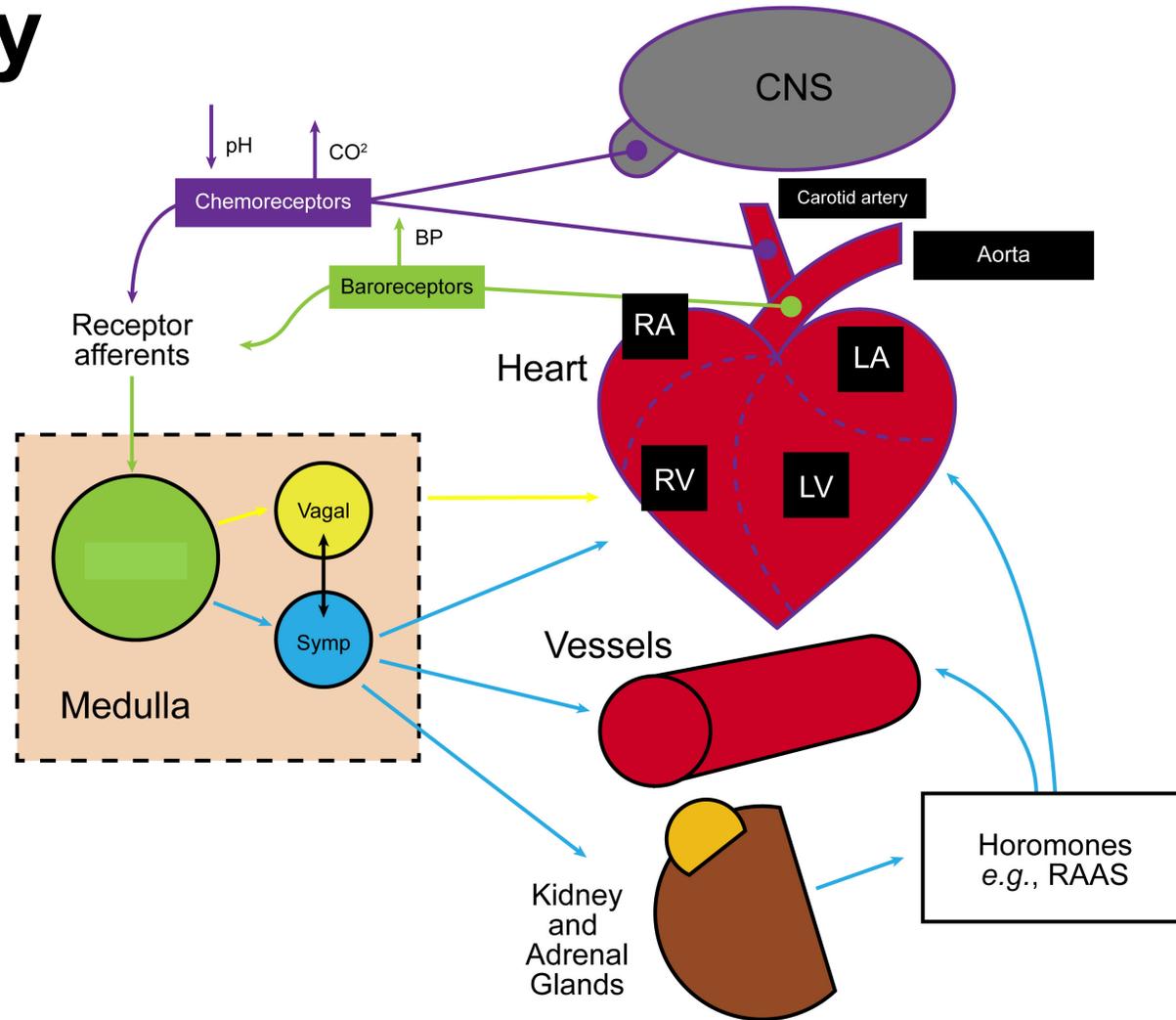


Heart Rate

60 – 100 beats per minute

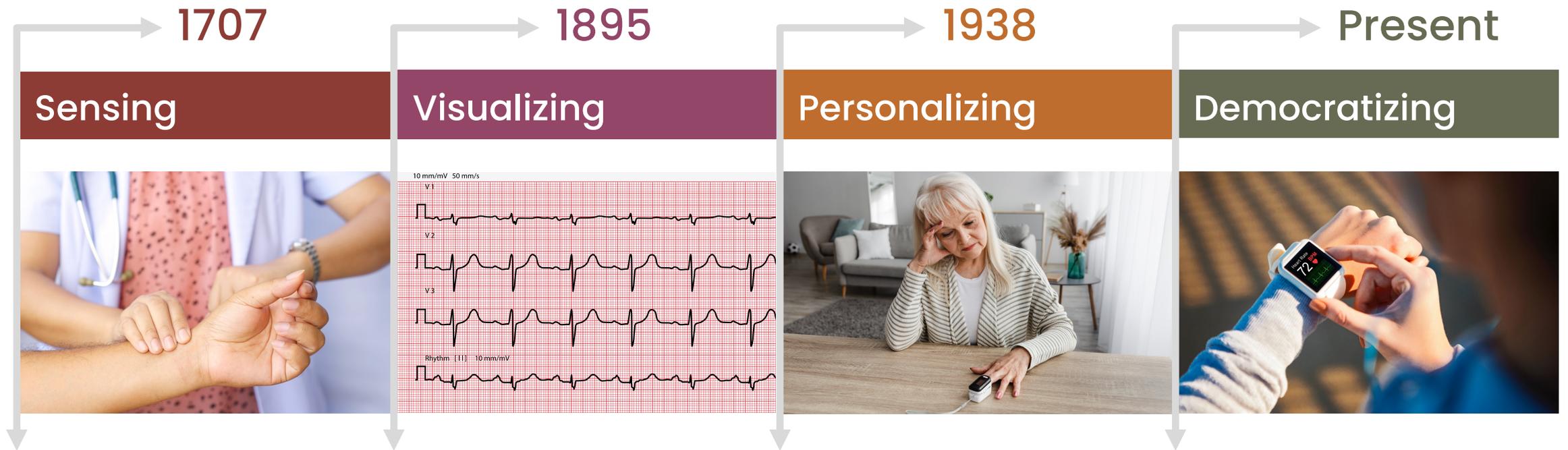


Heart Rate Physiology



Heart Rate

Measurement



Jane

- 35-year-old female with hx of asthma wants to know why her heart rate is not back to normal after Covid infection 2 months ago.
- HR 80bpm, 98.6°F



Potential



Feeling sick?
If you're feeling sick, start tracking your symptoms

[I'm Feeling Sick](#)

DETECT-AHEAD: New study available
You're invited to help us test new technologies

Baseline Survey
Tell us about your respiratory illness history and your demographics

Add COVID-19 Test Result
Add the results of a swab test, saliva test, or blood test

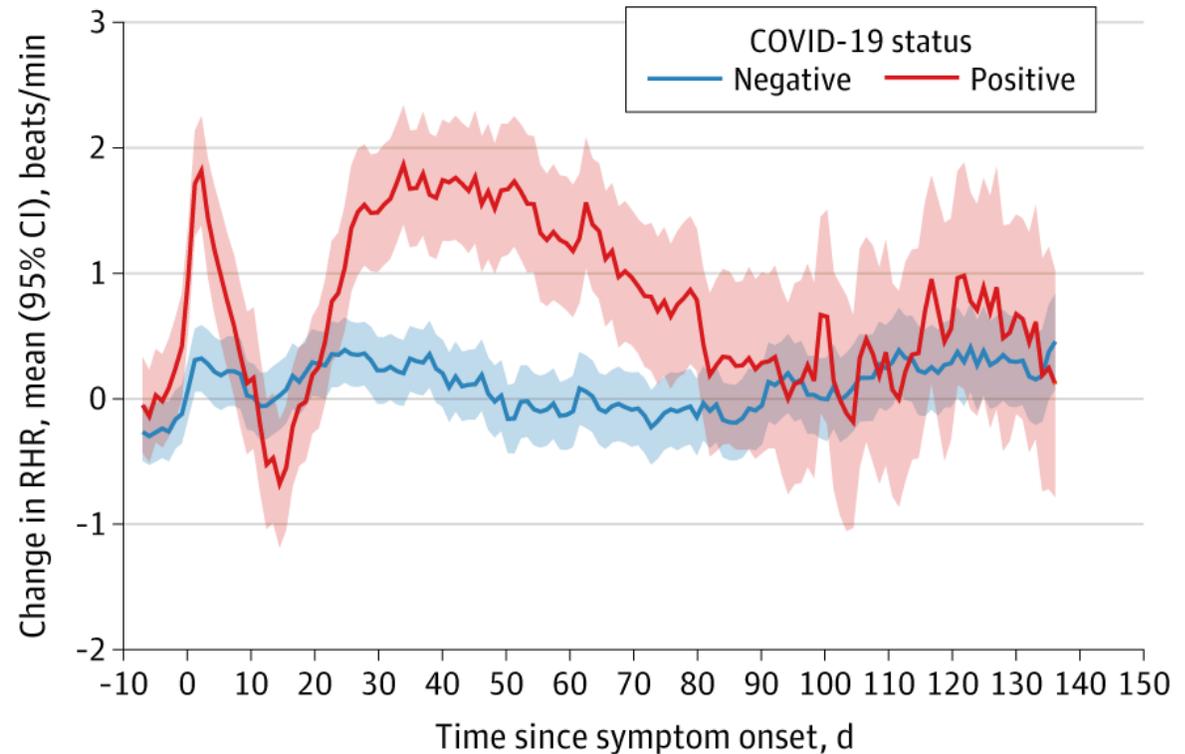
2/2 Vaccine Doses Received
✓ First dose on 9/9/2021
✓ Second dose on 9/30/2021

[Edit vaccine information](#)

[Home](#) [My Data](#) [Resources](#) [Account](#)

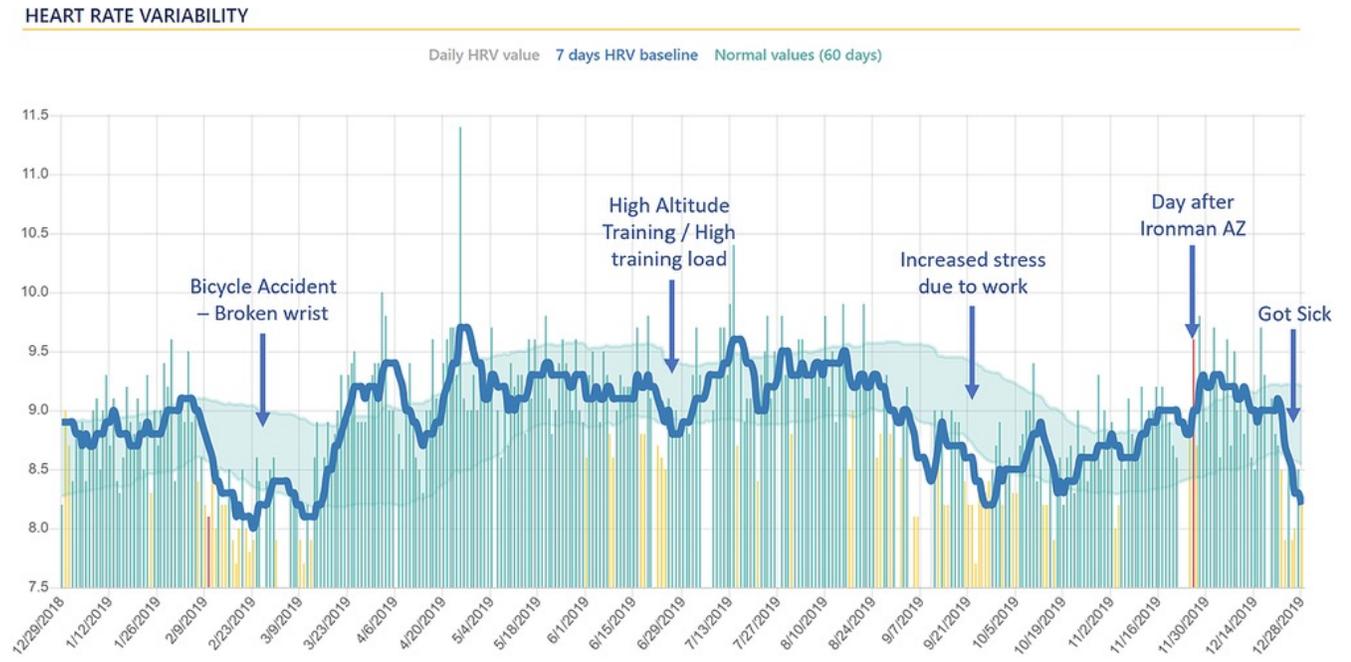
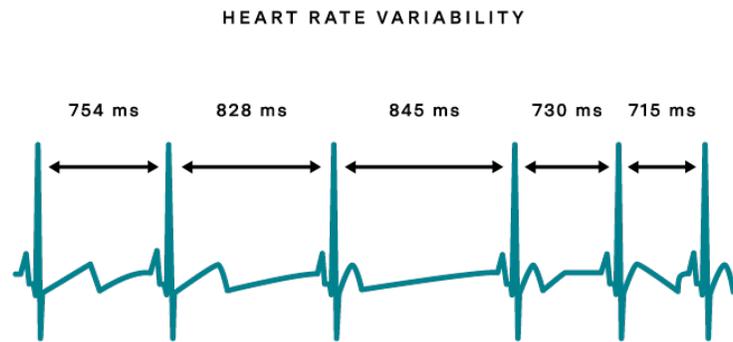
detect.scripps.edu

A Change in RHR for COVID-19-positive vs COVID-19-negative individuals



Potential

- Heart Rate Variability



Respiratory Rate

12-16 breaths per minute



Respiratory Rate Physiology

ACTIONS:

Medullary chemoreceptors detect an increase in blood pH (often caused by a decrease in blood CO₂), causing a decrease in breathing.



ACTIONS:

Medullary chemoreceptors detect a decrease in blood pH (often caused by an increase in blood CO₂) causing an increase in breathing.

REACTIONS:

Effectors Respond.
Decreased breathing increases blood CO₂.



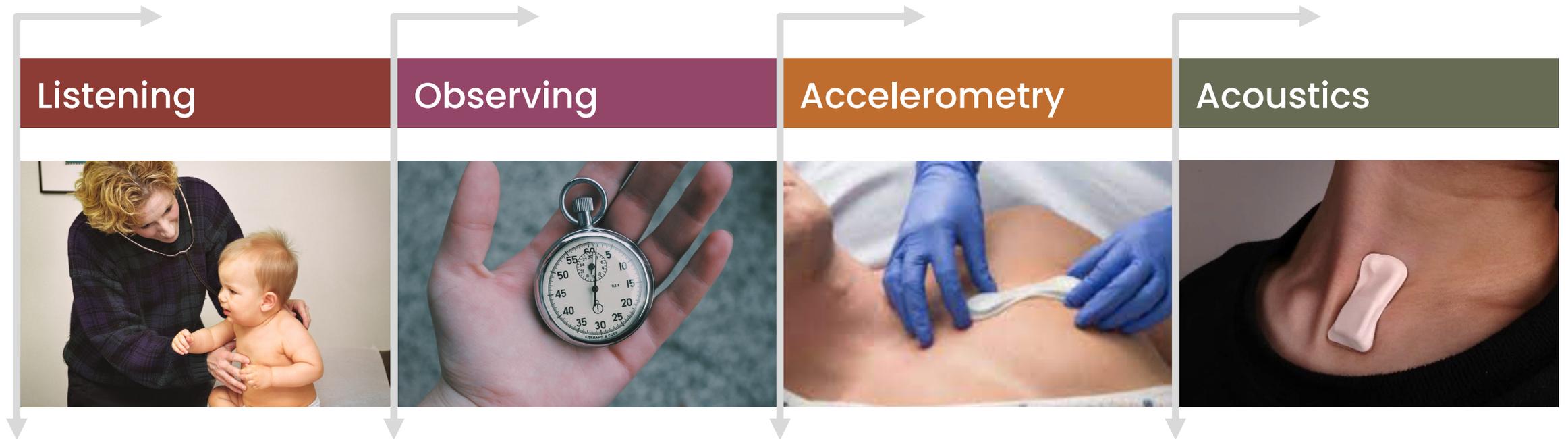
REACTIONS:

Effectors Respond.
Increased breathing decreases blood CO₂.



Respiratory Rate

Measurement



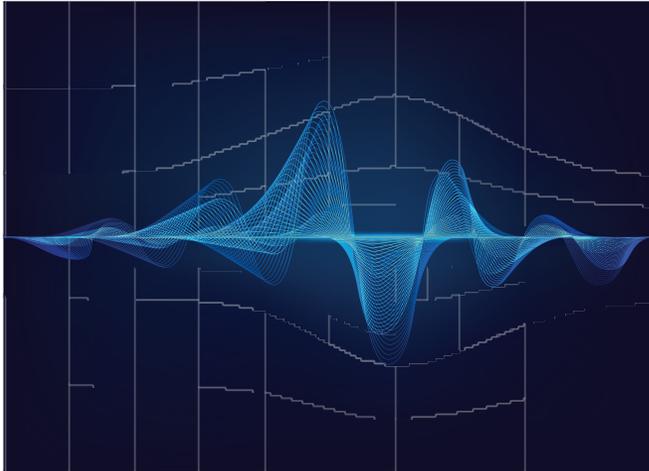
Jane

- 35-year-old female with asthma, Covid positive 6 months ago, vaccinated and now getting short of breath again.
- 98.6°F, HR 80, RR 16

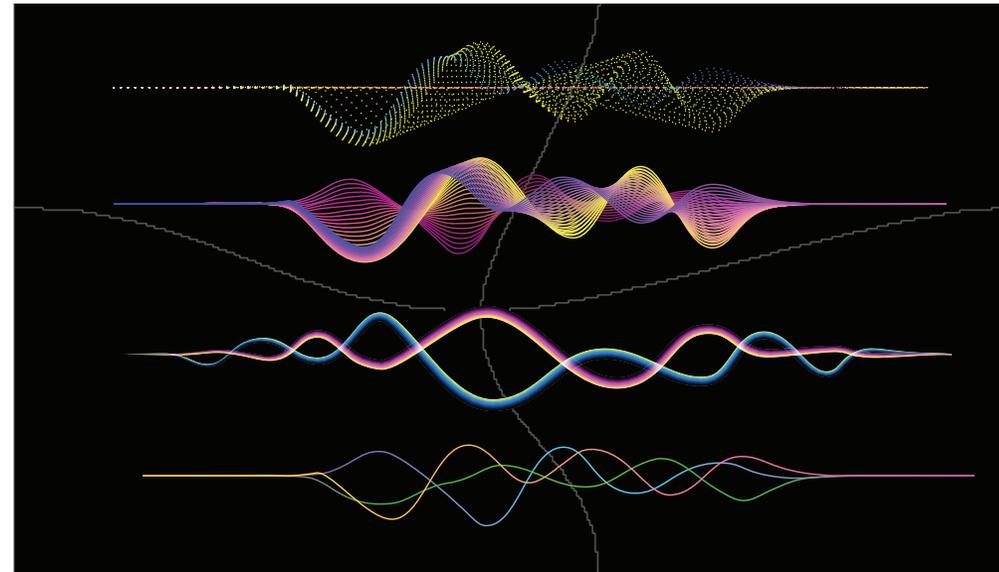


Acoustic Signaling

Potential



Compound Sound



Talking

Coughing

Snoring

Breathing

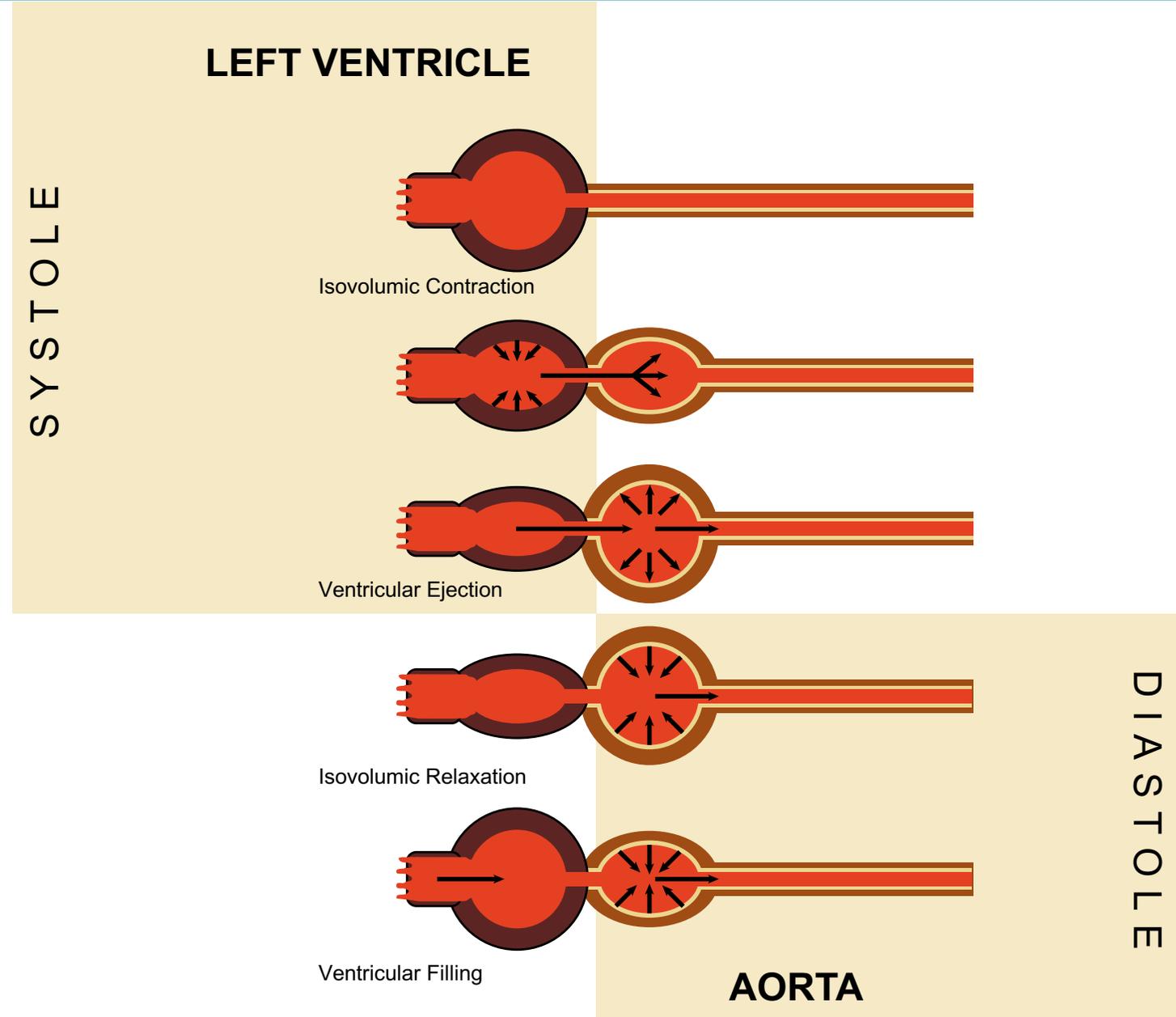


Blood Pressure

120/80mmHg

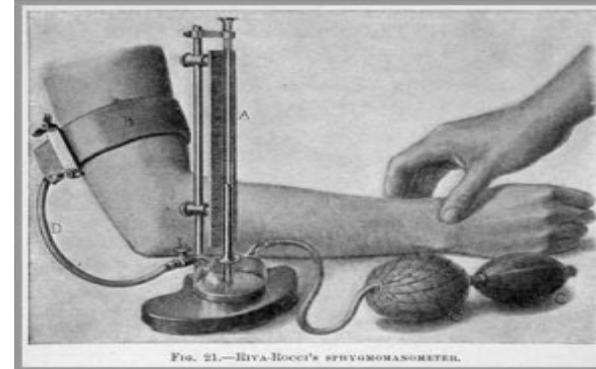


Blood Pressure
Physiology



Measurement

- Primary modifiable RF
- 2nd reason for OV
- >1B adults
- ~50% remain uncontrolled
- Cuff based

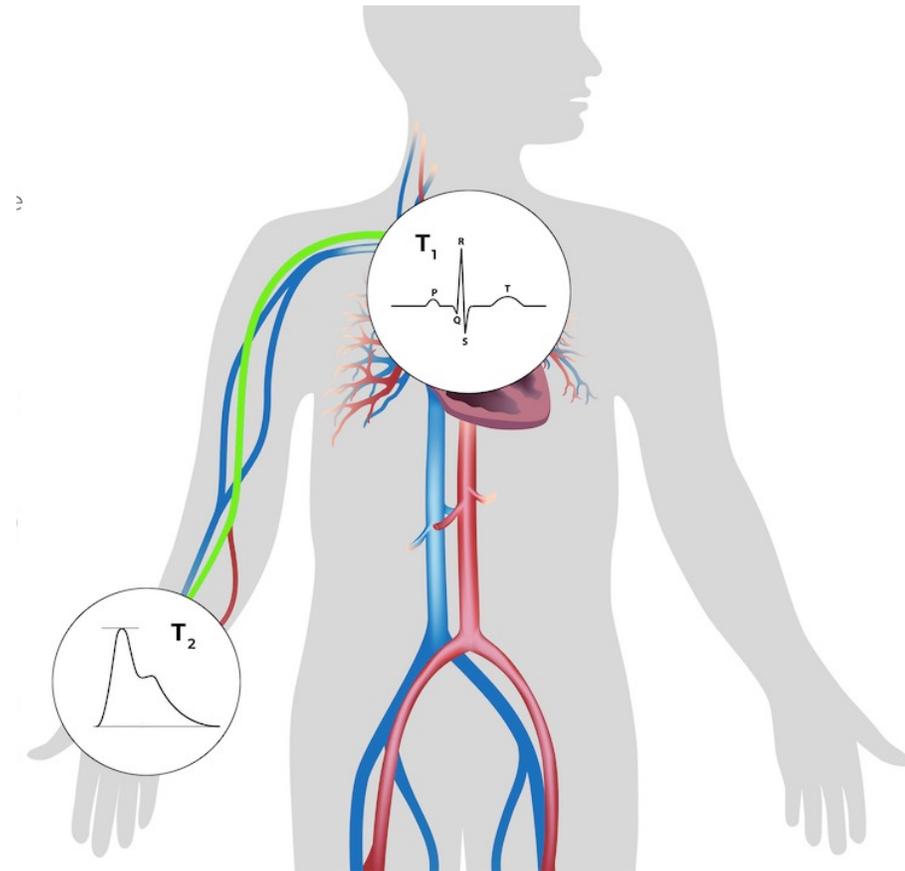
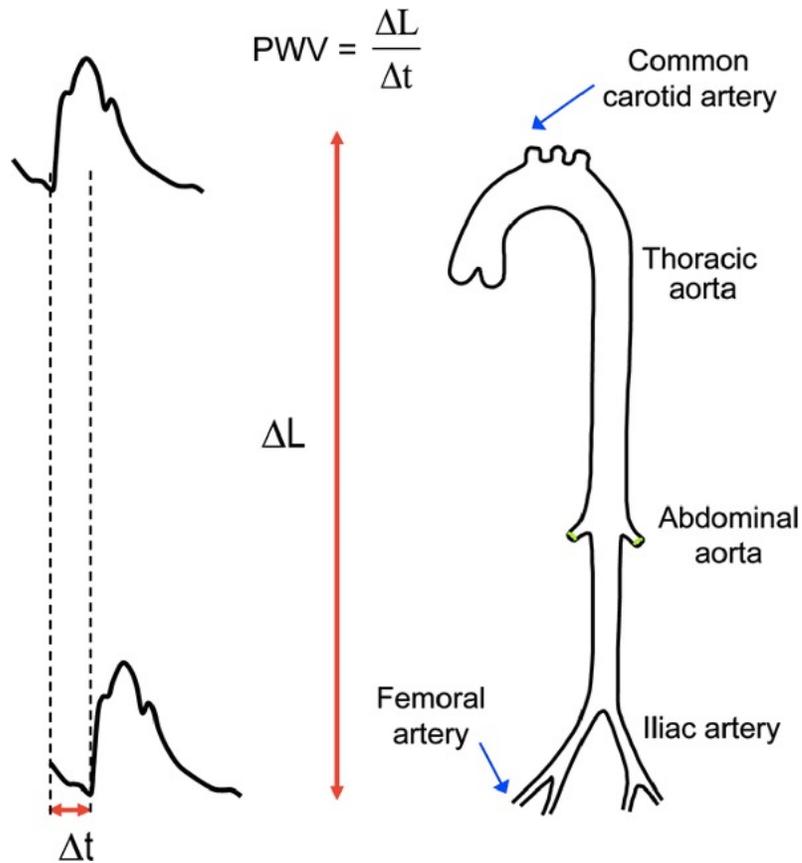


Blood Pressure

Measurement



Optical Sensor Measurement



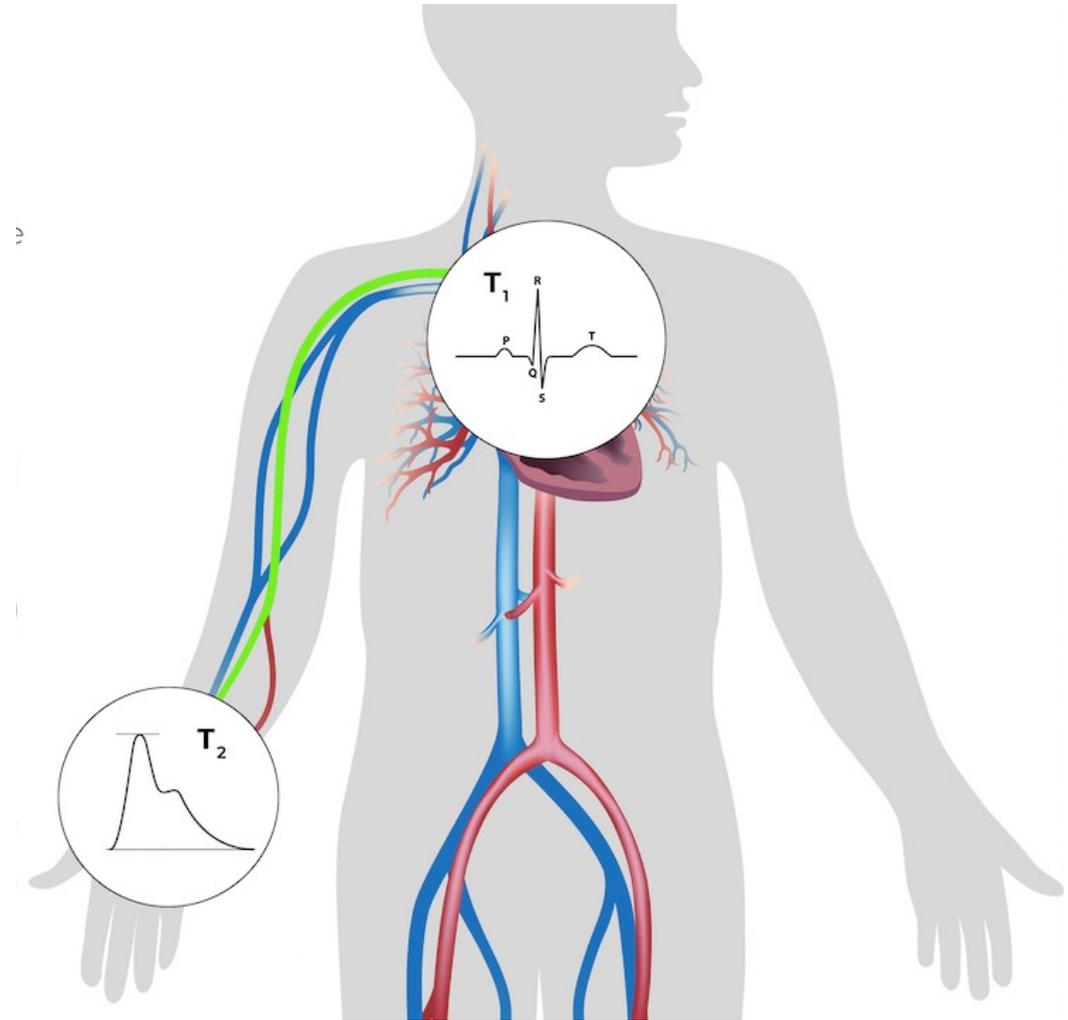
Problem

Assumptions

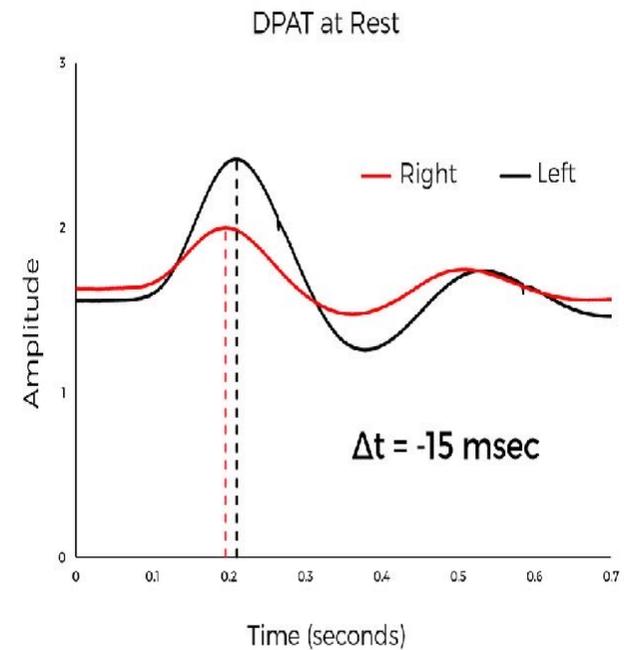
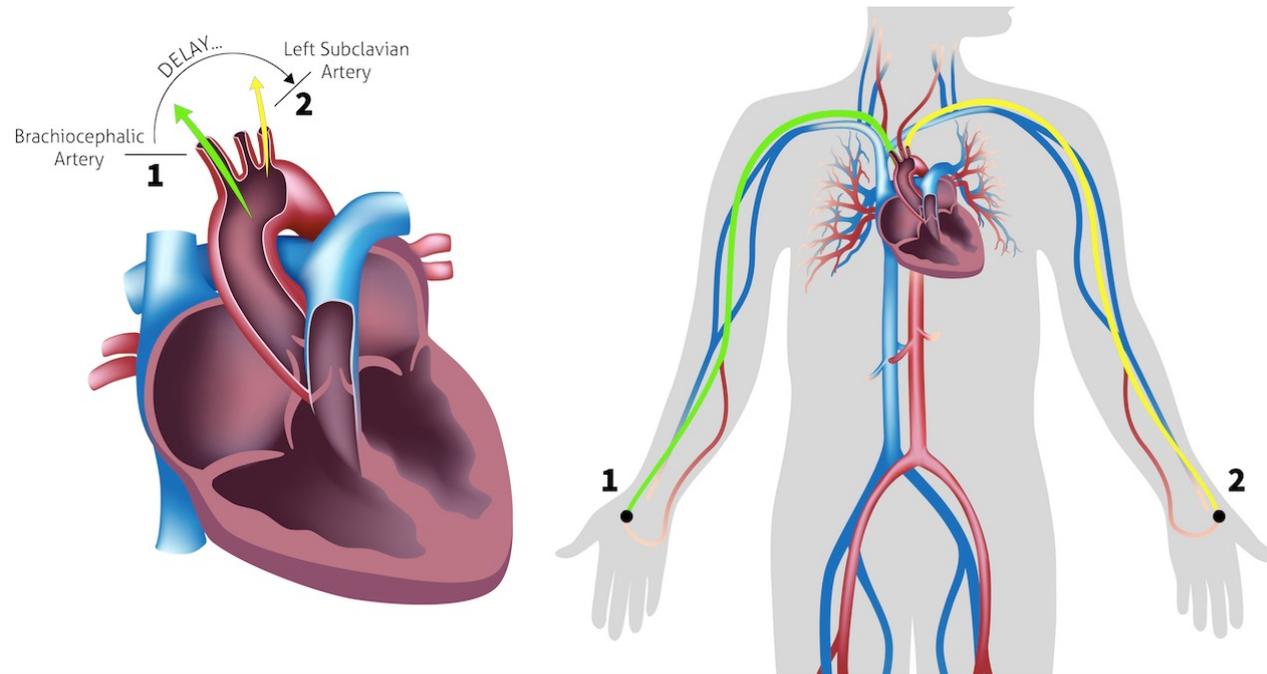
- Distance
- Conversion Equations

Pre-ejection period

- Electrical to mechanical



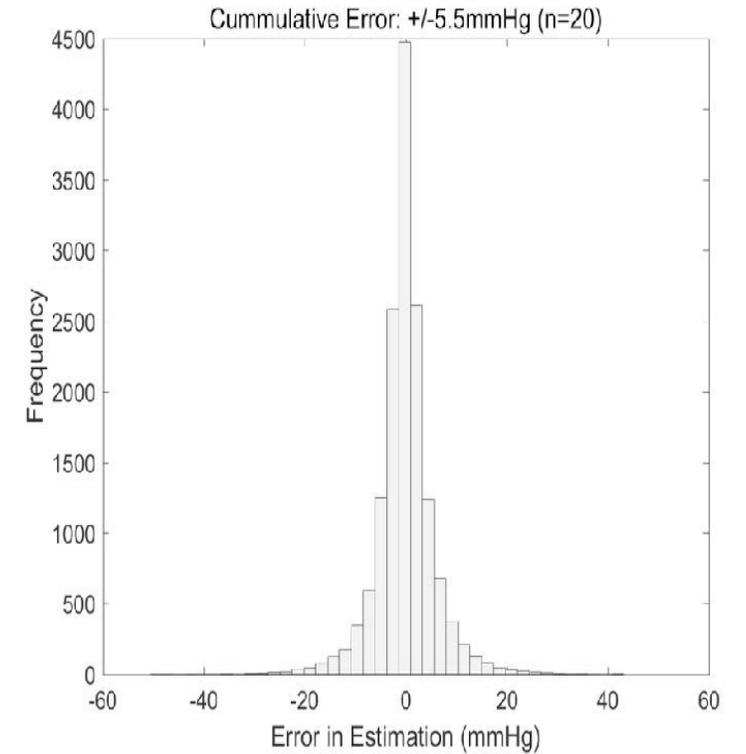
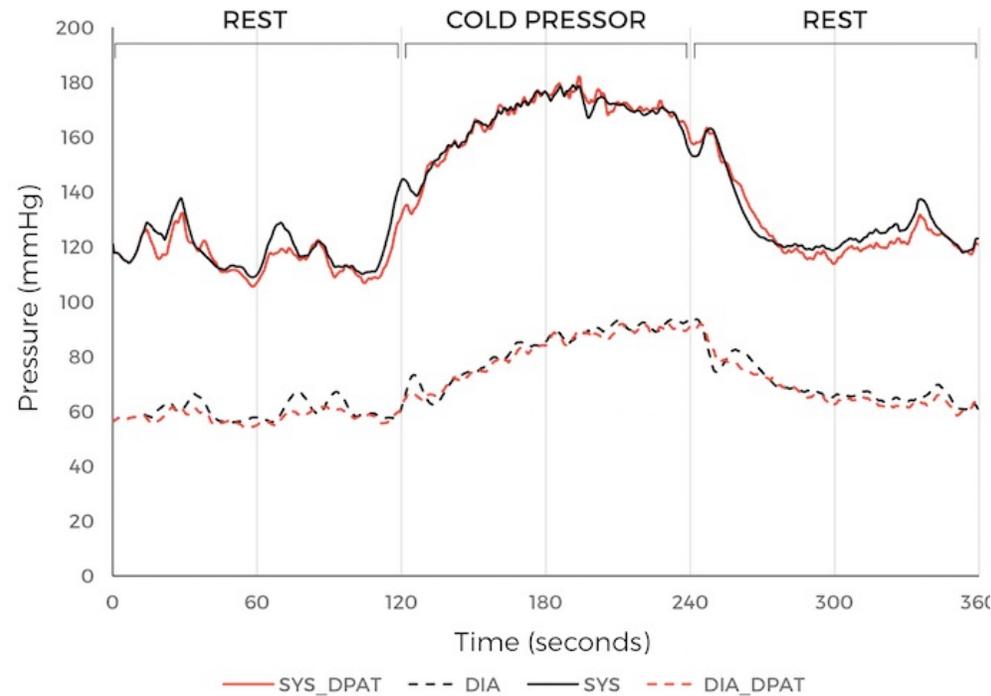
Solution: Differential Pulse Arrival Time



Blood Pressure

DPAT Validation

CLINICAL RESULTS
DEMONSTRATE
DPAT
ACCURATELY
ESTIMATES
BLOOD
PRESSURE
IN COMPARISON
TO CONTROL

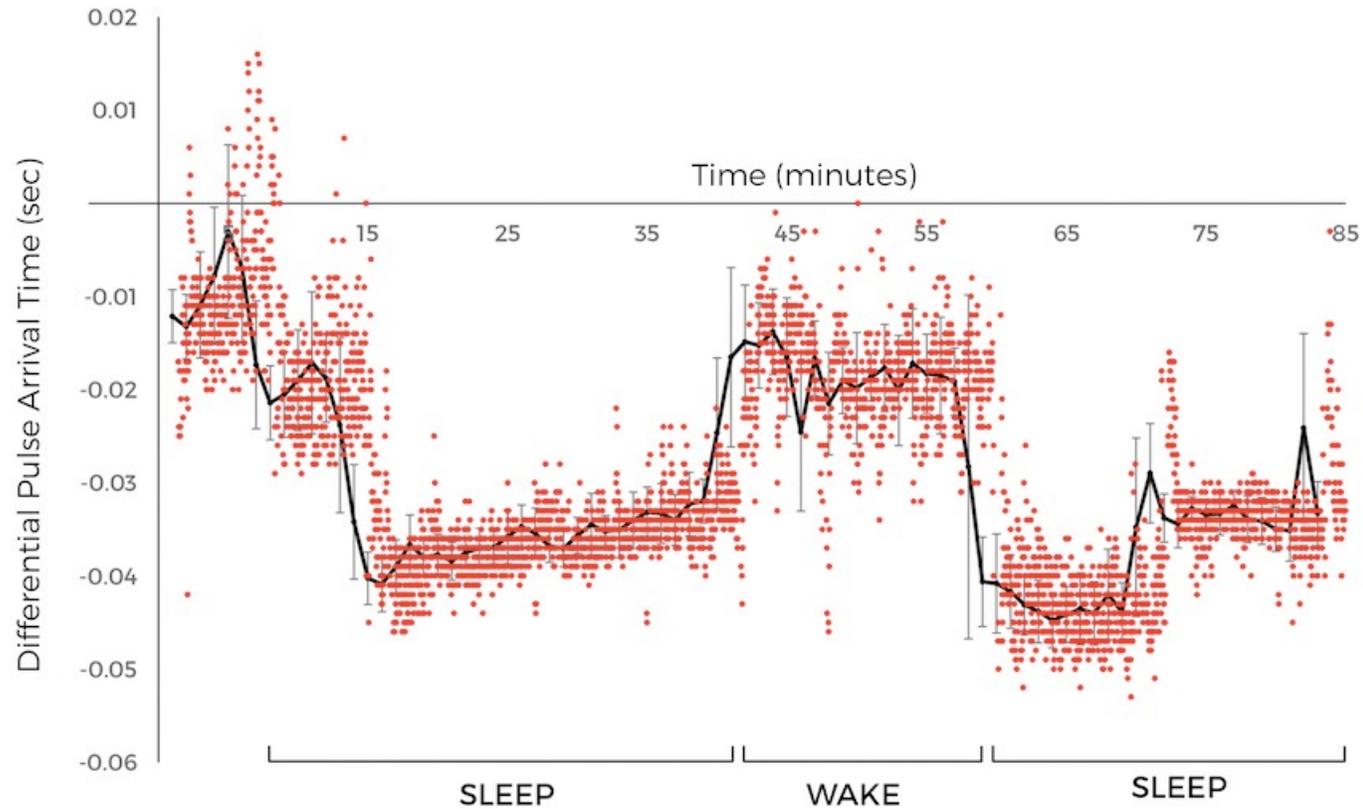


Study Demographics: n=12, Ages: 25-50, Gender: M/F, Normotensive & Hypertensive Subjects



Blood Pressure

DPAT Validation

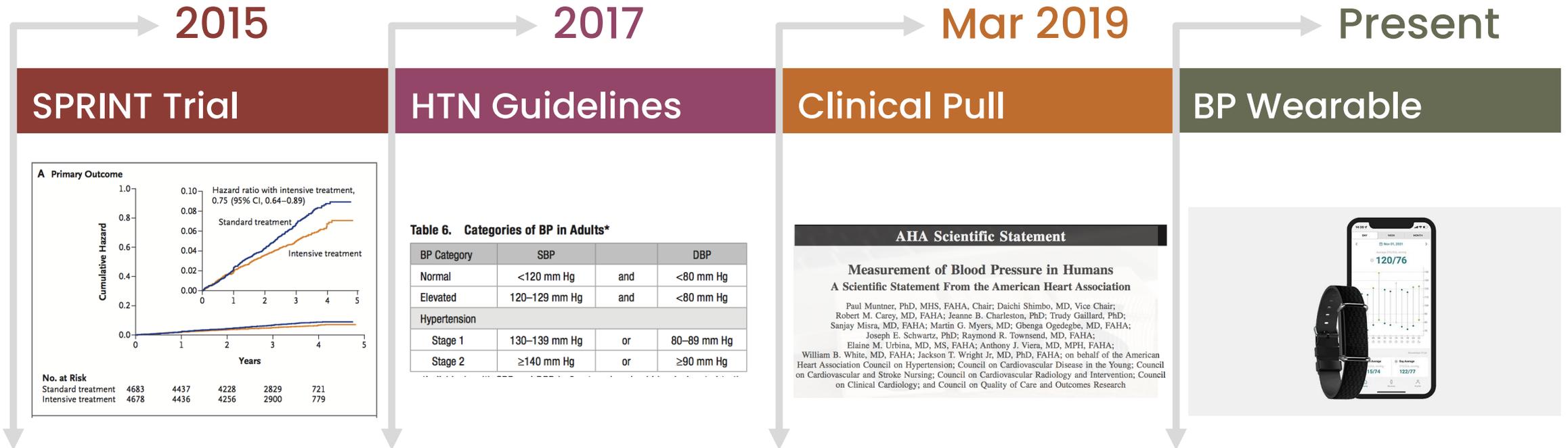


Blood Pressure

Prototype



Alignment of tech push and clinical pull



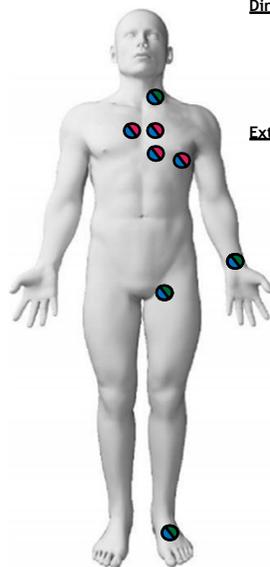
Remote Vitals Monitoring



RPM Diagnostics

Multi-modal, skin conforming, time synchronized wireless measurements of key data streams linked to physiological variables of interest:

Informed Wireless Device Locations



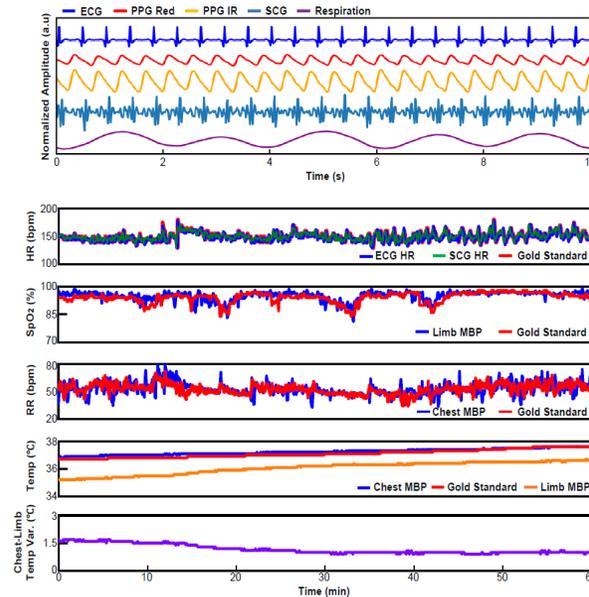
Direct Measurements

- ECG
- SCG
- PPG

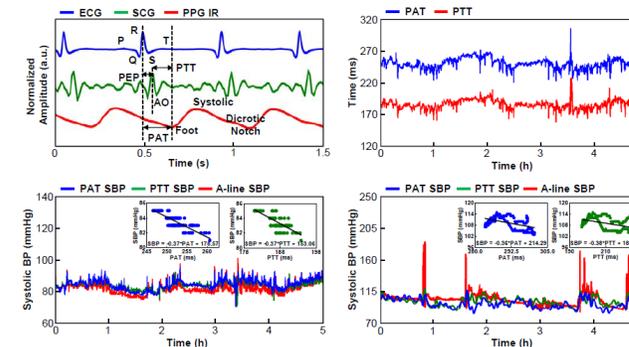
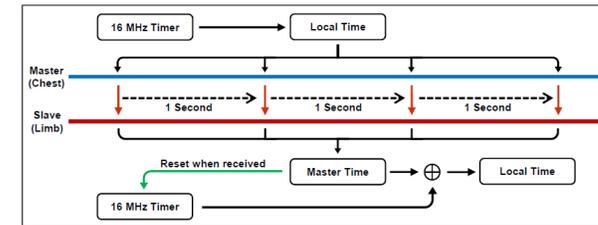
Extractable Quantities

- STI
- PWV
- HR
- RR
- SpO2
- BP
- SVR
- EF

Raw Data and Gold Standard

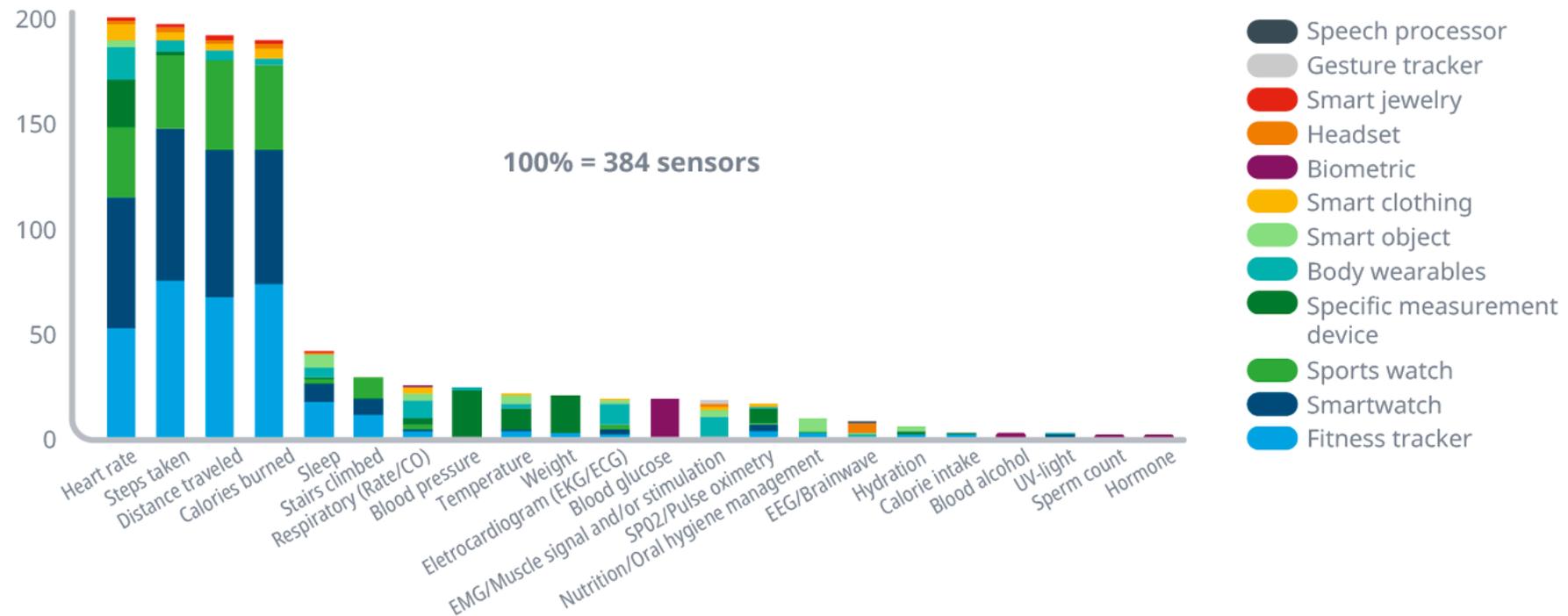


Multi-Device Time Correlation for PAT, PTT and BP



Sensor Capabilities

Parameters Measured by Consumer Digital Health Devices by Type



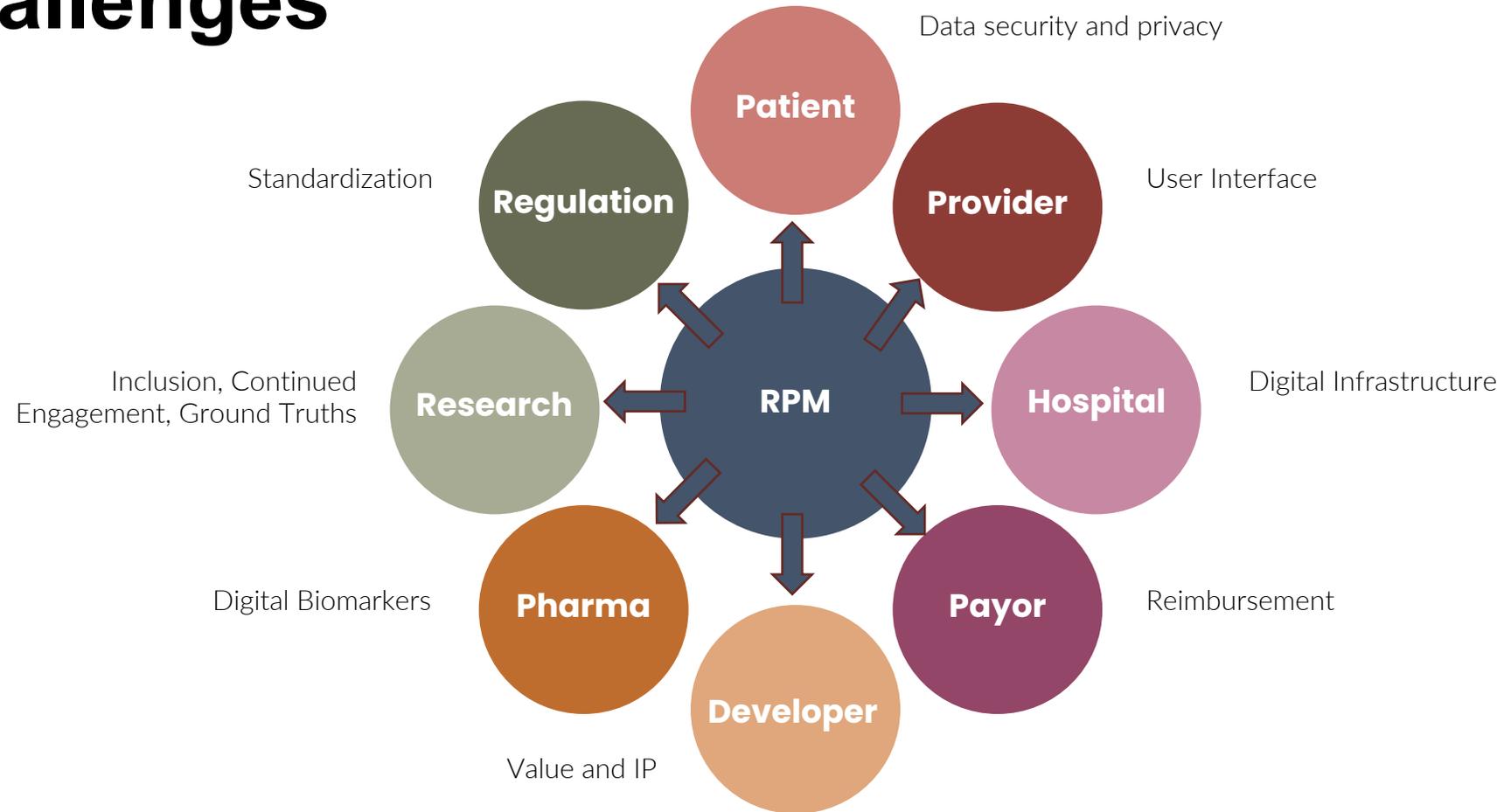
Source: IQVIA AppScript Device Database, Mar 2021; IQVIA Institute, Jun 2021

Notes: Chart includes data from 384 sensors. Total exceeds 384 due to multiple measures being tracked by a single sensor. Specific measurement devices include vitals measurement.

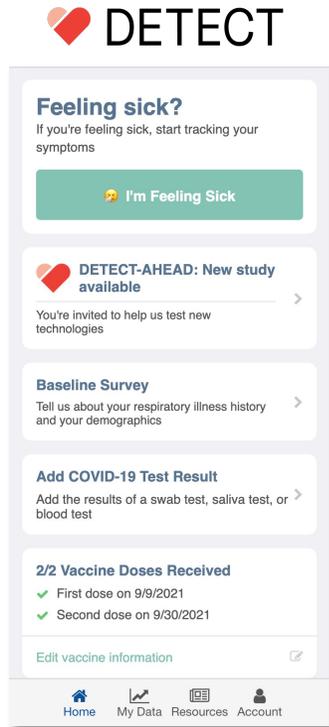
Report: Digital Health Trends 2021: Innovation, Evidence, Regulation, and Adoption. IQVIA Institute for Human Data Science, July 2021



Challenges



Our Efforts



DETECT

Feeling sick?
If you're feeling sick, start tracking your symptoms

I'm Feeling Sick

DETECT-AHEAD: New study available
You're invited to help us test new technologies

Baseline Survey
Tell us about your respiratory illness history and your demographics

Add COVID-19 Test Result
Add the results of a swab test, saliva test, or blood test

2/2 Vaccine Doses Received
✓ First dose on 9/9/2021
✓ Second dose on 9/30/2021

Edit vaccine information

Home My Data Resources Account

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Infectious
Diseases



PowerMom

Welcome Jane,

You are in your 1st Trimester
10 weeks and 3 days Pregnant

Due Date: Dec 17th, 2021
29 weeks and 4 days left

Update Pregnancy Status

Your Fitbit is on the way!
Keep an eye out for an email from Fitbit regarding tracking information for your device.

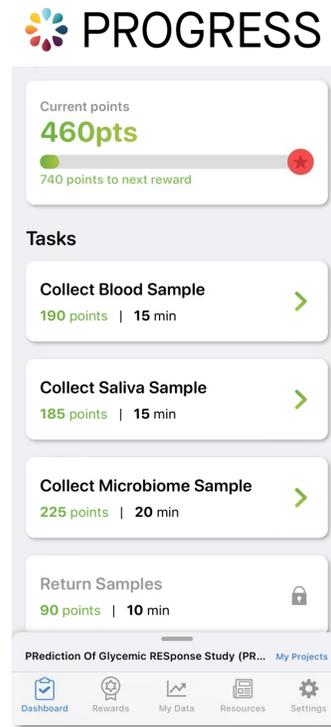
Tasks

Health History Survey
10 - 15 minutes

Dashboard My Data Resources Settings

powermom.scripps.edu

Maternal
Health



PROGRESS

Current points
460pts
740 points to next reward

Tasks

Collect Blood Sample
190 points | 15 min

Collect Saliva Sample
185 points | 15 min

Collect Microbiome Sample
225 points | 20 min

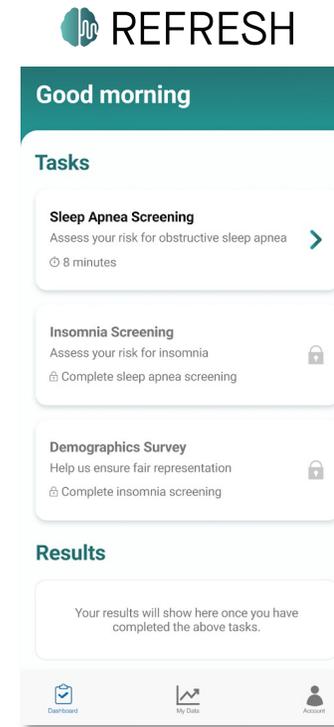
Return Samples
90 points | 10 min

PRediction Of Glycemic REsponse Study (PR... My Projects

Dashboard Rewards My Data Resources Settings

progress.scripps.edu

Precision
Nutrition



REFRESH

Good morning

Tasks

Sleep Apnea Screening
Assess your risk for obstructive sleep apnea
8 minutes

Insomnia Screening
Assess your risk for insomnia
Complete sleep apnea screening

Demographics Survey
Help us ensure fair representation
Complete insomnia screening

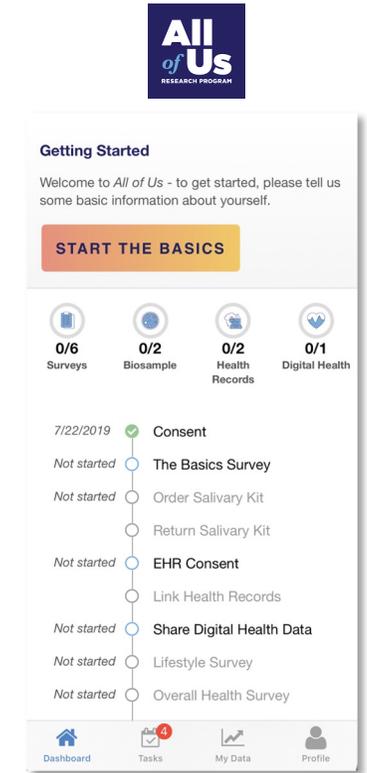
Results

Your results will show here once you have completed the above tasks.

Dashboard My Data Account

refresh.scripps.edu

Sleep
Medicine



All of Us
RESEARCH PROGRAM

Getting Started
Welcome to All of Us - to get started, please tell us some basic information about yourself.

START THE BASICS

0/6 Surveys 0/2 Biosample 0/2 Health Records 0/1 Digital Health

7/22/2019 **Consent**

Not started **The Basics Survey**

Not started Order Salivary Kit

Return Salivary Kit

Not started **EHR Consent**

Link Health Records

Not started **Share Digital Health Data**

Lifestyle Survey

Not started **Overall Health Survey**

Dashboard Tasks My Data Profile

go.joinallofus.org

Precision
Medicine



Future Outlook



What's Next?



Biofluids with
vitals



Multimodal
Integration



Expanding access



From active to
passive



From post
processing to real
time



From unregulated
to regulated



Road Map

- Introduction
- Temperature
- Heart Rate
- Respiratory Rate
- Blood Pressure
- Remote Monitoring
- Future Outlook
- **Final Case**



Final Case –

- 38- year-old male cardiologist with hx of brain cancer s/p surgery, chemotherapy, and radiation.
- Gets MRIs every 3-4 months for screening because not enough data on risk factors of tumor recurrence.
- Precision health enabled by digital health technology with large longitudinal datasets might hold this answer.



Thank you

- SRTI: Eric Topol, Katie Baca-Motes, Ed Ramos, Giorgio Quer, Julia Moore-Vogel, Jennifer Radin, Ali Torkamani, Kristian Anderson, Steve Steinhubl, Evan Muse, Athena Phillis-Tsimikas, Laura Nicholson and the rest of the SRTI team.
- Northwestern BCVI: Clyde Yancy, Sanjiv Shah, John Rogers, Patrick McCarthy, Faraz Ahmad, Andreas Tzavelis, Anjan Tiberwala, Stefanie Miller, Julie Petersen, Sean Connell, Kyle Miller, Andrew Wu, Sonia Kim and the rest of the BCVI and Northwestern team. Stanford and UCSF colleagues and mentors.
- “If you want to go fast, go alone, if you want to go far, go together.” – African Proverb
- Digitaltrials.scripps.edu





THE FRONT ROW
at Scripps Research

Upcoming Lecture



The hunt for regenerative medicines

Michael Bollong PhD

Assistant Professor, Department of Chemistry

Wednesday, June 29, 2022 | 1:00 pm PT/4:00 pm ET

Register
now at:

frontrow.scripps.edu



SCAN ME

