Welcome

"The Emerging Role of Mobile Computing in Health"

Shwetak Patel

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- This session is being recorded and will be archived for on-demand viewing in a few days

The Emerging Role of Mobile Computing in Health

Speaker: Shwetak Patel

Moderator: Marco Gruteser

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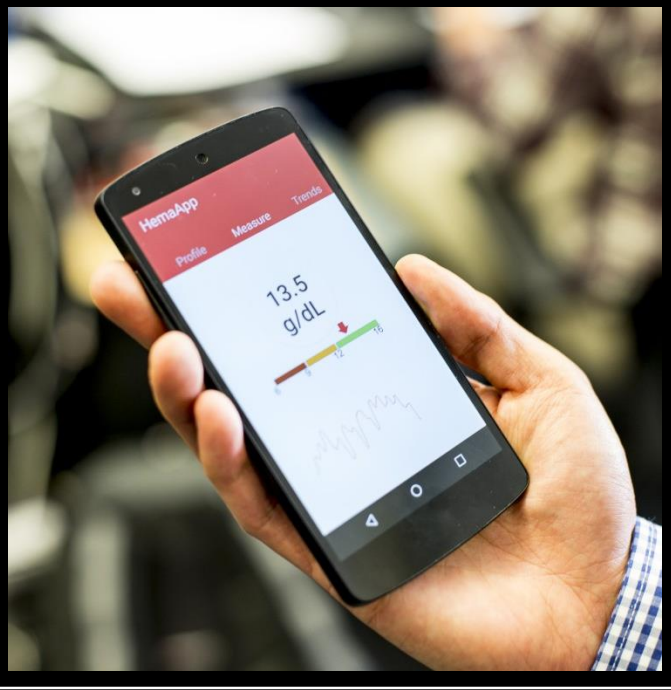
The Emerging Role of Mobile Computing in Health



Shwetak N. Patel

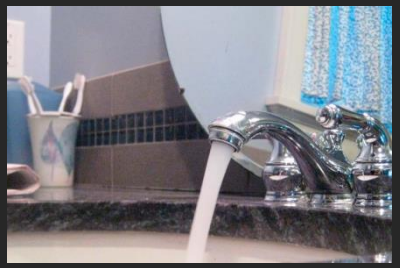
Washington Research Foundation Endowed Professor
Allen School of Computer Science & Engineering
Electrical & Computer Engineering

University of Washington

http://ubicomplab.cs.washington.edu/

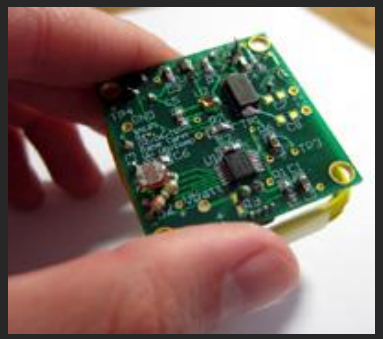
Quick Research Overview

Energy monitoring



Health

Low-power wireless sensing

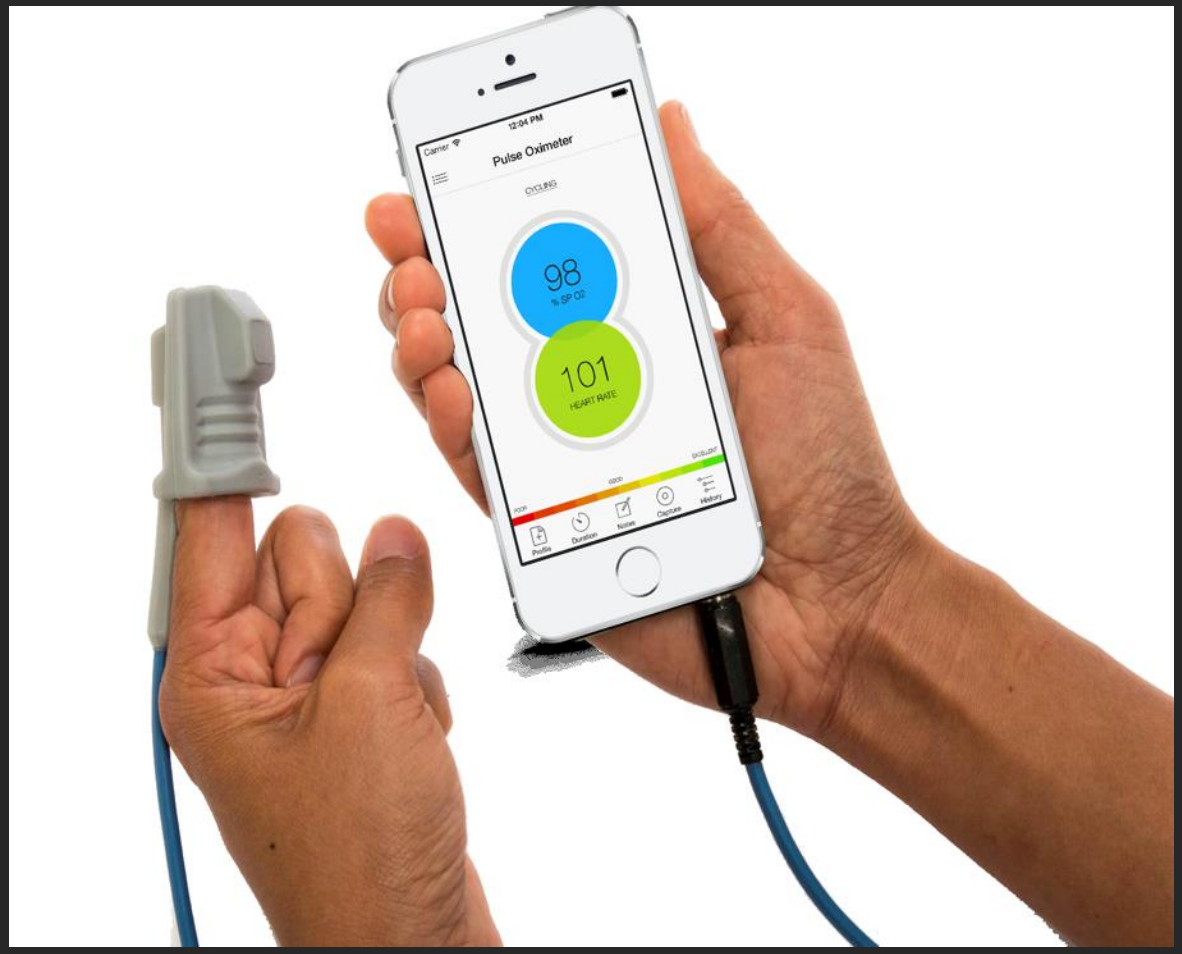


New interaction techniques

Personal Health Monitoring

Point of Care Diagnostics

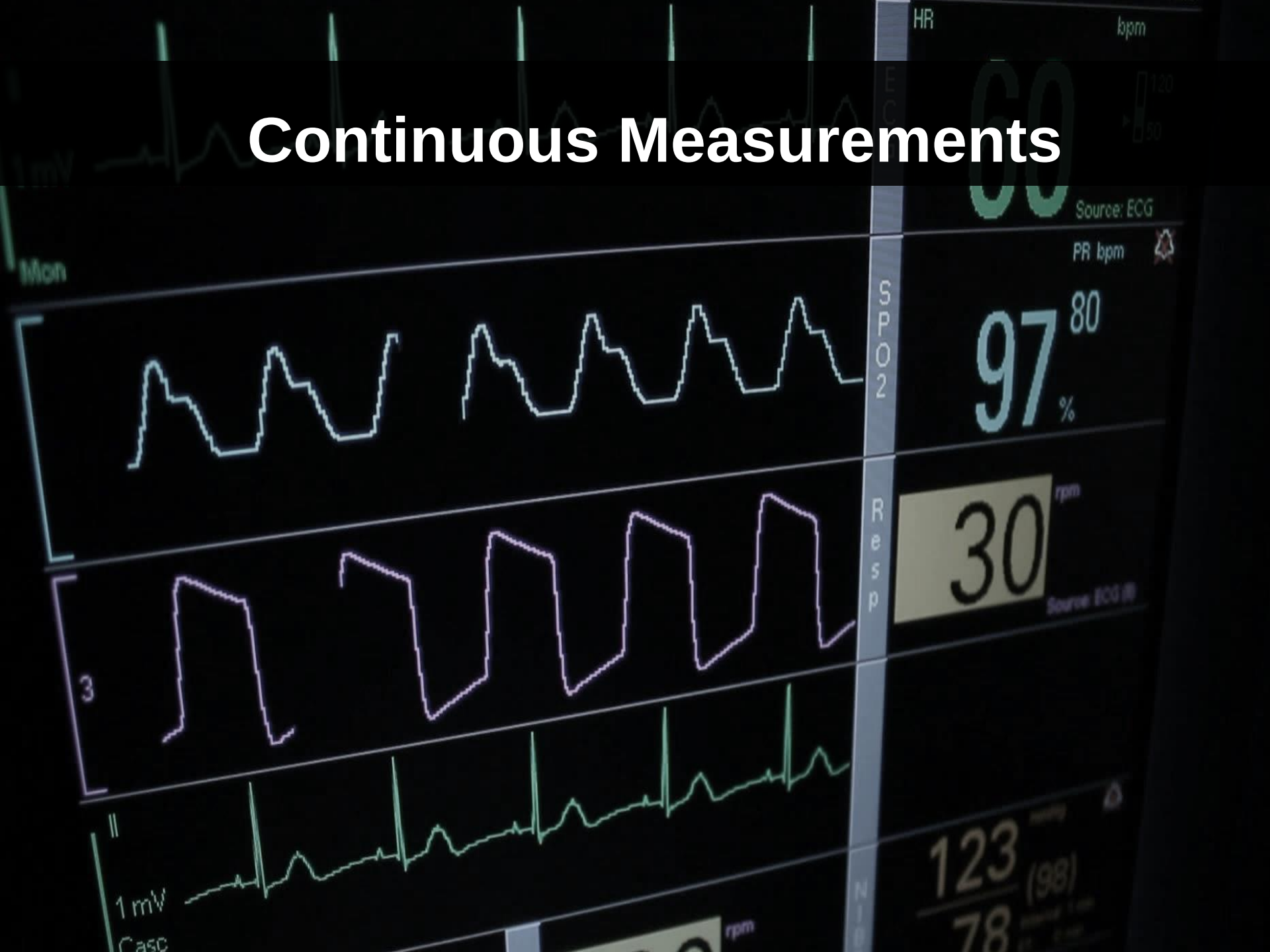
Another Paradigm Shift in Health Care



Mobile Phones as Health Monitors

Opportunities with Mobile Health

- Chronic disease management
- New screening tools
- Population health
- New discoveries in diagnostics
- Improvement in treatment
- Evolving the patient-provider relationship



Continuous Measurements

PROGRESS
412 REMAINING OF 1200
592
Net
-220
Burned
812
Consumed
FOOD DIARY
TRANING SCHEDULE
MICRONUTRIENTS CHART
42%
31%
27%
Proteins: 53.97
Carbs: 32.18
Fats: 95.34

The Modern Smartphone

Headphone jack

Camera/Flash

Wireless Antenna/Signal
GSM/LTE/WIFI/BT

Capacitive touch

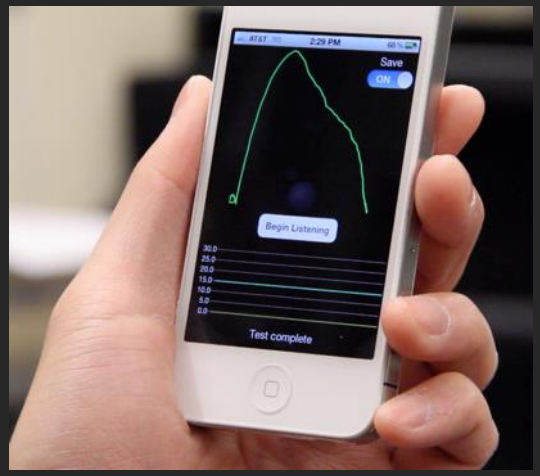
Speakers

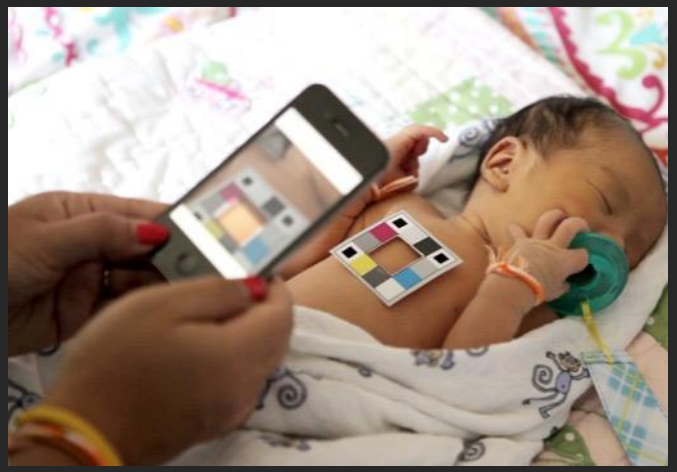
Accelerometer/Gyro

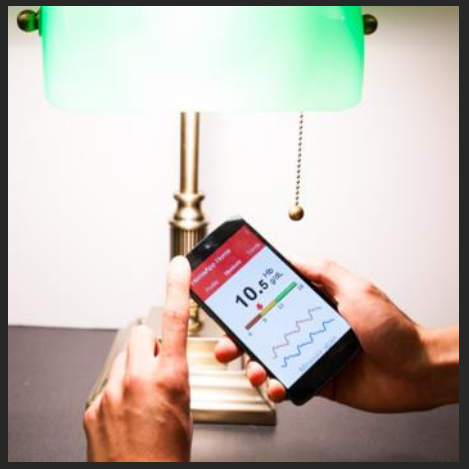
Microphone

Mobile Health Sensing

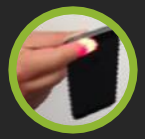
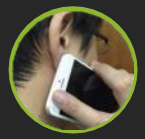
- Using existing sensors on mobile phones for health sensing







Using Mobile Phones for Diagnostics

Pulmonary	Blood screening	Cardiovascular	Disease Specific
Spirometry	Hemoglobin	 $SP0_2$	Sleep apnea
Cough analysis	Bilirubin	 Blood pressure	Osteoperosis

Measuring Lung Function

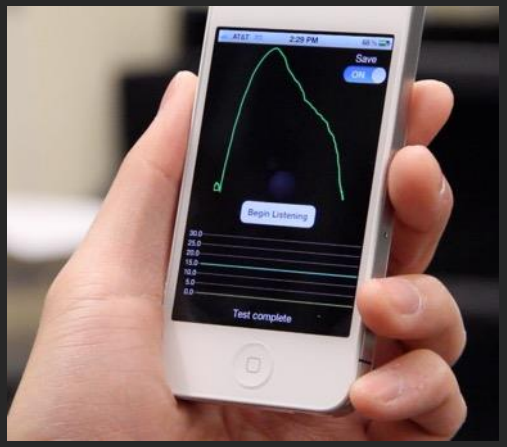
- Spirometry
  - Mainstay of monitoring respiratory conditions (Asthma, COPD, CF)

Clinical Spirometers

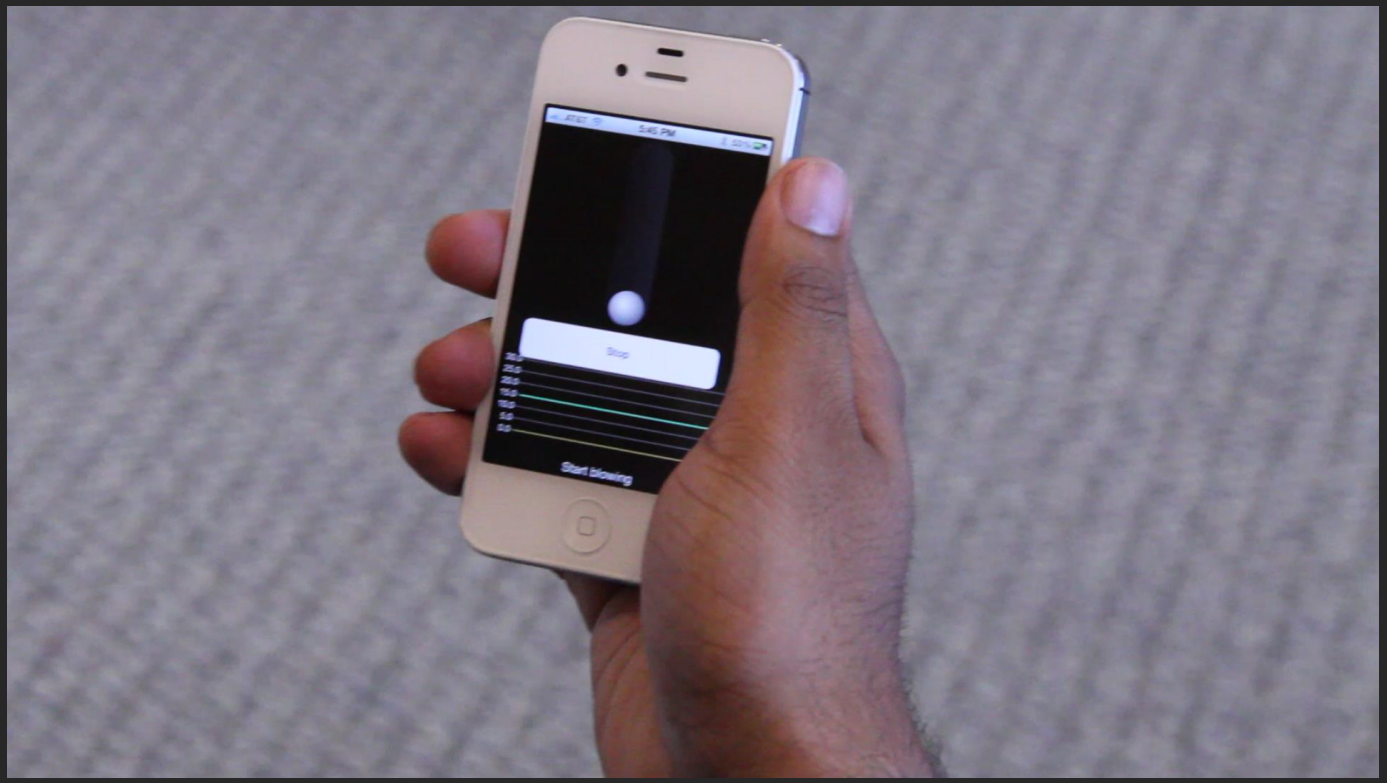
Home Spirometer

SpiroSmart: Mobile Phone Spirometer

- No additional hardware needed
  - All done with software

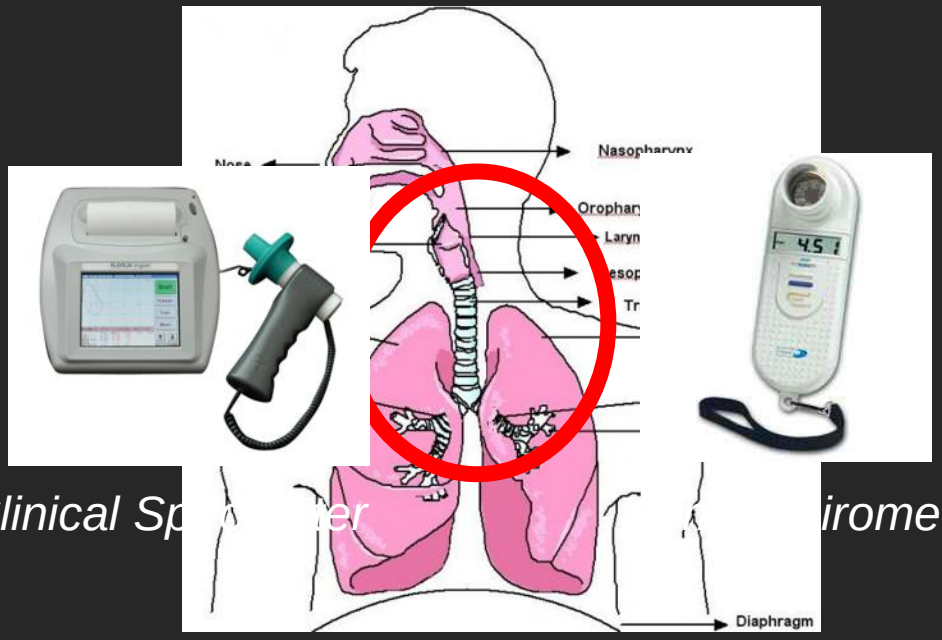


SpiroSmart: Mobile Phone Spirometer



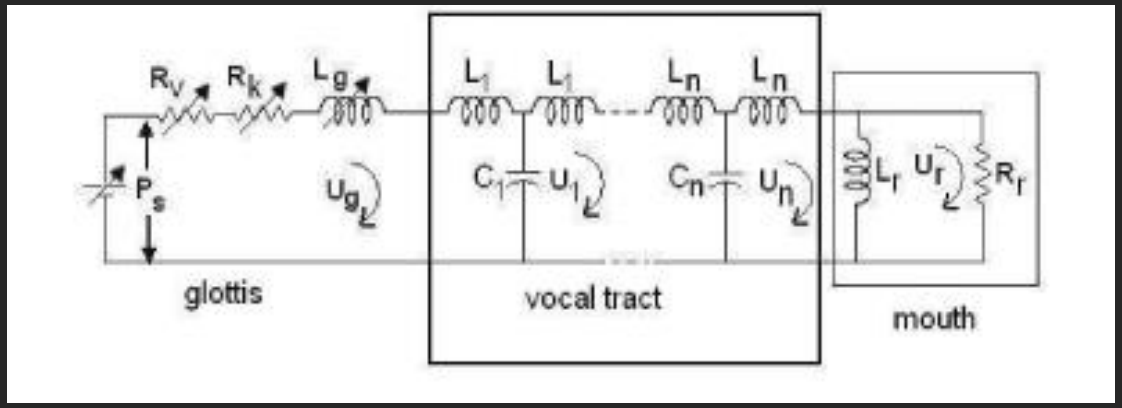
How it Works

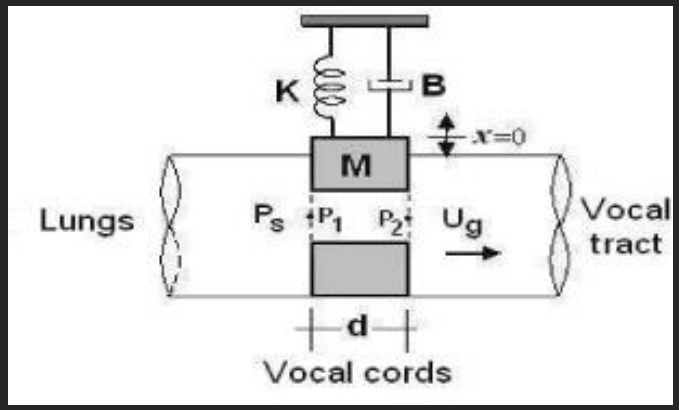
- Traditional spirometers use a flow sensor (e.g., turbine) – we only have the microphone
- Vocal tract resonances to infer flow
  - The “noise” in speech recognition



Clinical Sp[illegible]er *[illegible]irometer*

Vocal tract model





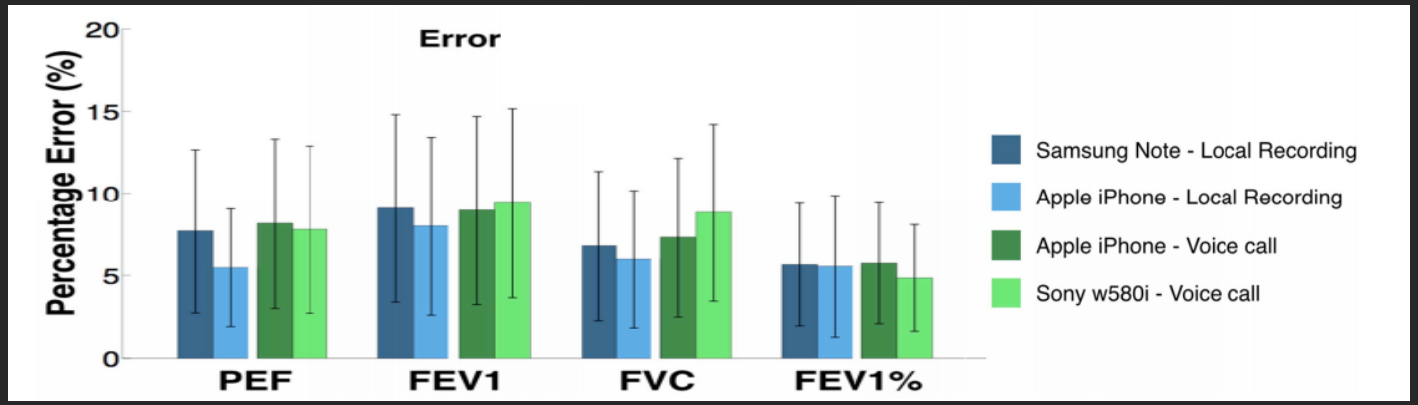
SpiroCall

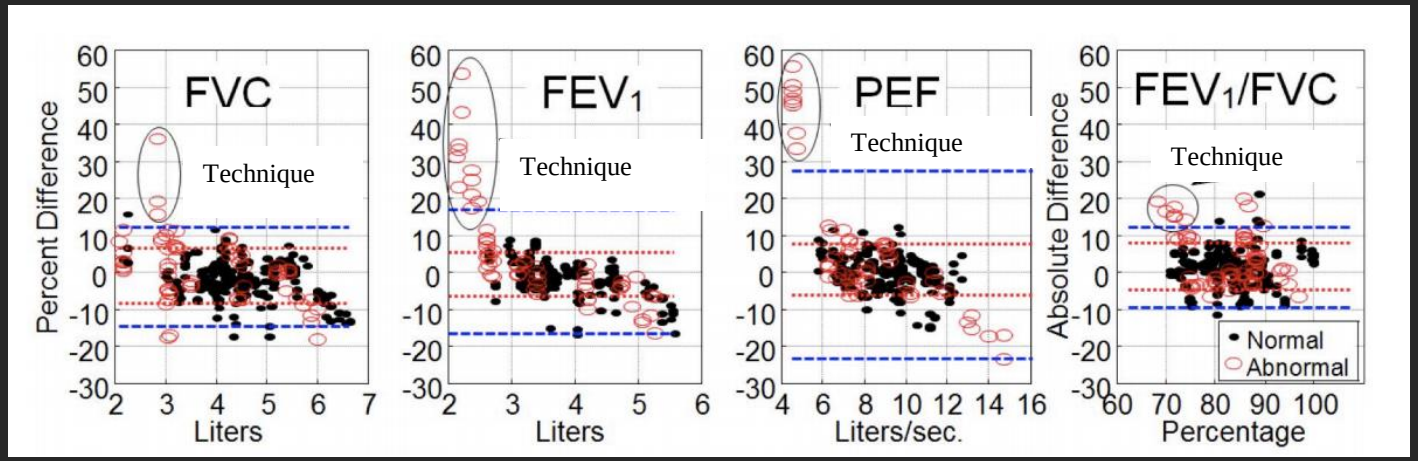
NOKIA
Your SpiroCall
results:
FEV1: 4.41 L
FVC: 5.35 L
FEV1%: 82%
PEF: 11.42 L/s
Options
Back

Detecting and Studying Cough

- Cough is a common symptom, but not quantifiable
- Might be useful for studying the spread of disease
- Cough may tell us a lot about a disease
- Human ears may miss subtle characteristics

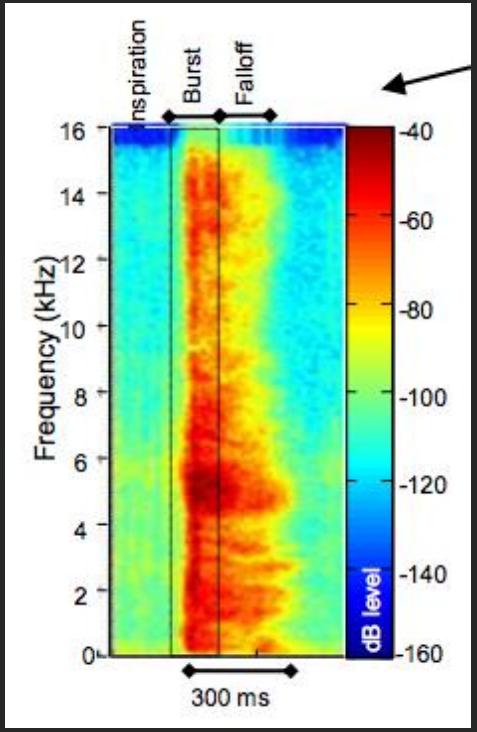
SpiroSmart and SpiroCall Clinical Trials





Sound Analysis from Microphones

- Frequency based analysis with associated glottis model



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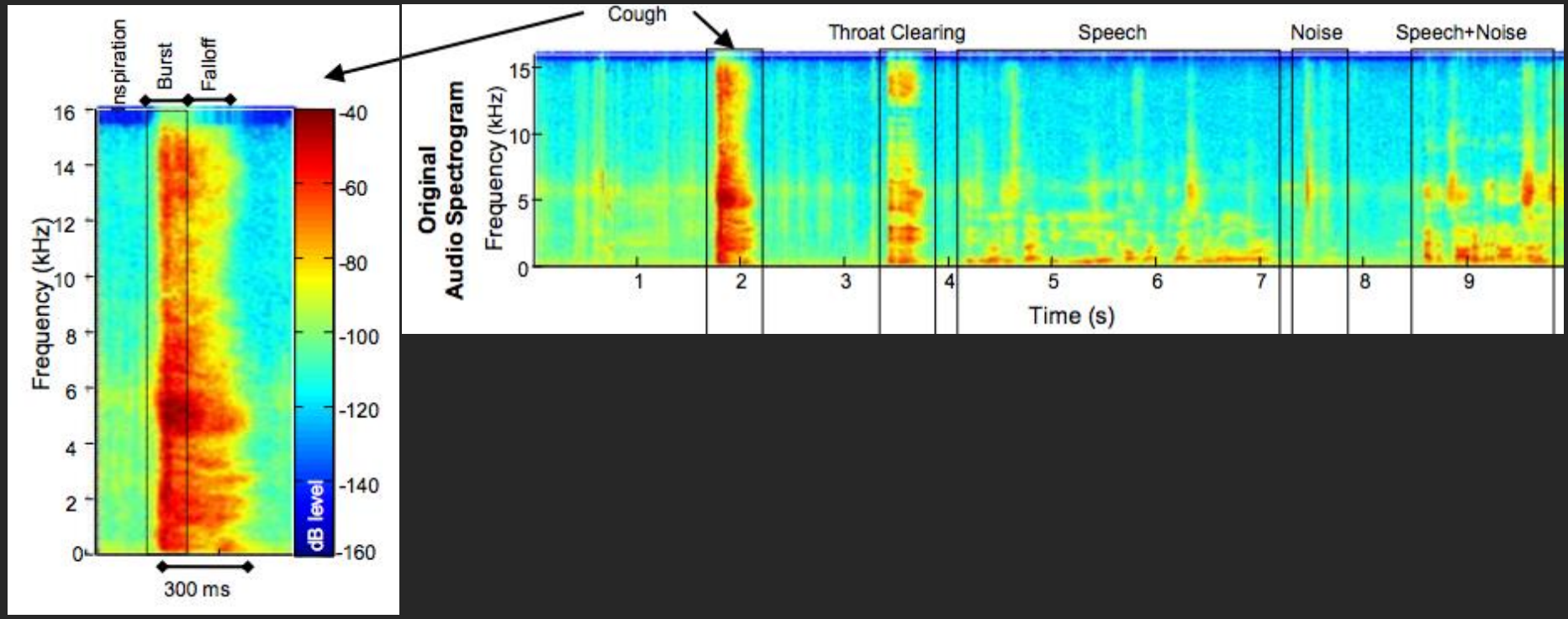
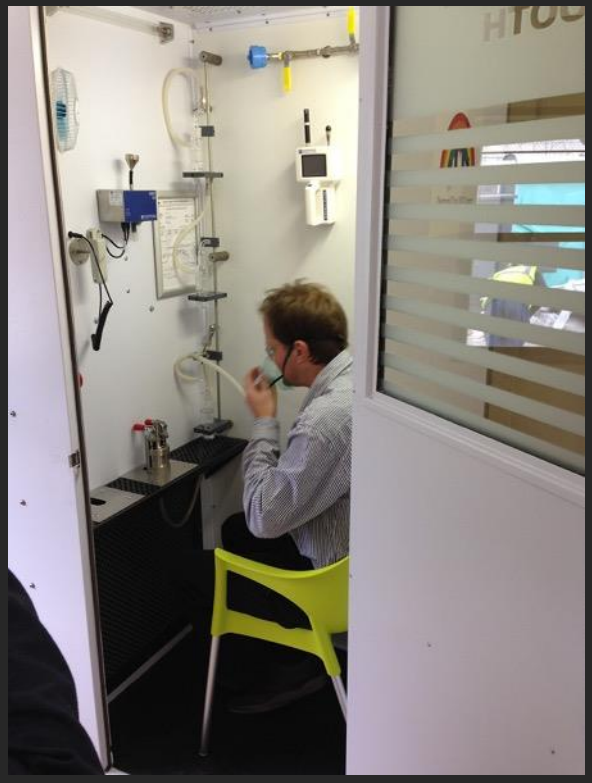


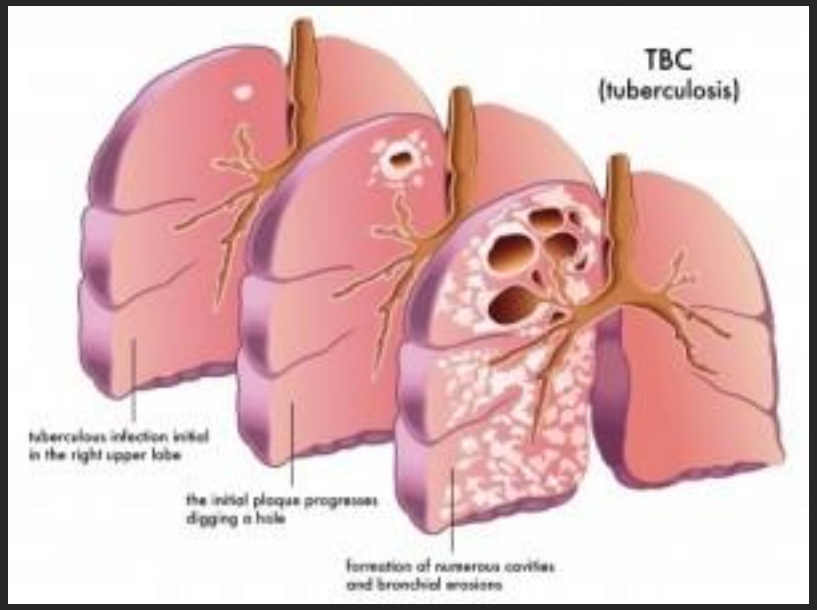
Studying Tuberculosis

- Highly infectious lung disease
- The spread of TB spreads is still being studied
- Coughing is a major symptom

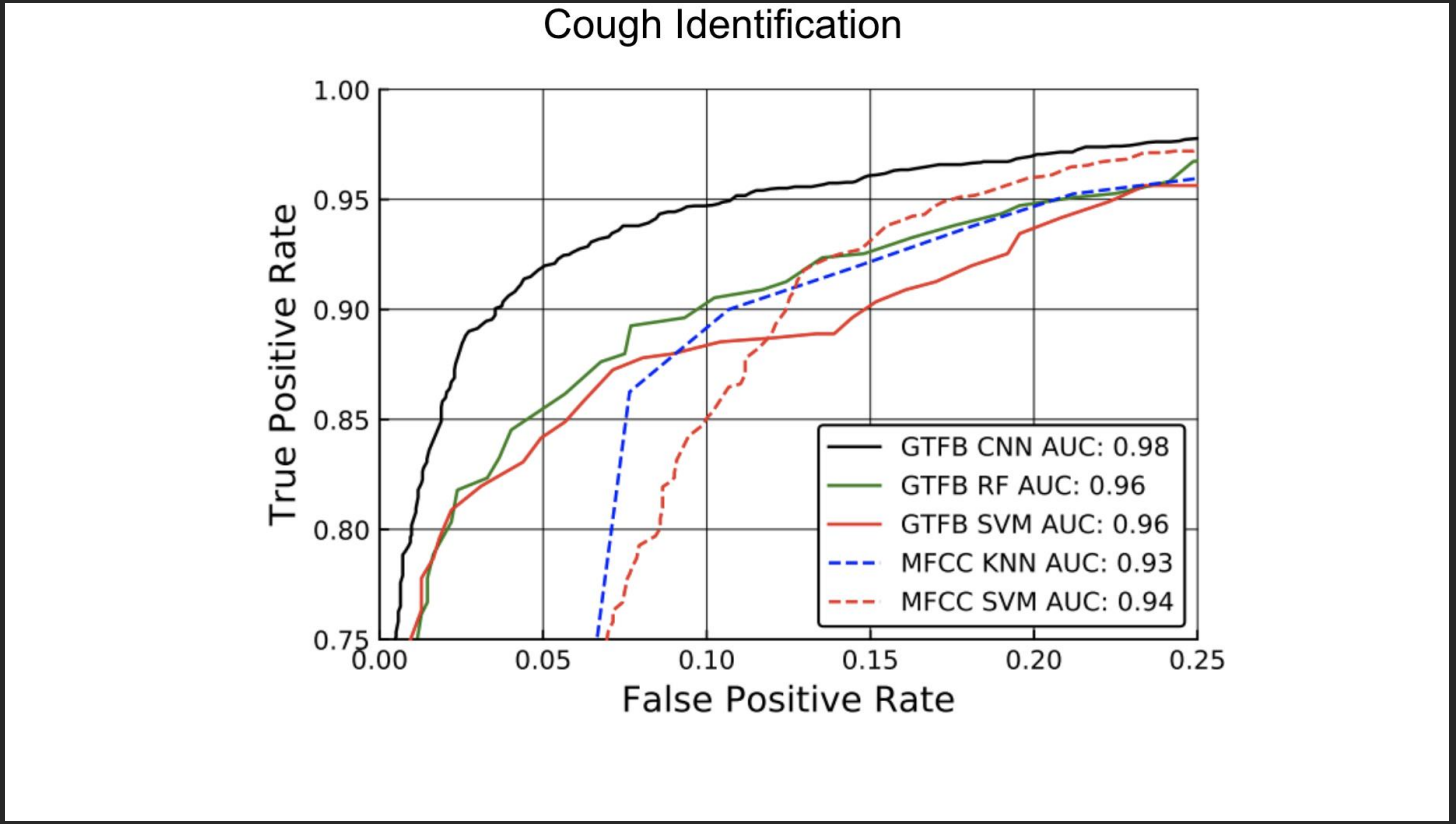
BILL & MELINDA GATES *foundation*

TB Study in South Africa





Cough Identification & Classification



BiliCam

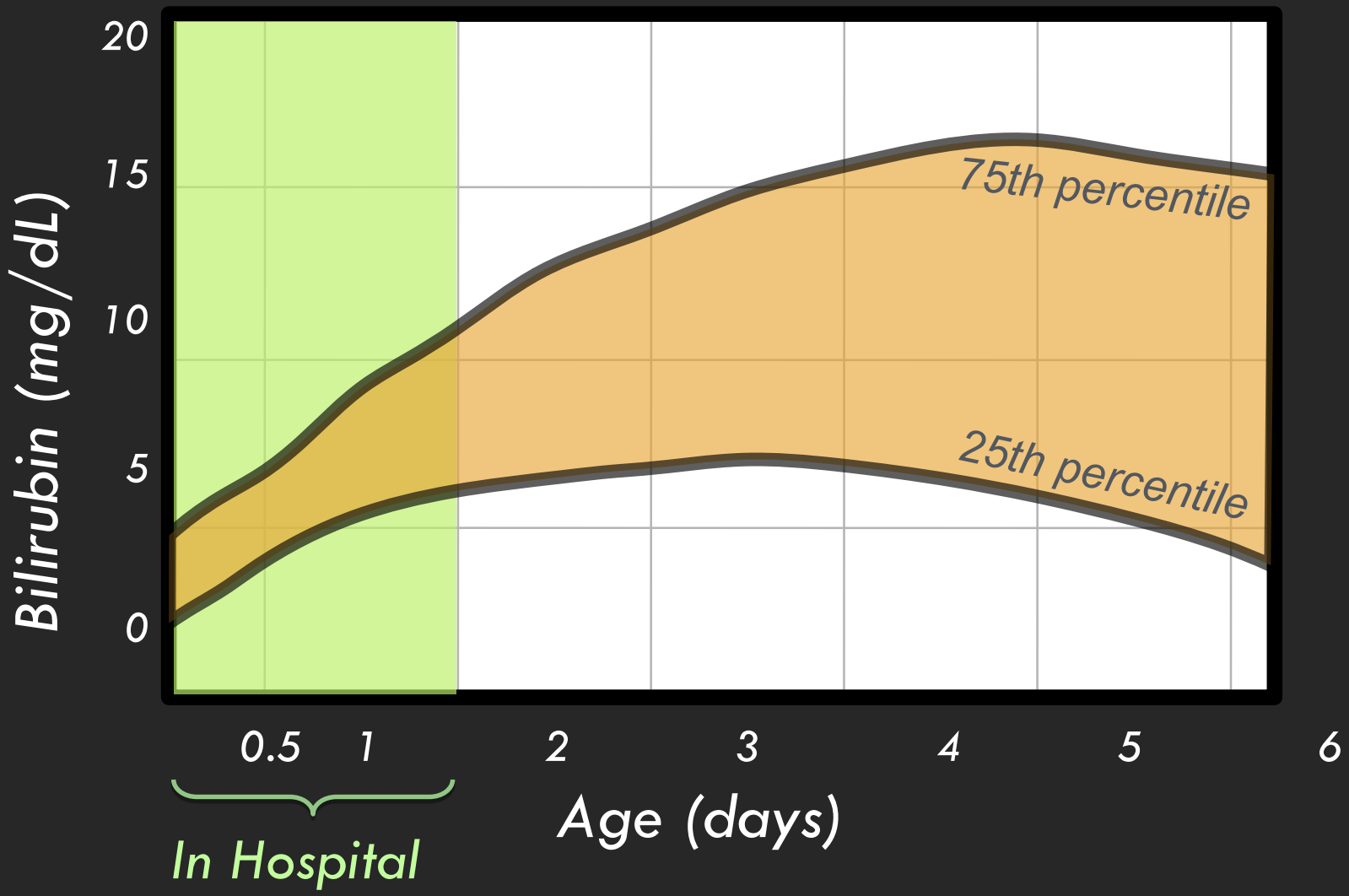
- Using mobile phones to monitor newborn jaundice

Current Technology

- Total serum bilirubin (TSB)

- Transcutaneous Bilirubinometer

Bilirubin Levels



Screening Challenges

In Hospital

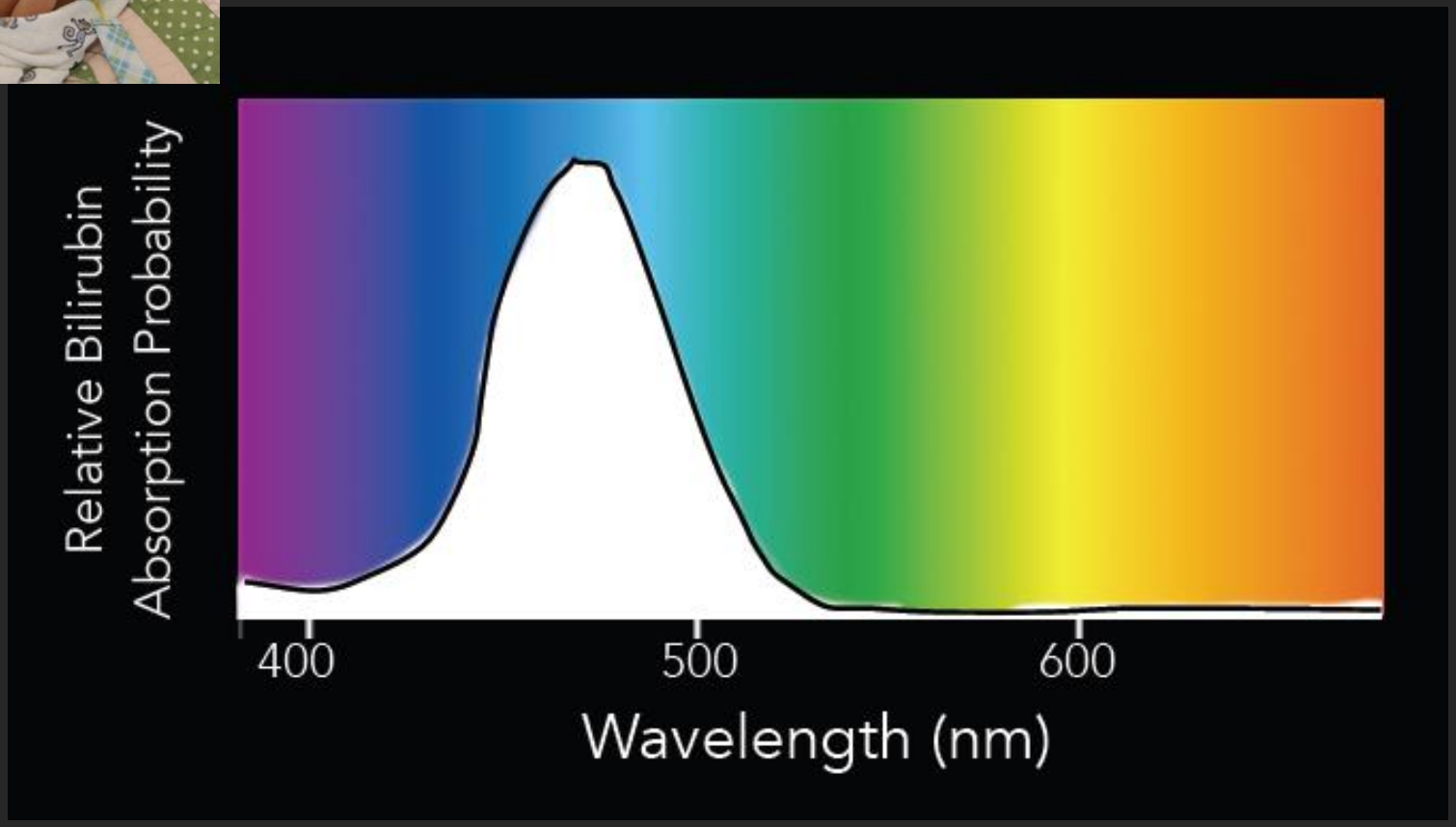
At Home

Visual Assessment

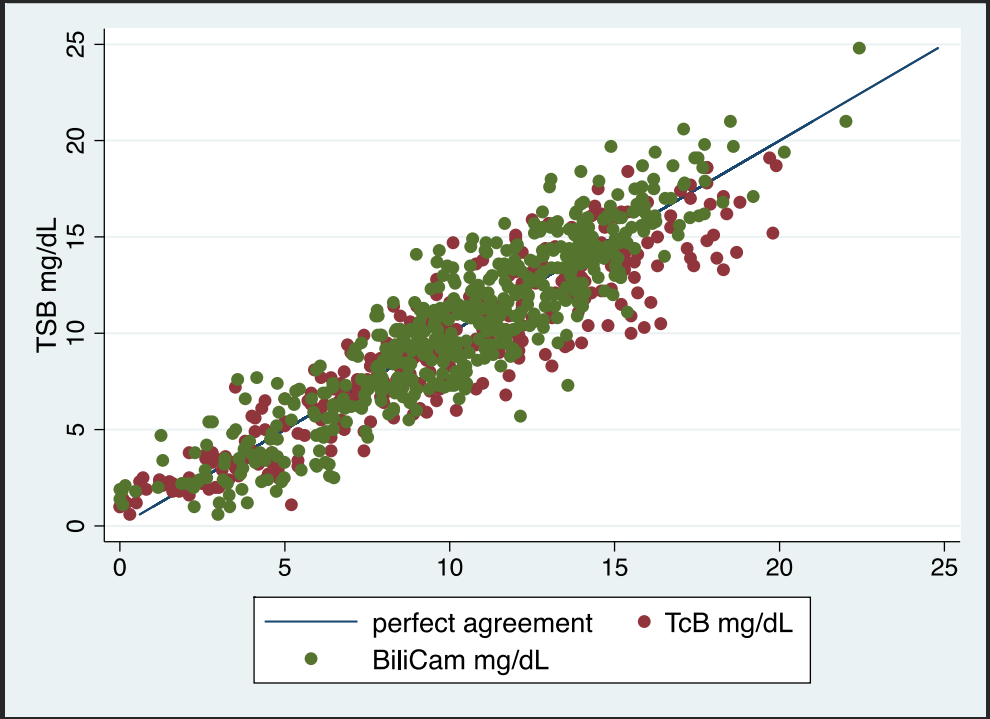
- *Parents*
- *Many physicians*
- *Traveling practitioners*

Tend to underestimate

Absorption Properties of Bilirubin



Trial of 530 Newborns

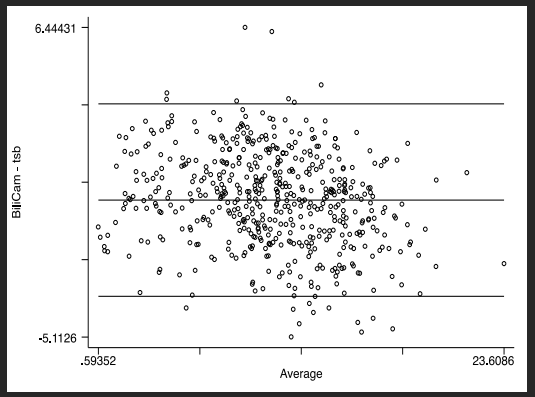


BiliCam

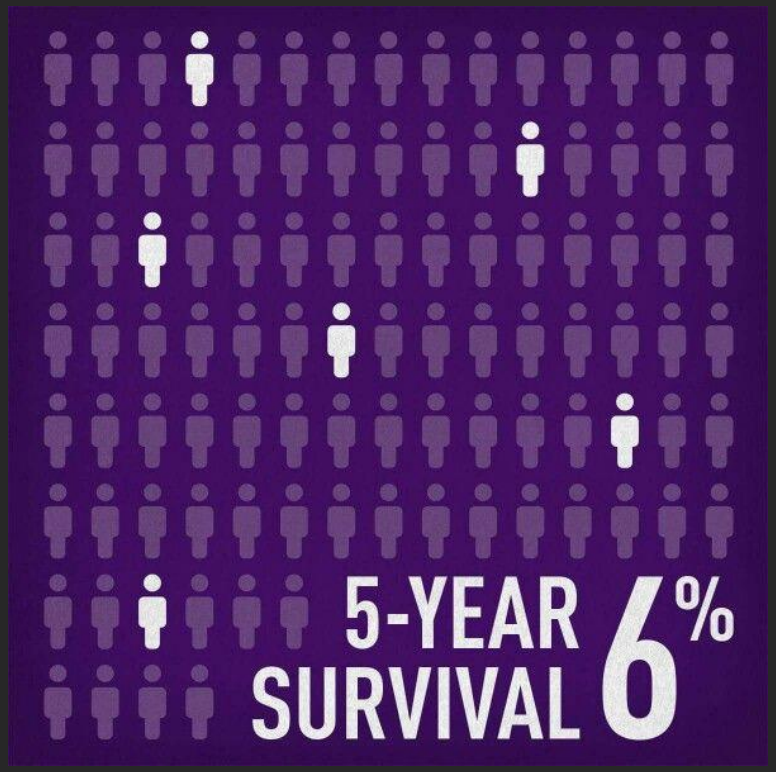
0.91 *correlation*

TcB

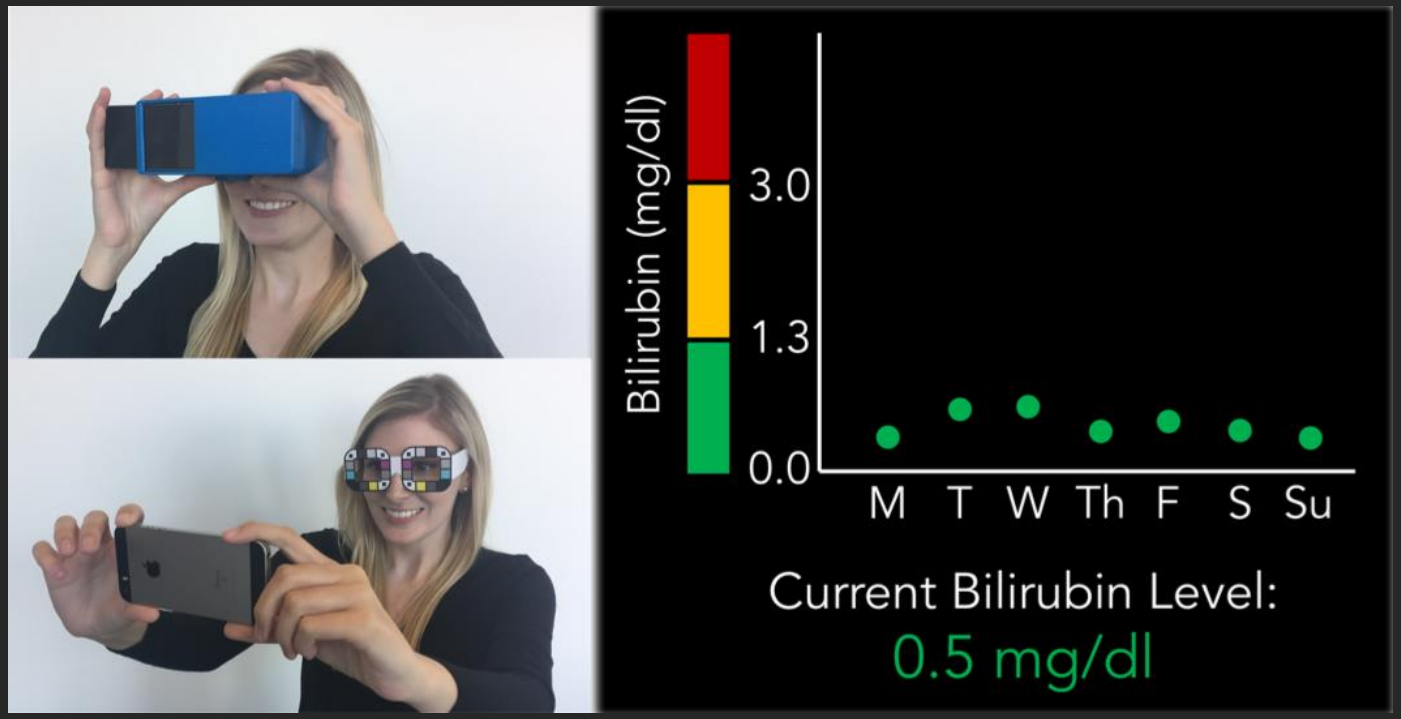
0.92 *correlation*

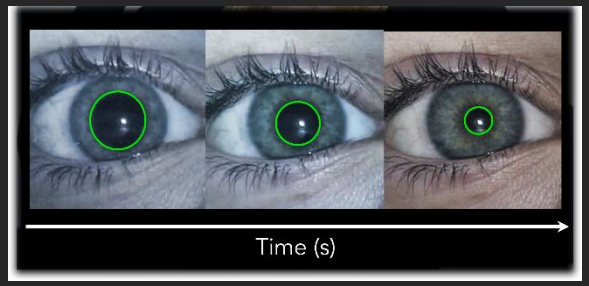


Bilirubin in Adults: Pancreatic Cancer

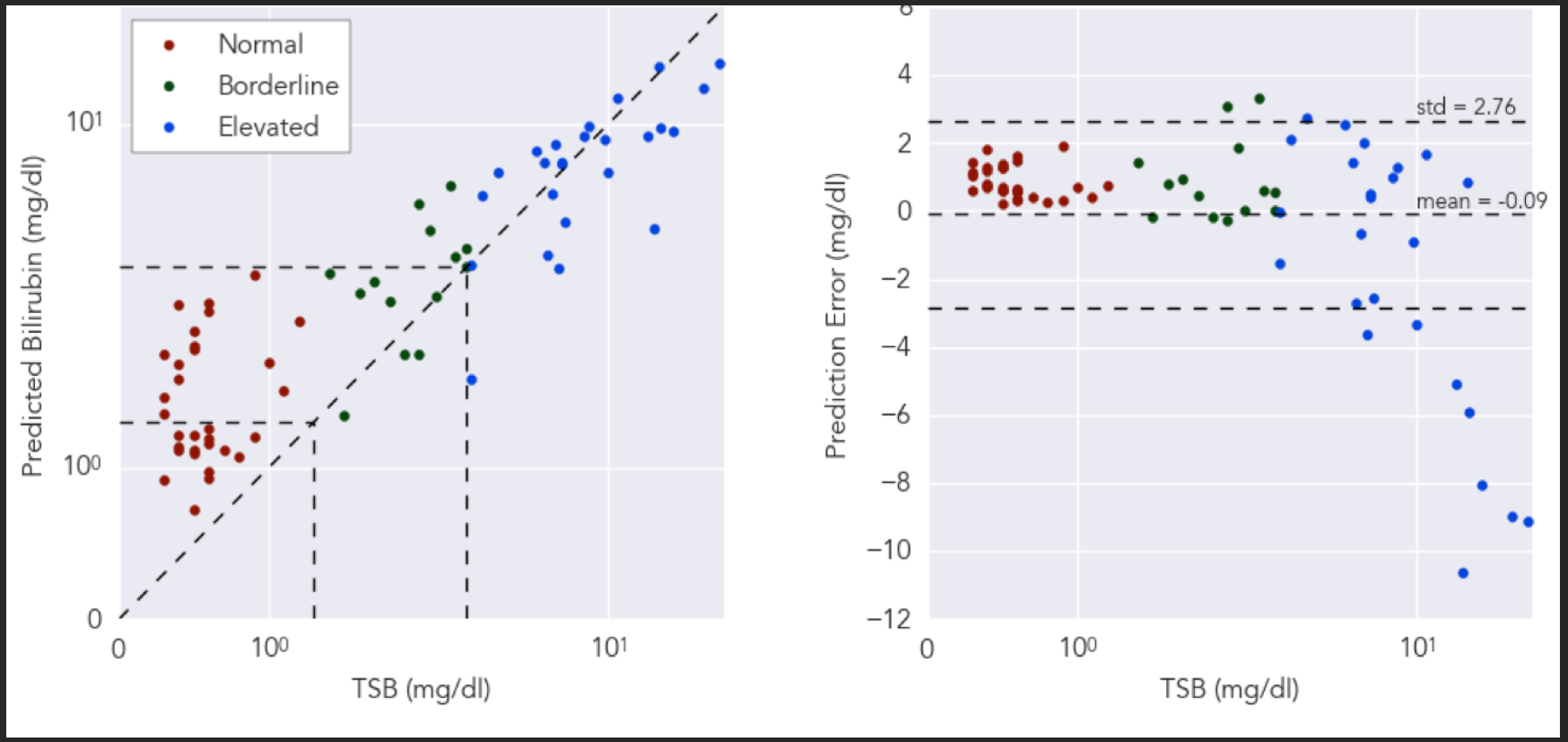


Observable Jaundice in the Sclera



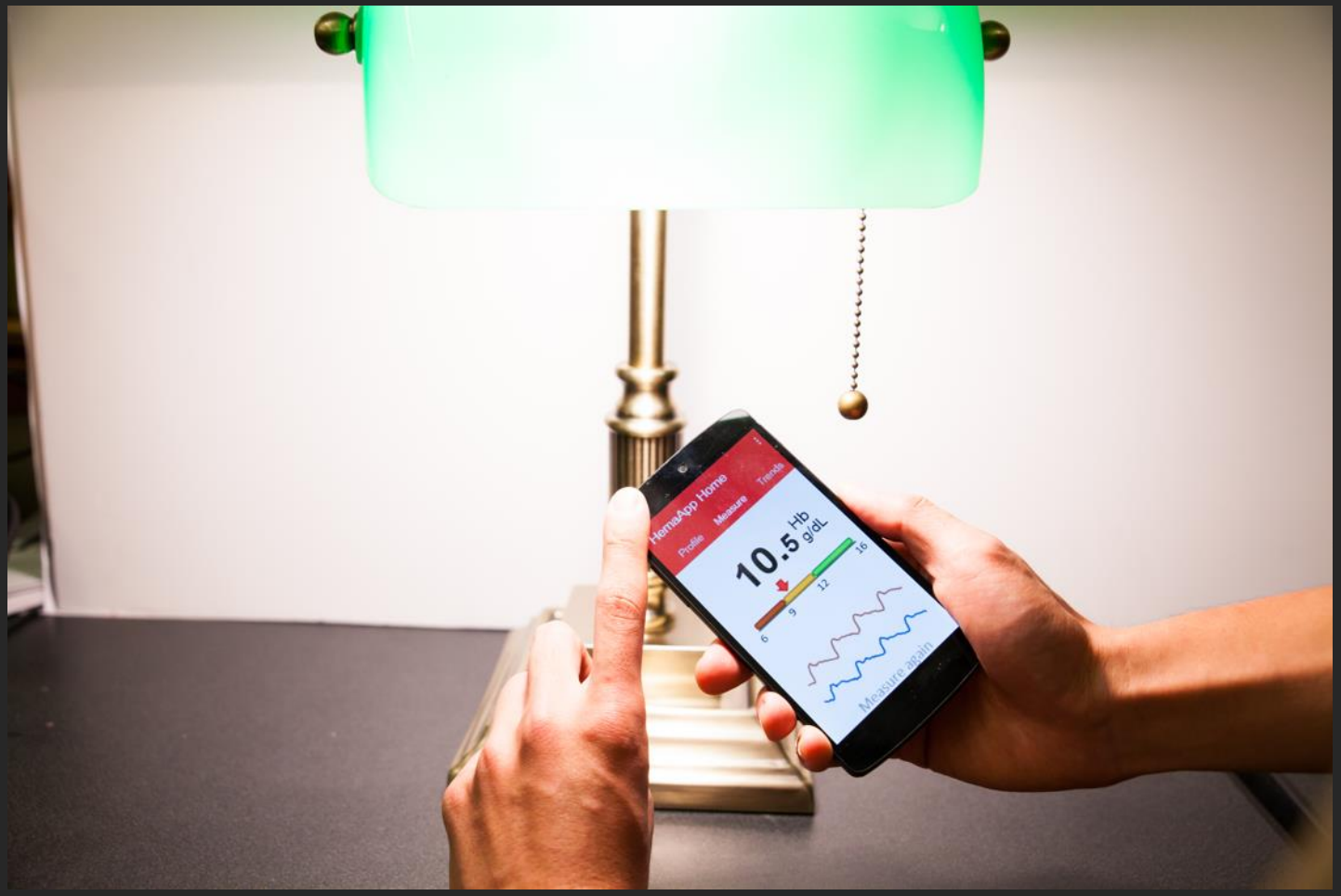


Bilirubin from the sclera

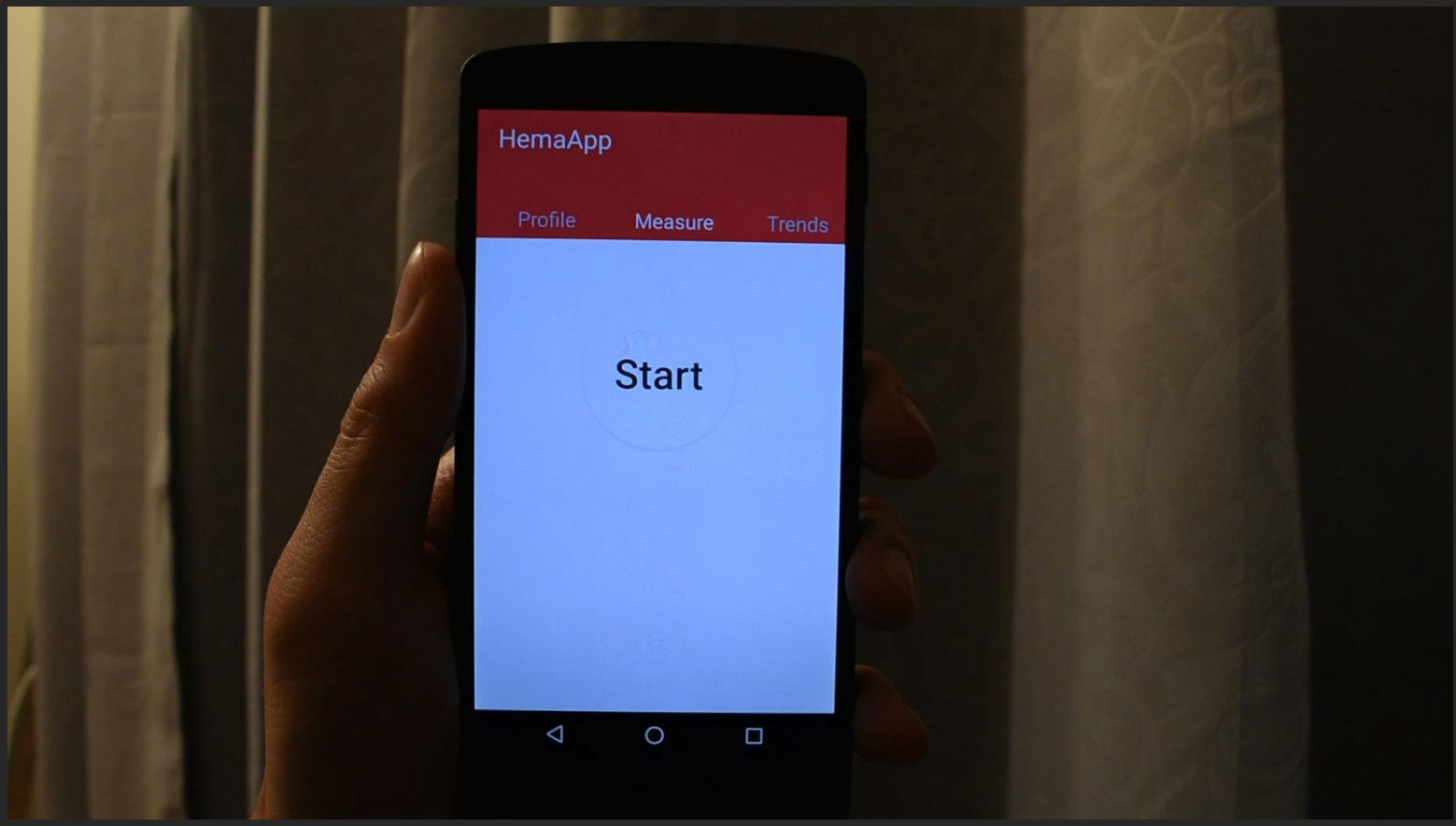


$R^2 = 0.89$

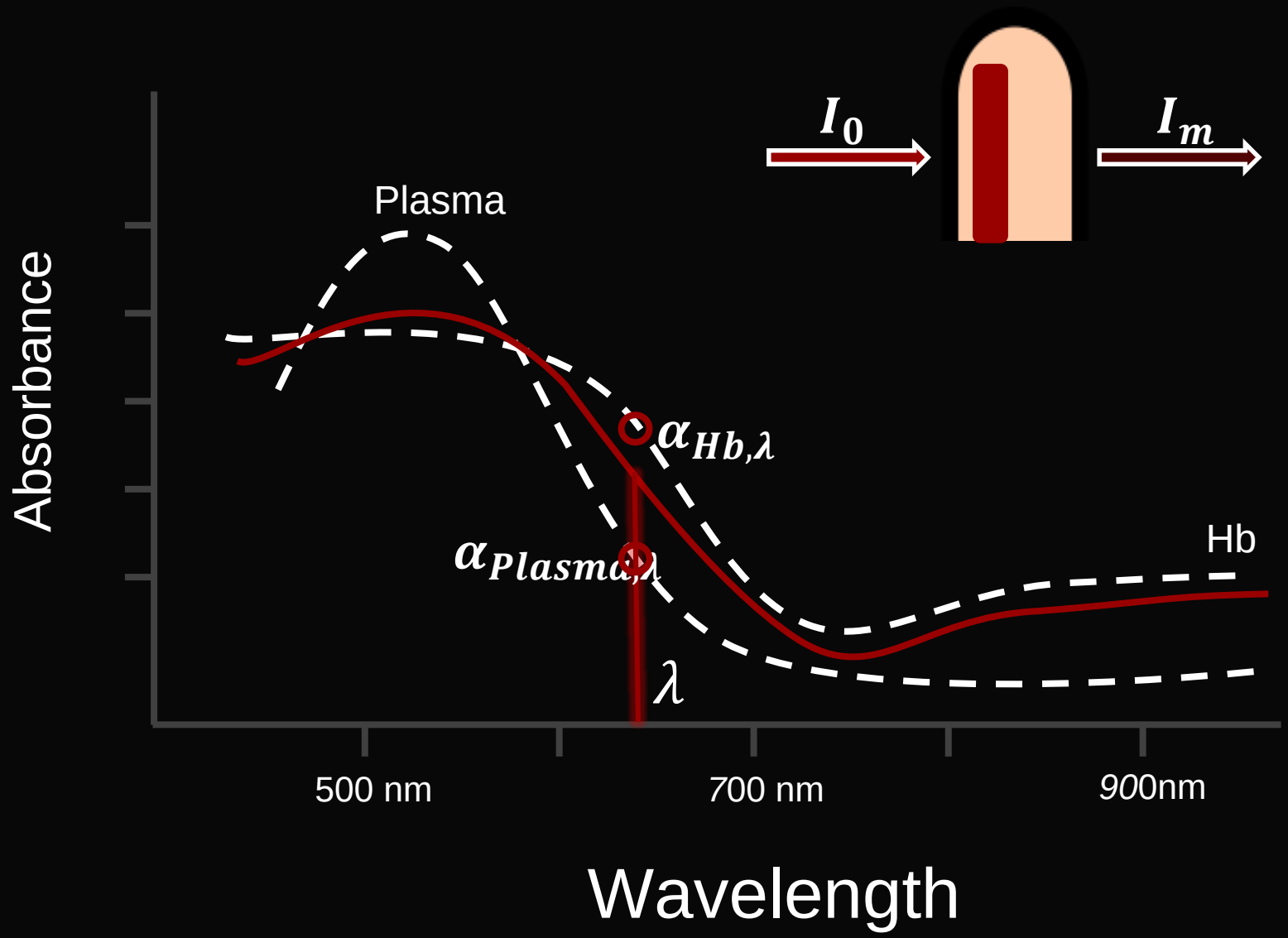
Mobile Phone Hemoglobin



Mobile Phone Hemoglobin



Hemachrome Analysis



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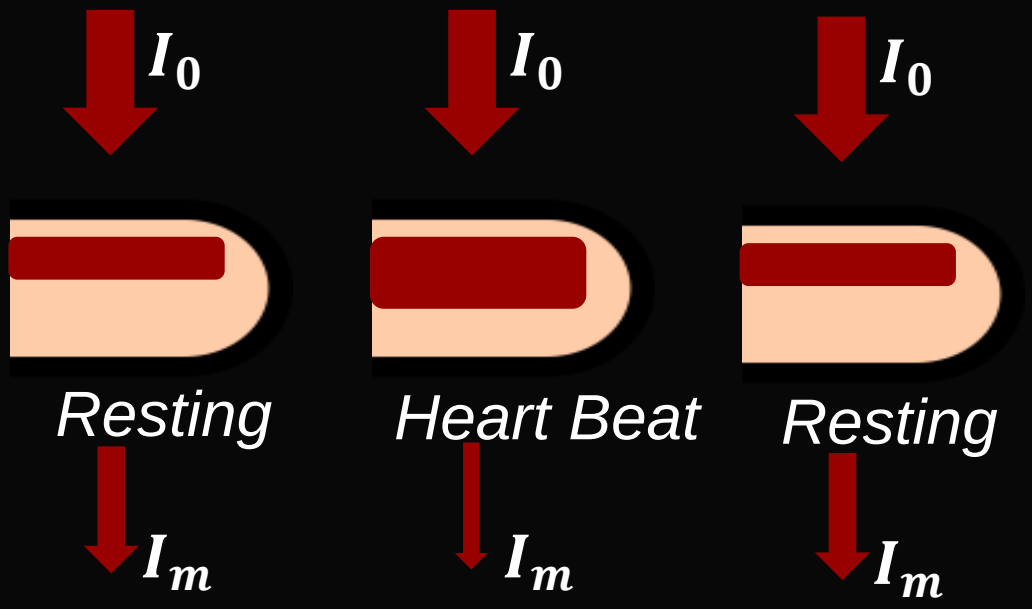
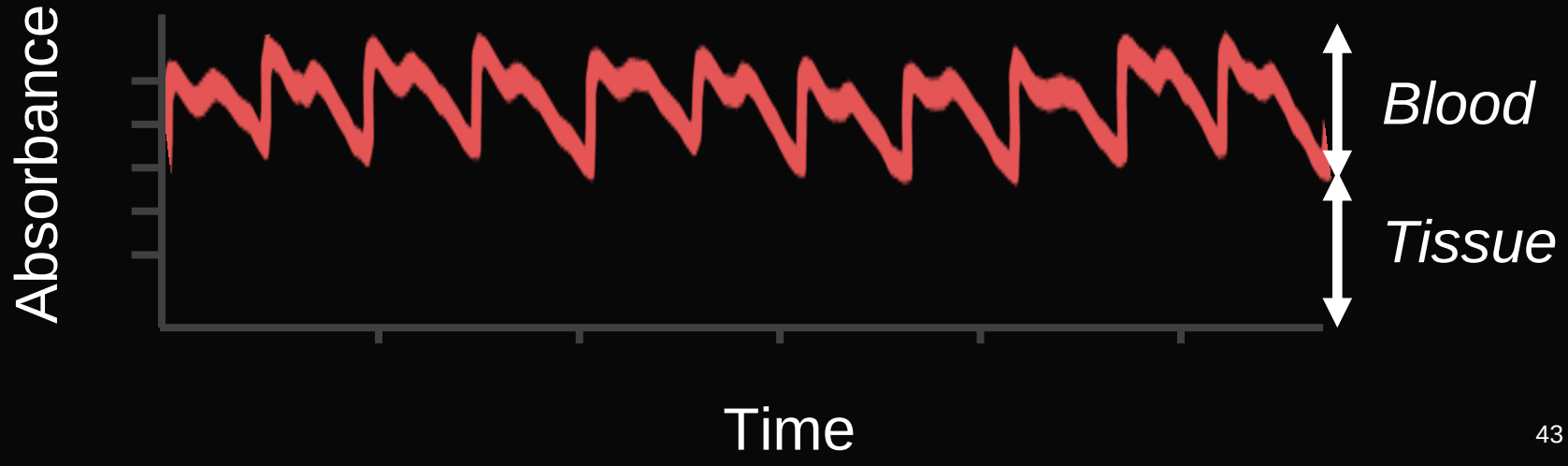
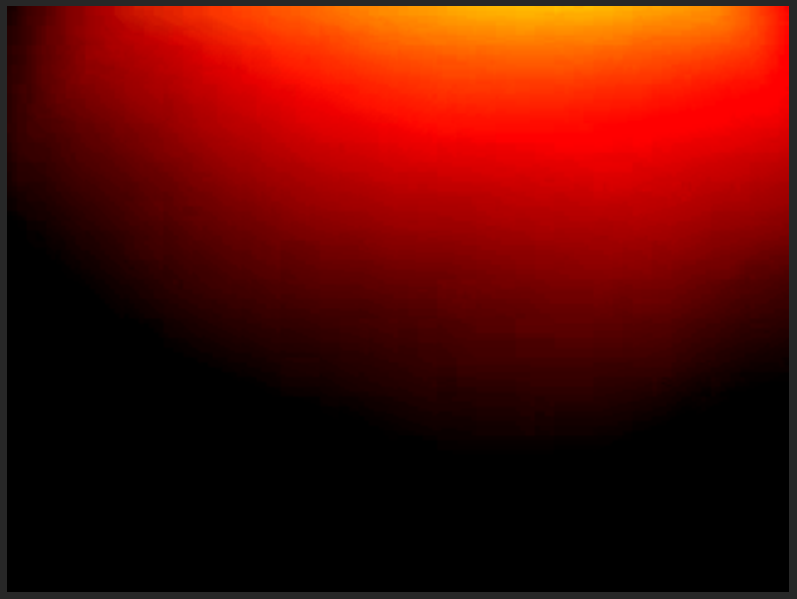
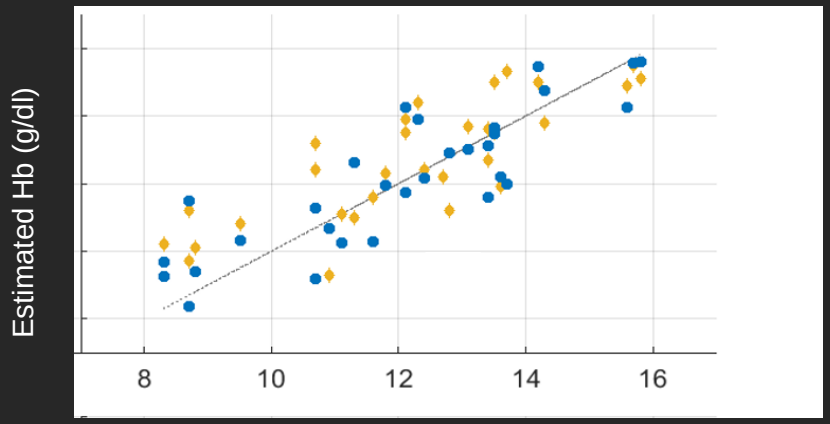




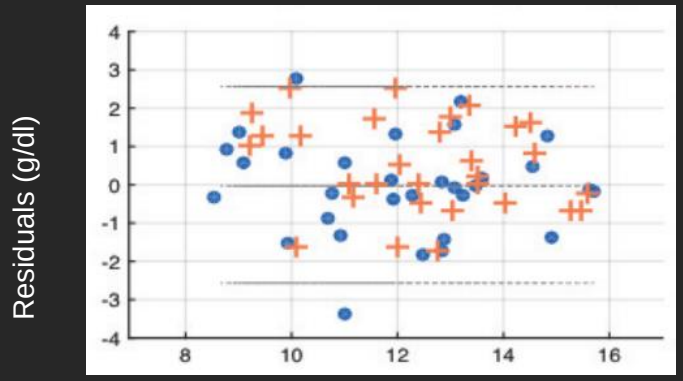
Isolate Blood Absorption



Trial of 81 Patients



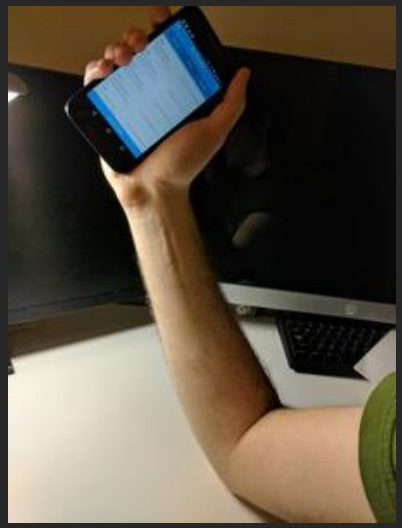
- *HbApp*
  0.81 *correlation*
- *Pronto*
  0.82 *correlation*

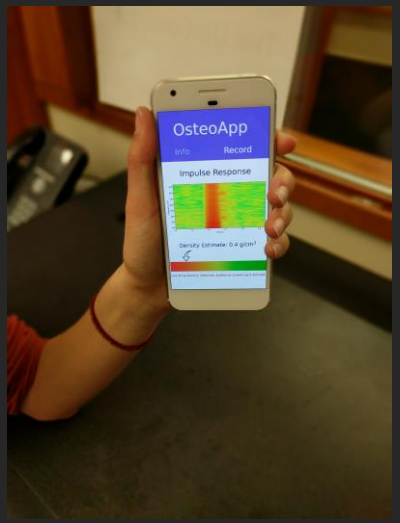


Peru Deployment

OsteoApp

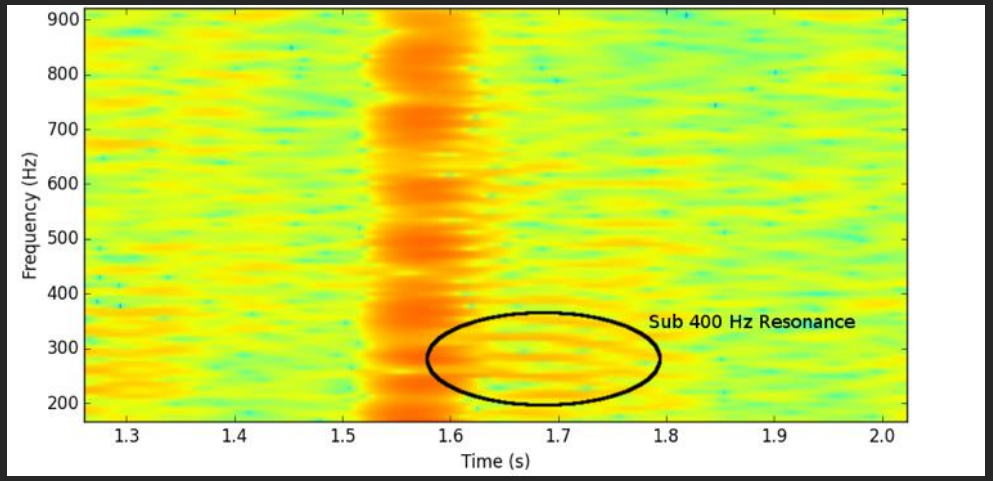
- Inferring bone density with resonance tracking for osteoporosis



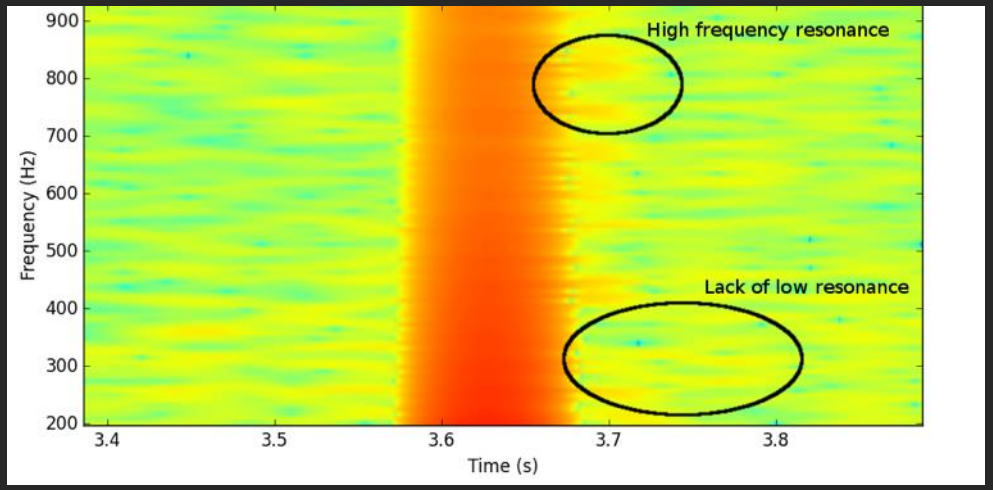


OsteoApp

Healthy bone


900
800
700
600
500
400
300
200
Frequency (Hz)
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
Time (s)
Sub 400 Hz Resonance

Osteoporosis


900
800
700
600
500
400
300
200
Frequency (Hz)
3.4
3.5
3.6
3.7
3.8
Time (s)
High frequency resonance
Lack of low resonance

Considerations in Mobile Health

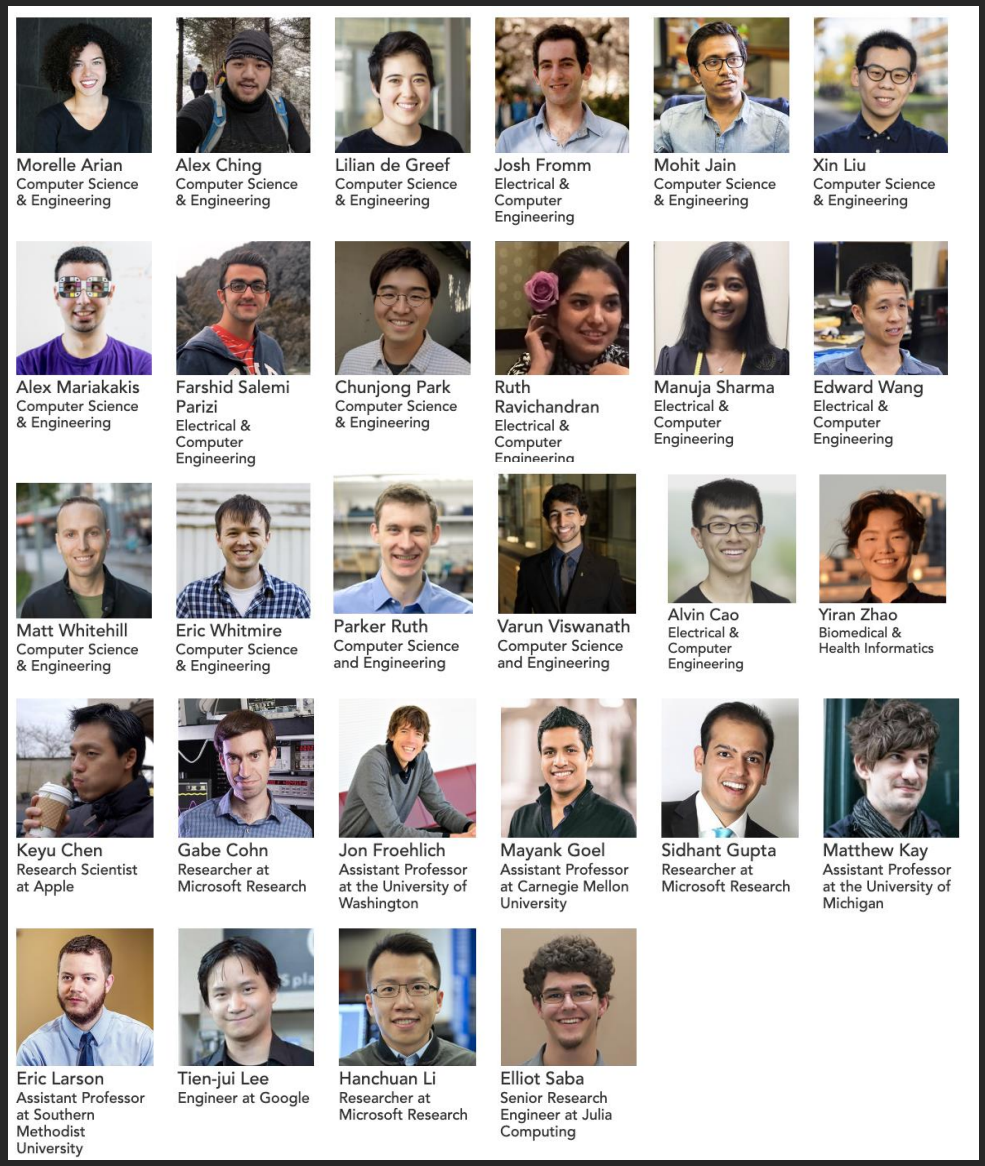
- Regulatory
- Safety and trust
- Patient - provider interaction
- New applications of computing advances

- Still need to take into accounts other factors such as social determinants

Conclusions

- Opportunities for discovering new biomarkers for health
- Mobile phones as a healthcare delivery platform
- Opportunities for better prediction and individualized care with continuous monitoring

Thanks!


Morelle Arian
Computer Science & Engineering
Alex Ching
Computer Science & Engineering
Lilian de Greef
Computer Science & Engineering
Josh Fromm
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