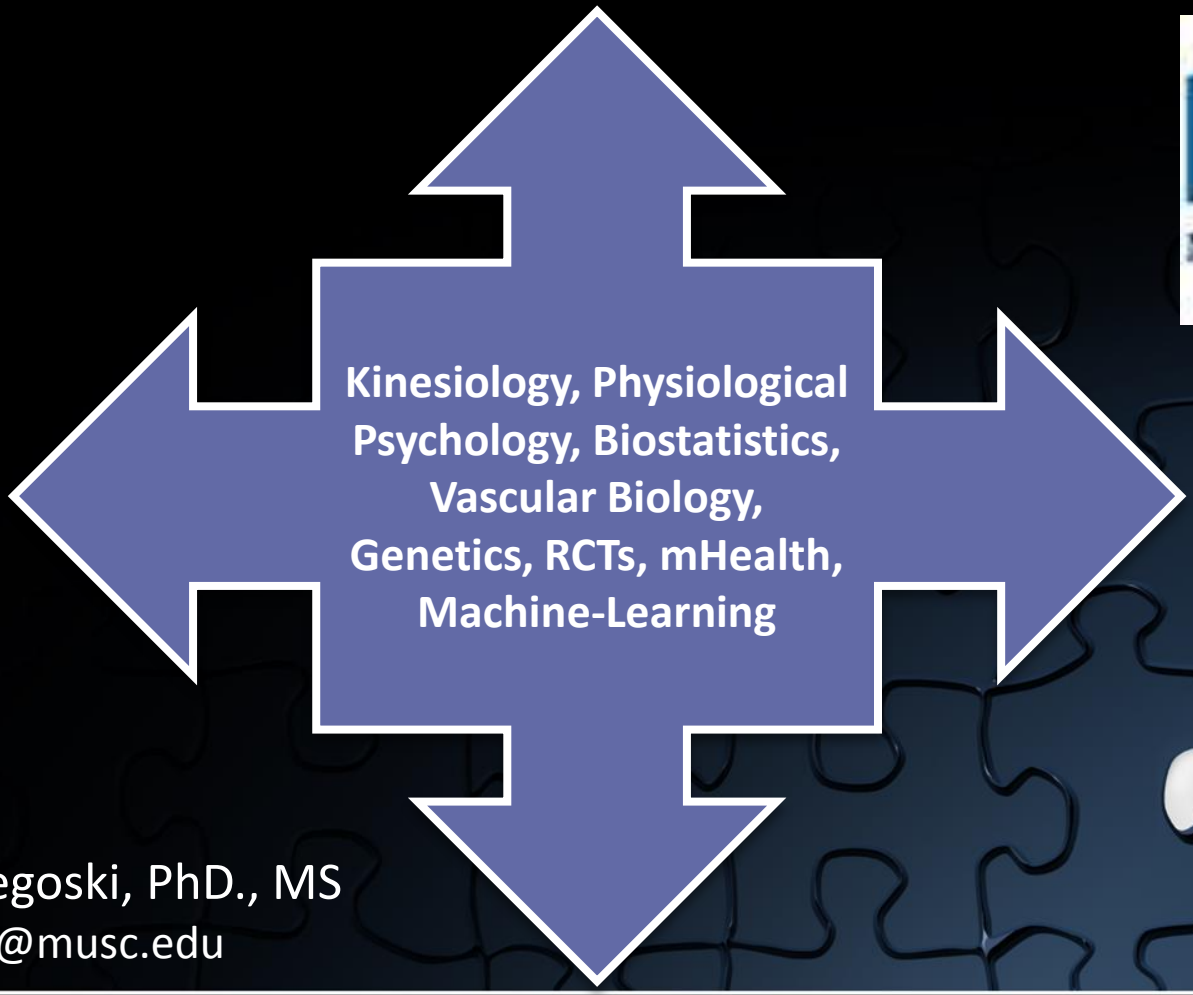
Strategies for Integrating Wearable Technologies into Behavior Change Interventions

Mathew J Gregoski, PhD.MS., Matthew Buman, PhD, Eric Hekler, PhD., Aaron Coleman and Praduman Jain

My research focuses on targeting the interconnection of biological, psychosocial, genetic, and environmental attributes to create (behavior) change for improving health; *sometimes it's technology infused*



MUSC
MEDICAL UNIVERSITY of SOUTH CAROLINA

Mat Gregoski, PhD., MS
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Academic Center Developed

- BEAT (Kelechi) wound care patients that are minimally able to move.

Consumer off the shelf

- Fitbit for GOAL (Ford, Peterson, Turner, Magwood)

Industry Partner

- STEPS for Healthy Empowered Active Lifestyles (Gregoski, Turner)

Adherence and Wound Therapy (Kelechi)

BEAT (Bluetooth Enabled Acceleration Tracker)

- No previous studies with accelerometers & smartphones to examine physical activity adherence in chronic, minimally ambulatory underserved populations with severely deconditioned legs such as those with leg and foot ulcers.
- Utilizes Conditioning Activities for Lower-leg Function (CALF) exercises previously shown to significantly increase ankle range of motion and leg strength through internet coaching.

Challenges

- Commercial Accelerometers not designed to capture lower acceleration levels that occur during CALF exercises in this population.
- Commercial Accelerometers only provide energy expenditure output.
- System must be easy to put on and easy to use.

Teresa Kelechi
Mat Gregoski
Aleksey Shaporev
Aldimir Reukov
Frank Treiber
Alexey Vertegel

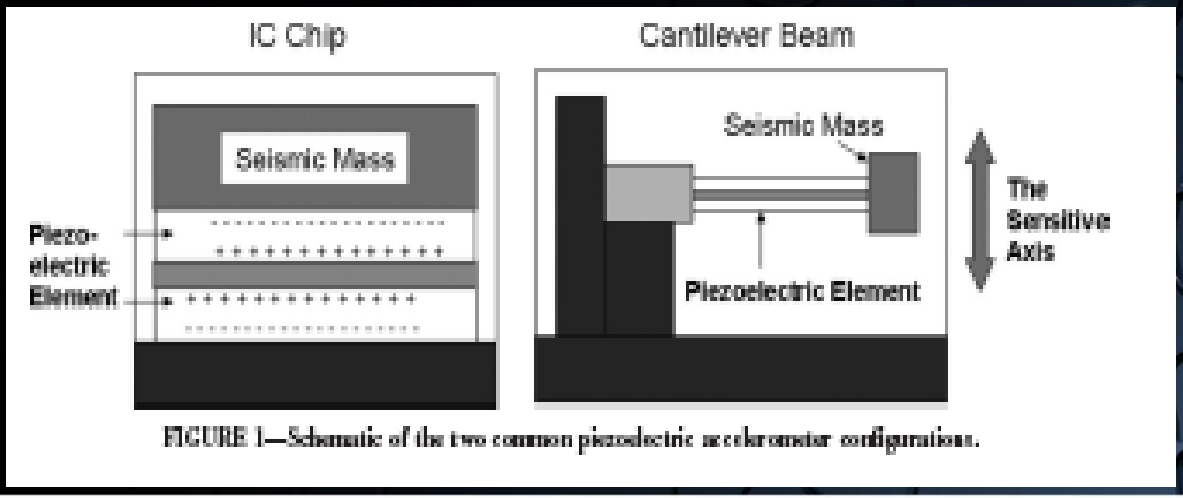


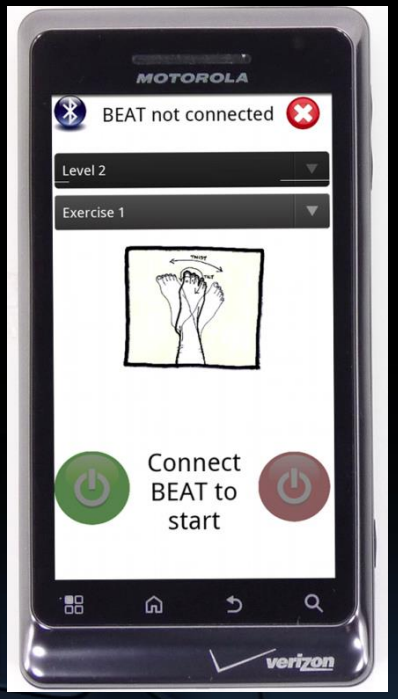
FIGURE 1—Schematic of the two common piezoelectric accelerometer configurations.

Solutions:

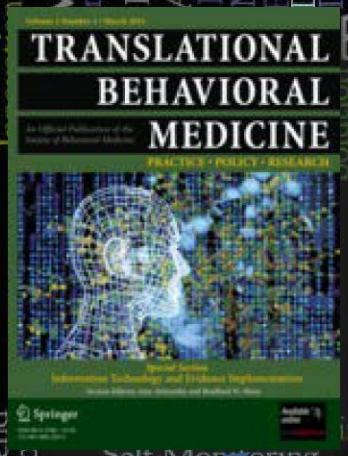
- Design our own unit.
- Use signal detection to classify CALF exercises rather than energy expenditure.

Human-Centered Approach

- Provide guided CALF program via Smartphone.
- Easy to wear slipper mounted device.



Exercise set	Exercise done by each volunteer	Exercise set-up to be recognized by BEAT	Number of one-way motions	Purpose of experiment	Total Across Participants (%)
1	Exercise 1	Exercise 1	50	Exercise 1 true positives	100%
2	Exercise 1	Exercise 2	50	Exercise 1 false positives	.02%
3	Exercise 2	Exercise 1	60	Exercise 2 false positives	.003%
4	Exercise 2	Exercise 2	60	Exercise 2 true positives	100%


TRANSLATIONAL
BEHAVIORAL
MEDICINE
PRACTICE • POLICY • RESEARCH

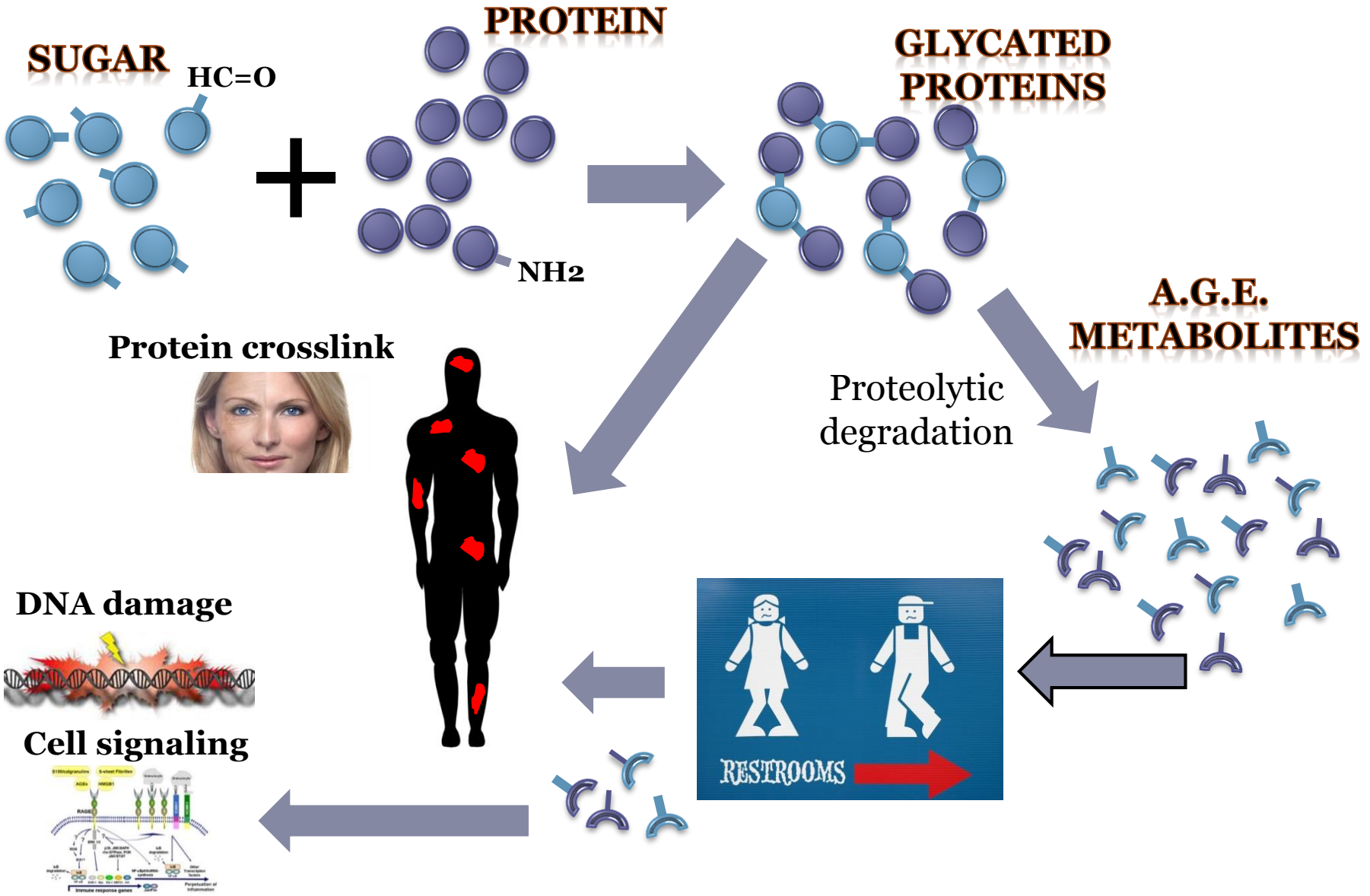

MOTOROLA
BEAT connected
Level 1
Exercise 3
Exercise 3 Level 1 - 10 counts recorded
Exercise finished
verizon


BEAT Adherence Summary 4/16/2012 -4/23/2012
Participant XXXX Level 1

Feasibility Study GOAL Intervention on Reducing Levels of Advanced Glycation End Products in Overweight Breast Cancer Survivors

Marvella E. Ford, David P. Turner, Gayenell Magwood, Lindsay Peterson

Advanced Glycation End Products (AGEs)



Lifestyle AGE's





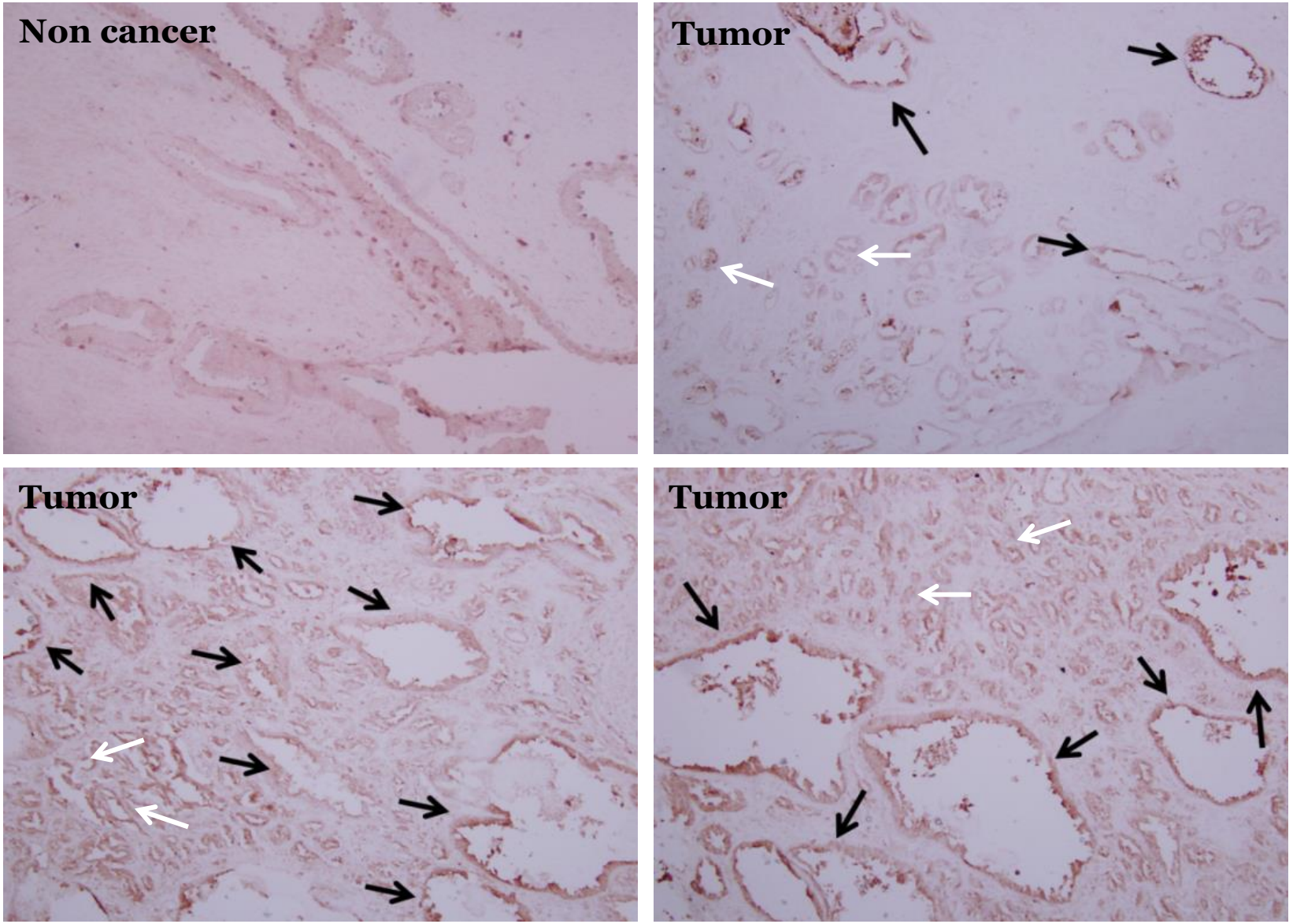


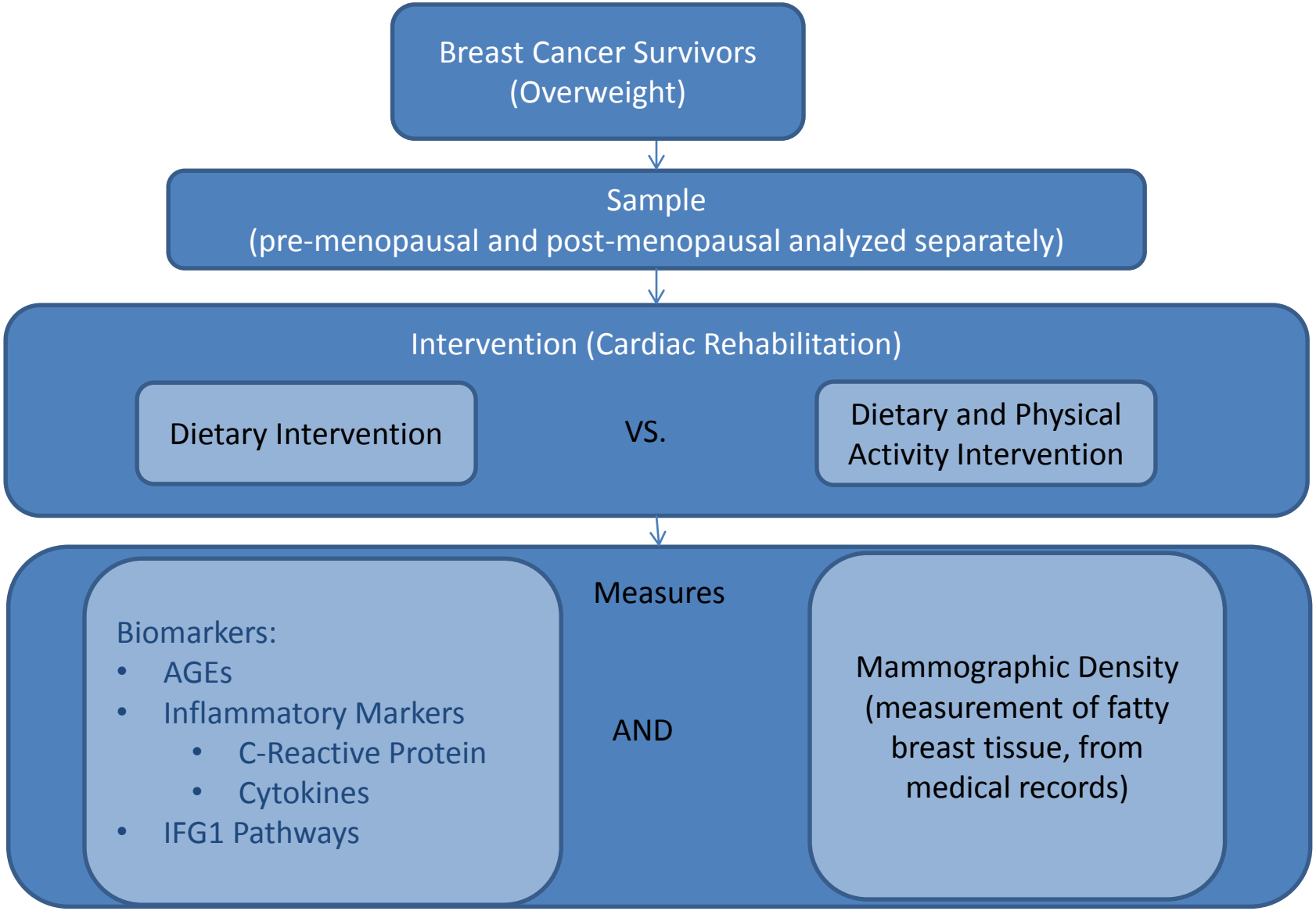
- Consuming foods that are heavily cooked, high in sugar/fat or are highly processed substantially increases the levels of AGEs in our bodies
- Processed/manufactured foods, for reasons of safety and convenience or to enhance flavor and appearance, have high AGE levels
- Dietary AGE's are naturally present in raw animal-derived foods but grilling, broiling, roasting, searing, and frying propagate and accelerate new AGE formation
- Alcohol and smoking elevates AGE accumulation in our bodies
- **Carbohydrate-rich foods such as vegetables, fruits, whole grains, and milk contain few AGEs even after cooking**

APPLE VS BACON (kilounits/serving)

13 vs. 11,905!!!!

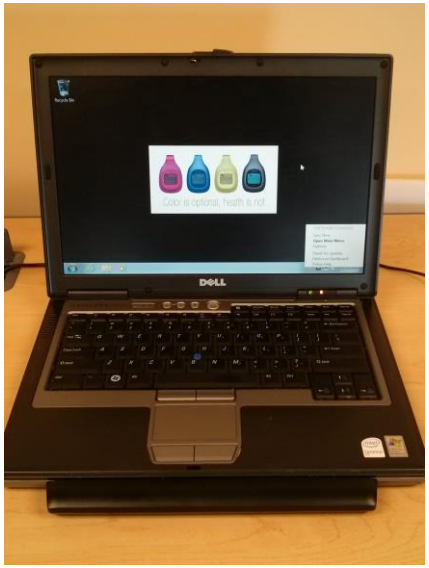
What does an excess in AGES do?





- **NOTES:**
- Include people with BRCA, Stages I-III
- Include people with diabetes
- Analyze pre/post-menopause separately (months since last period)
- Many women gain weight during chemotherapy due to intake of comfort foods
- Application will look at rural, underserved, AA (a lot), Sea Island

Secure automated login by Patients via MUSC Cardiac Rehabilitation Site. Fitbit Zip data encrypted data sent via low-energy Bluetooth 4.0



Data sent secure & encrypted to Fitbit database servers

VISUALIZATION INTERACTION VITAL TECHNOLOGY AND LEARNING COLLABORATIVE

Data pulled from Fitbit encrypted server using National Science Foundation VITAL Collaborative with 2-stage authentication and then saved via Redcap for analyses

NSF

GOAL Study: Getting Onboard with an Active Lifestyle

Fitbit Zip: What it is and How to Use it

This is a Fitbit Zip.

Just tap the device face with your fingertip to change the display.

Each tap cycles through one of five modes:

1) **Steps** (footprint icon)
2) **Distance** (markers with dots between)
3) **Calories burned** (fire icon)
4) **Fitbit Smiley** (highlights your recent activity level)
5) **Time** (clock)

Please remember to ***always wear your Fitbit Zip*** and record your information to help you meet your physical activity goals!

STEPS (Academic + Industry)

Mat Gregoski
College of Nursing

David Turner
Department of Pathology

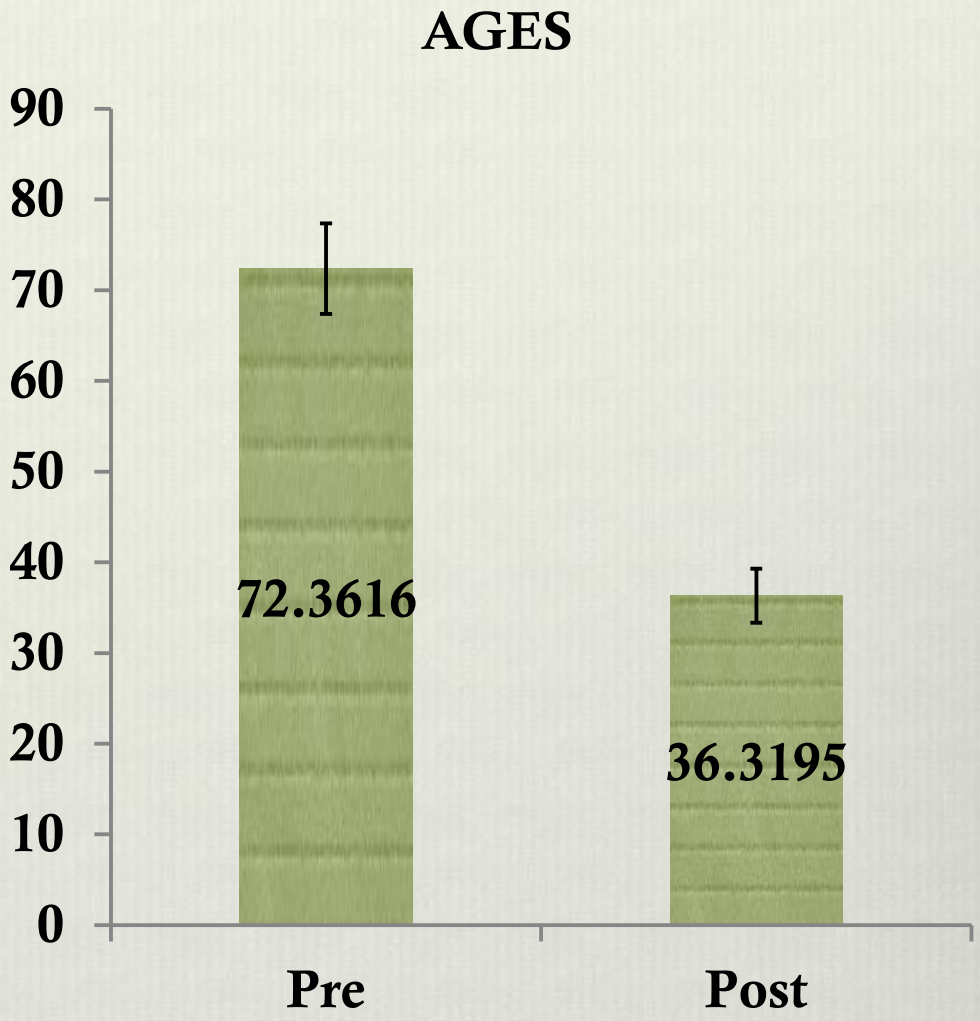
Magie Young
Dietician

Janis Newton
Wellness Center Director

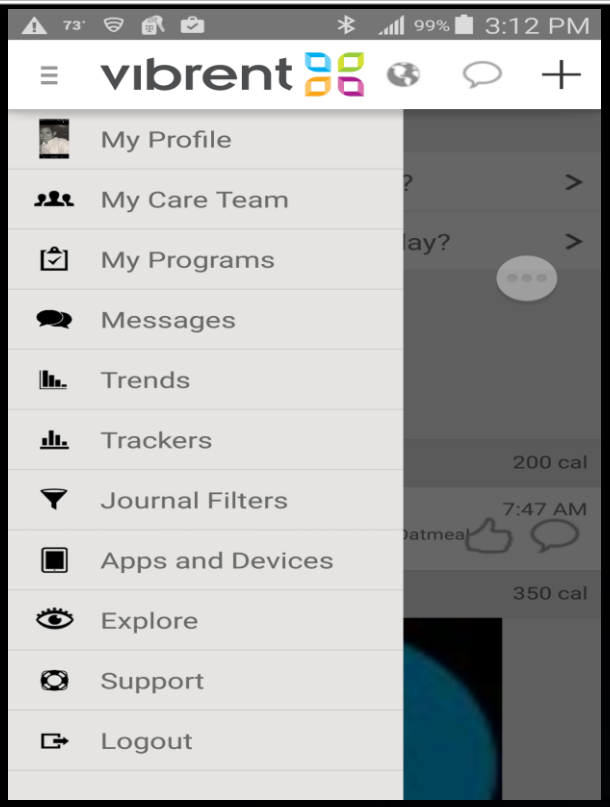
Praduman Jain
Vibrent

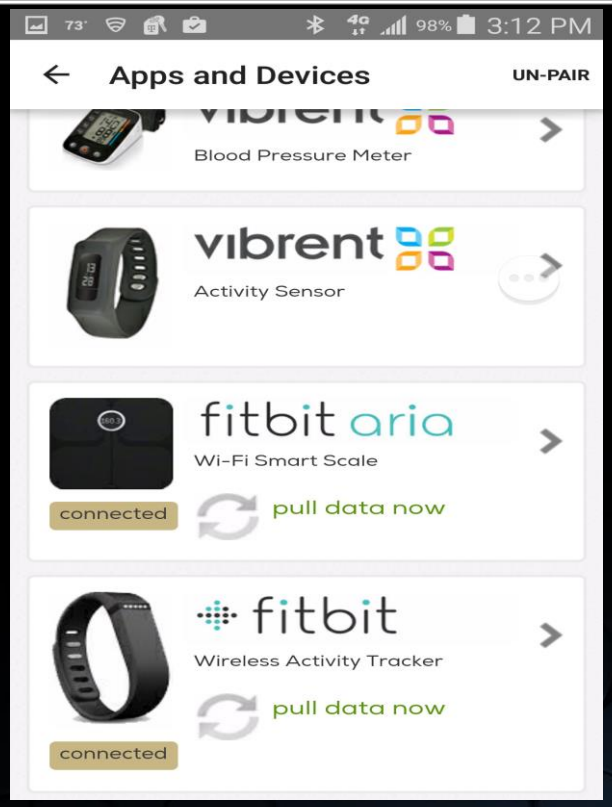
Dave Klein
Vibrent

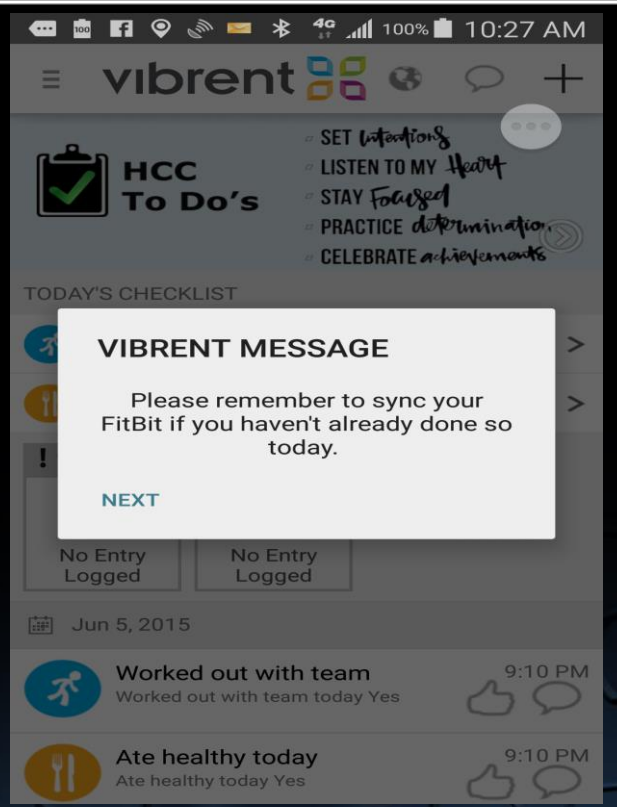
- 12-week group based wellness program that teaches proper self-management skills
- Daily workout as a team with mentors and trainers
  - Trainers are certified
  - Mentors are previous participants
- 1x week weight-in and educational session
- One on One with Dietician "Clean Diet"



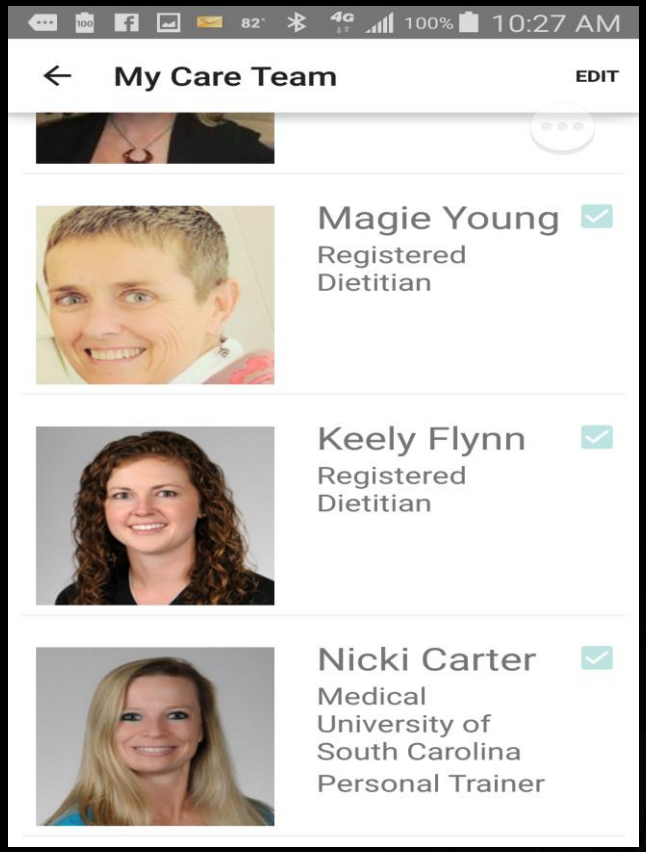
Steps Feasibility

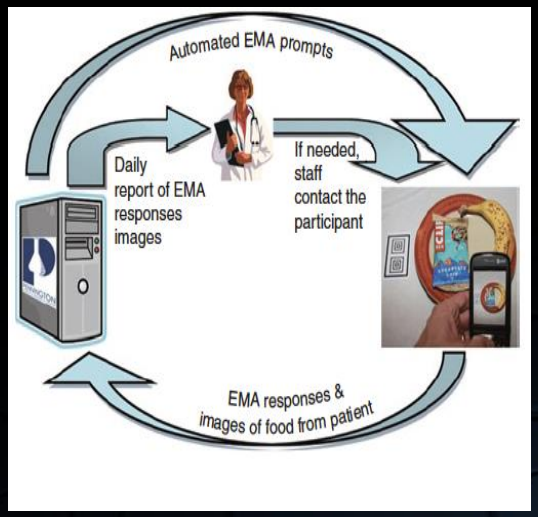


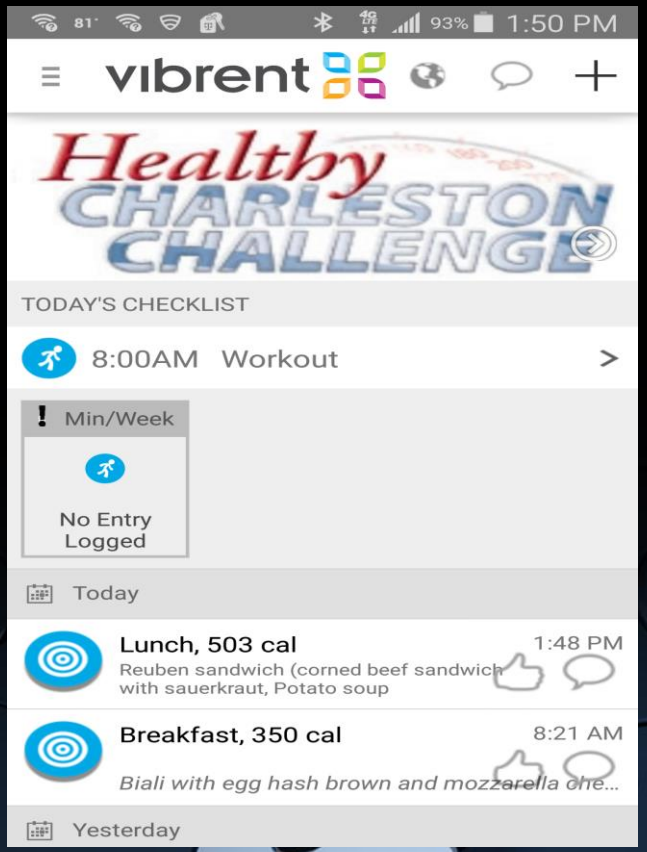




Steps Screenshots







EMA with real-time components

Table 2 Outcomes of STEPS		
Weight Loss		Application and Adherence to Intake
lbs	%	
-8.2	-3.57	Strong user, did not always eat enough
-11	-5.16	Strong user, consistently followed recommendations
-6	-1.95	Minimal use, struggled with intake recommendations
-2.8	-1.41	Used, struggled with intake recommendations
-8	-3.84	Used, struggled with intake recommendations
-9.8	-5.08	Strong user, consistently followed recommendations
-2.4	-1.36	Used, struggled with intake recommendations
-8.6	-4.96	Strong user, consistently followed recommendations

Lessons Learned

- Academic Development
- Off the shelf
- Industry Partner

Psychol Health. 2011 Nov;26(11):1479-98. doi: 10.1080/08870446.2010.540664. Epub 2011 Jun 28.

A refined taxonomy of behaviour change techniques to help people change their physical activity and healthy eating behaviours: the CALO-RE taxonomy.

Michie S[1], Ashford S, Sniehotta FF, Dombrowski SU, Bishop A, French DP.

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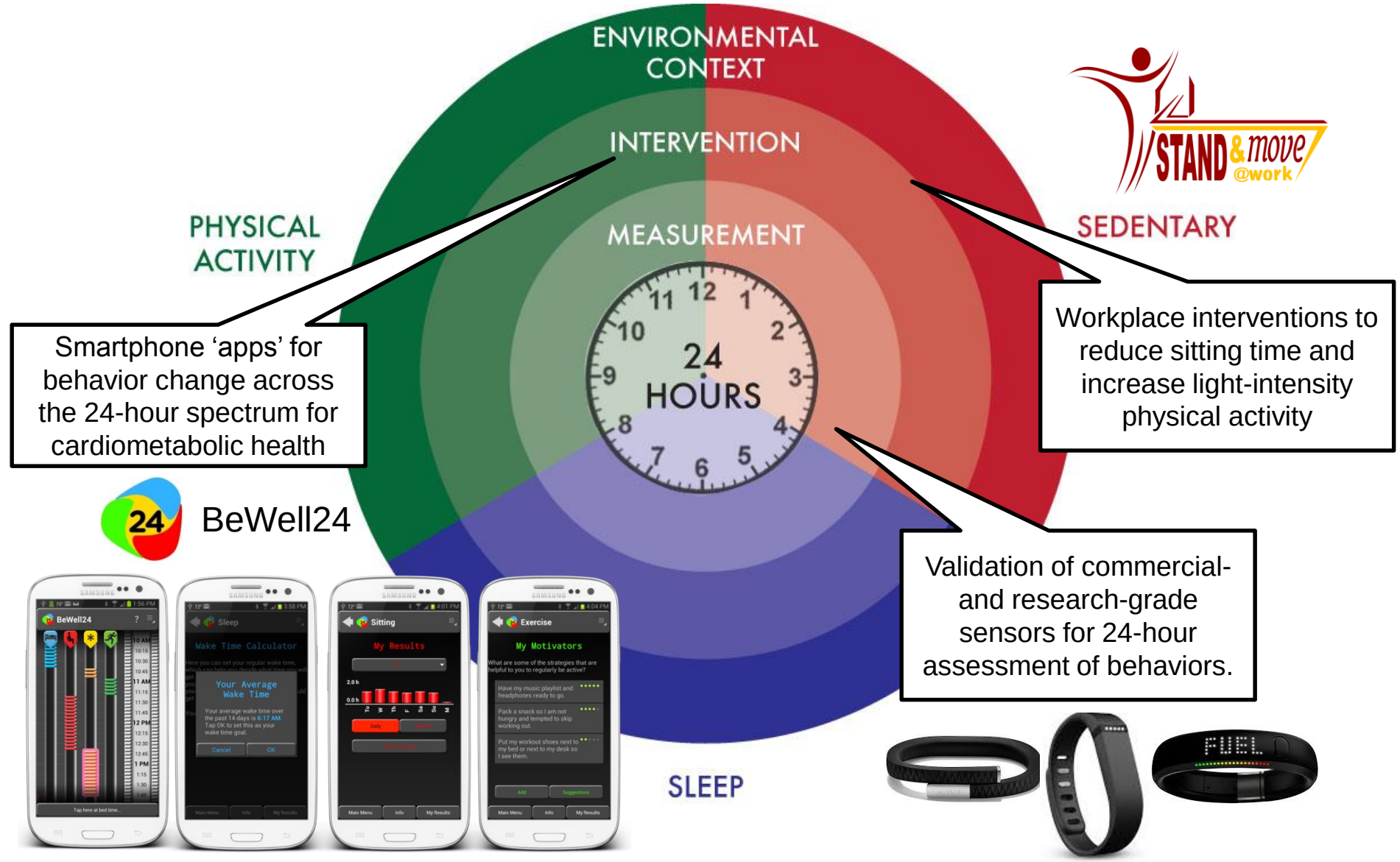


Lessons learned for integrating wearables into behavioral research

- Be clear of what is intervention and what is assessment (and whether they overlap)
- Be clear of what behavior you are trying to change (and whether your sensor is suitable for it)
- Consider context/wearability for your target population

Eric Hekler, Arizona State University

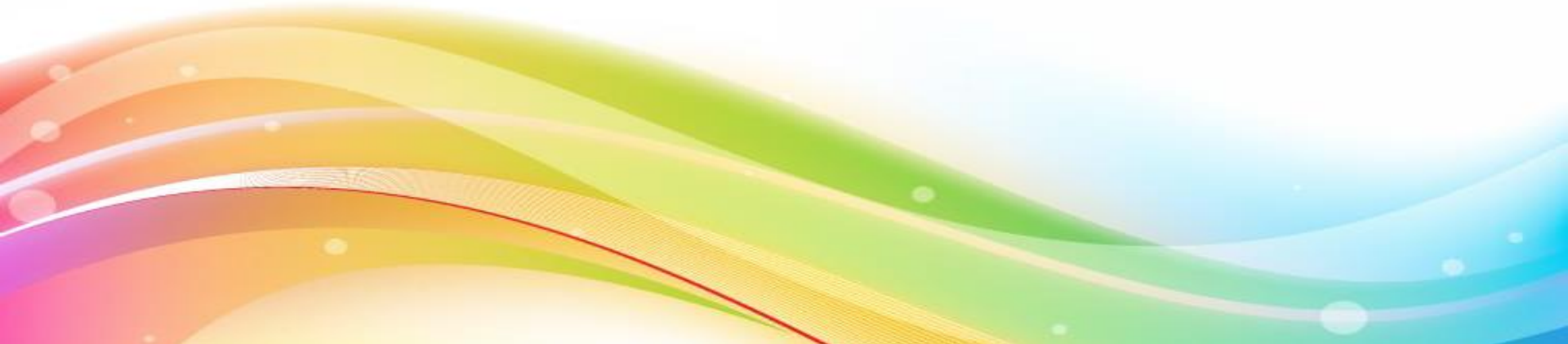
- Precision behavior change
  - Just-in-time adaptive interventions
  - Self-experimentation

- Agile Science
  - www.agilescience.org

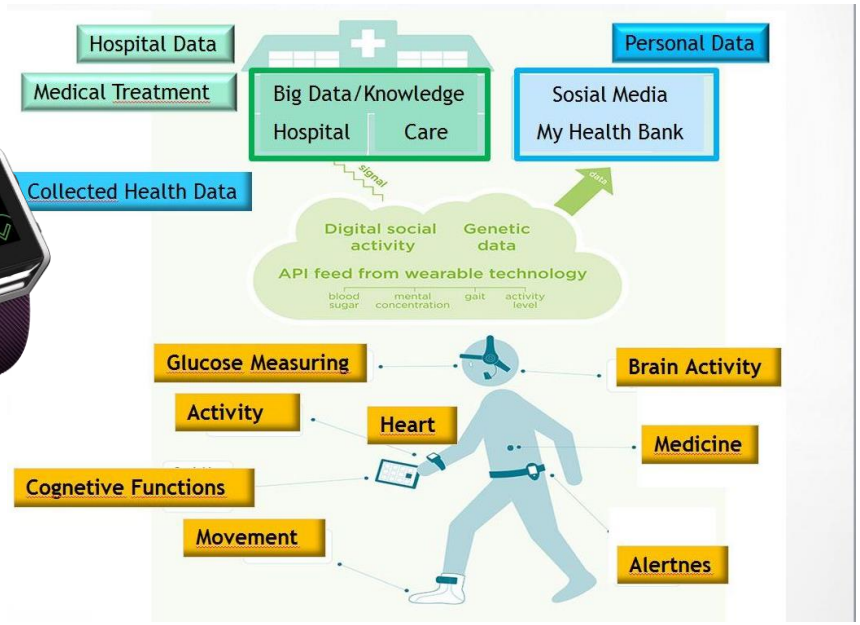
Wearable Take Home Messages

- Some data is better than no data
- Physical activity is NOT physical activity
- One person’s noise is another person’s signal

Precision Medicine Enabler Wearables - Devices or Systems



Wearables – Potential for Rich Data, however Use Cases Need to be Carefully Thought Through



vibrent

Wearables Learnings from Various Implementations

1) Define use cases. Lots of data may not be the answer.
2) Wearables are SYSTEMS and are not alone
3) API based approach (wearables to individual app)
4) Real-time wearables integration directly with mobile applications
5) Privacy
6) Security
7) HIPAA compliance
8) Battery Life

vibrent

fitabase

Features

- View and Analyze Data
- Dashboard Monitoring
- Easy to Navigate Report Pages
- Reports Latest Sync & Battery Level
- Export Participant or Batch Data
- Export Data to .CSV

fitabase

Dashboard | FIT Study | Steps | Intensity | Calories | Sleep

TIMEFRAME

Currently showing 20 days

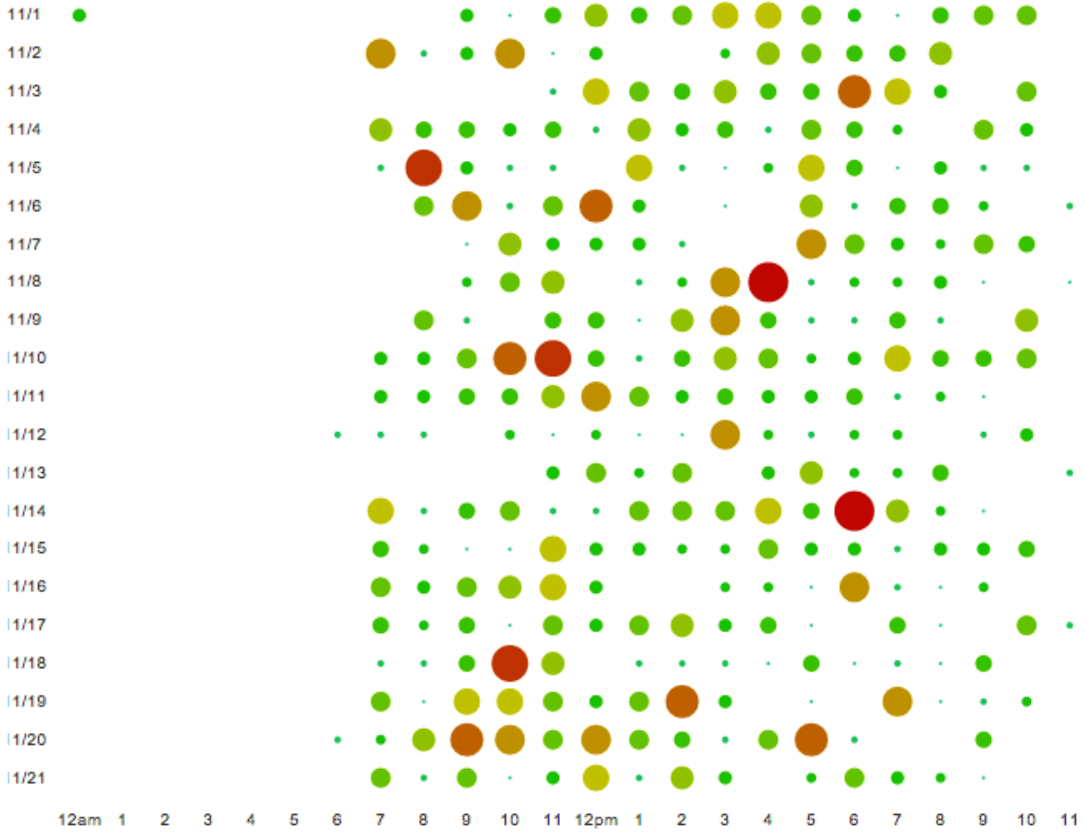
Start 11/01/2012 End 11/21/2012 Last 7 Days Last 14 Days Last 30 Days Last 60 Days

DATA SOURCE

TestUser1@fitabase.com

Steps

Steps/Day Kilometers/Day Miles/Day **Hour-by-Hour** Average Week



DATA INSIGHTS

fitabase

testUser
Log Off

Dashboard | FIT Study | Steps | Intensity | Calories | Sleep | Weight

TIMEFRAME

Currently showing 7 days

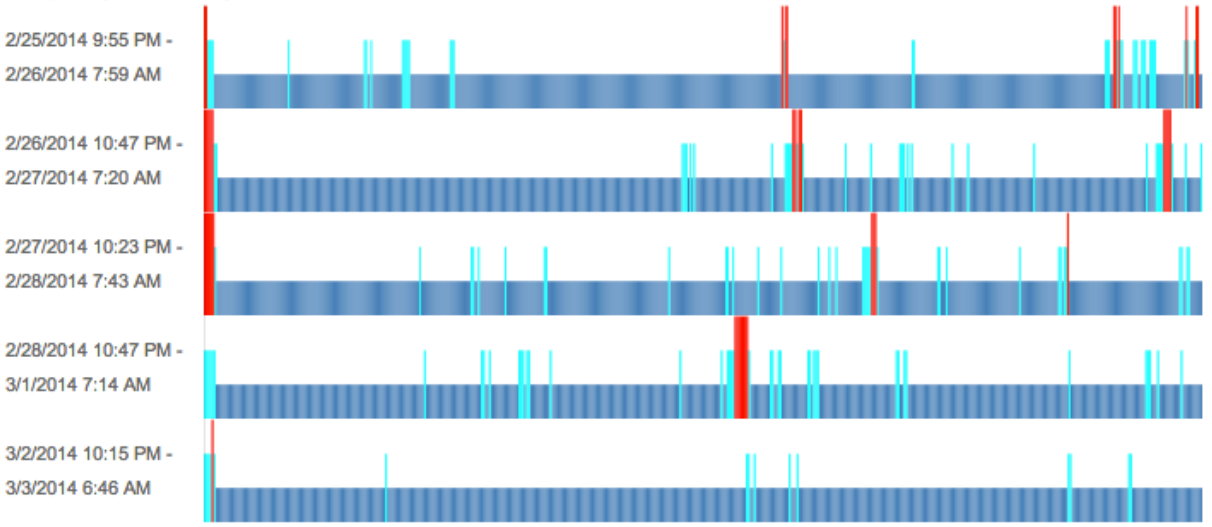
Start 02/25/2014 End 03/04/2014 Last 7 Days Last 14 Days Last 30 Days Last 60 Days

DATA SOURCE

AC Force

Sleep

Sleep / Day **Minute-by-Minute**



DATA INSIGHTS
2/25/2014 - 3/04/2014

Average

Minutes Asleep: **499.2**

High

Minutes Asleep: **556 (2/26/2014)**

Search:

Date	Mins Asleep	Mins In Bed	Mins Awake	Mins To Fall Asleep	Awakenings	Efficiency	Is Main Sleep
2/25/2014	556	605	43	6	14	93	true
2/26/2014	469	514	37	7	16	93	true
2/27/2014	516	561	38	7	21	93	true

Download

Day Minute Totals
Sleep Log Info
Sleep Log Minutes

@aaronc

fitabase

Dashboard | FIT Study | Steps | Intensity | Calories | Sleep | Weight

TIMEFRAME

Currently showing 425 days

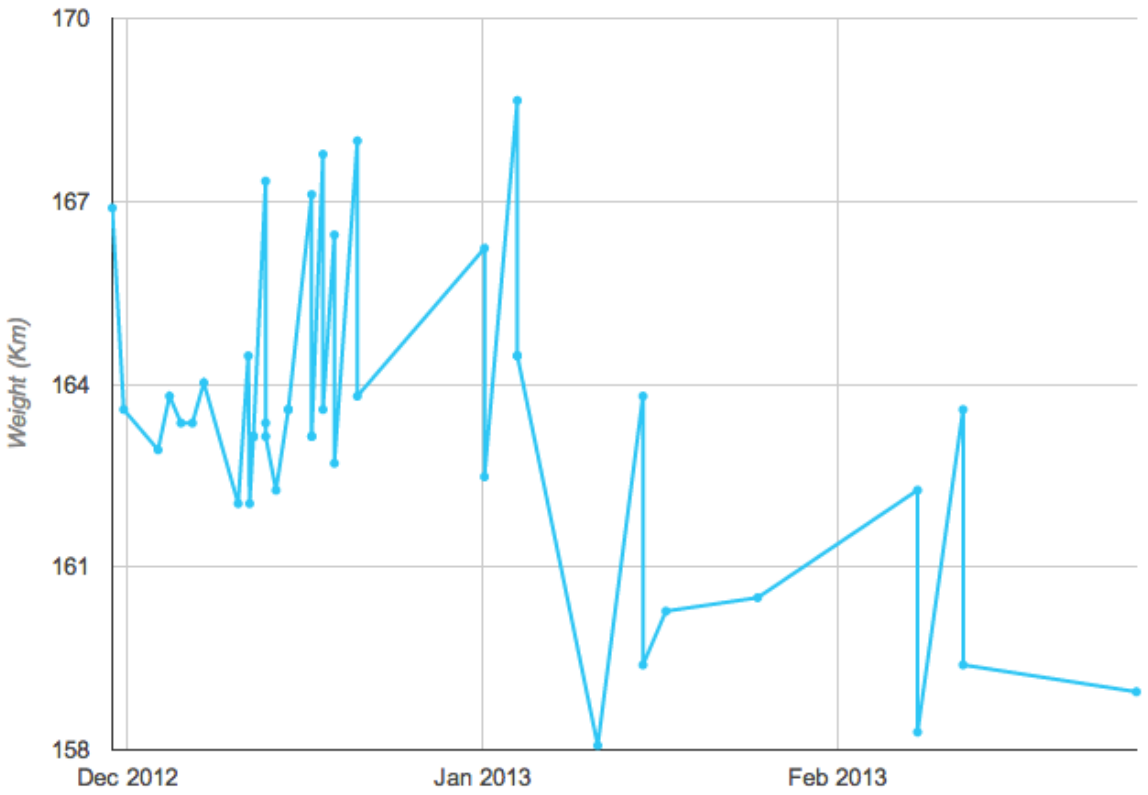
Start 11/29/2012 End 01/28/2014 Last 7 Days Last 14 Days Last 30 Days Last 60 Days

DATA SOURCE

AC 365

Weight

Weight (km) **Weight (lbs)** Fat % BMI



TIMEFRAME

Currently showing 1 day

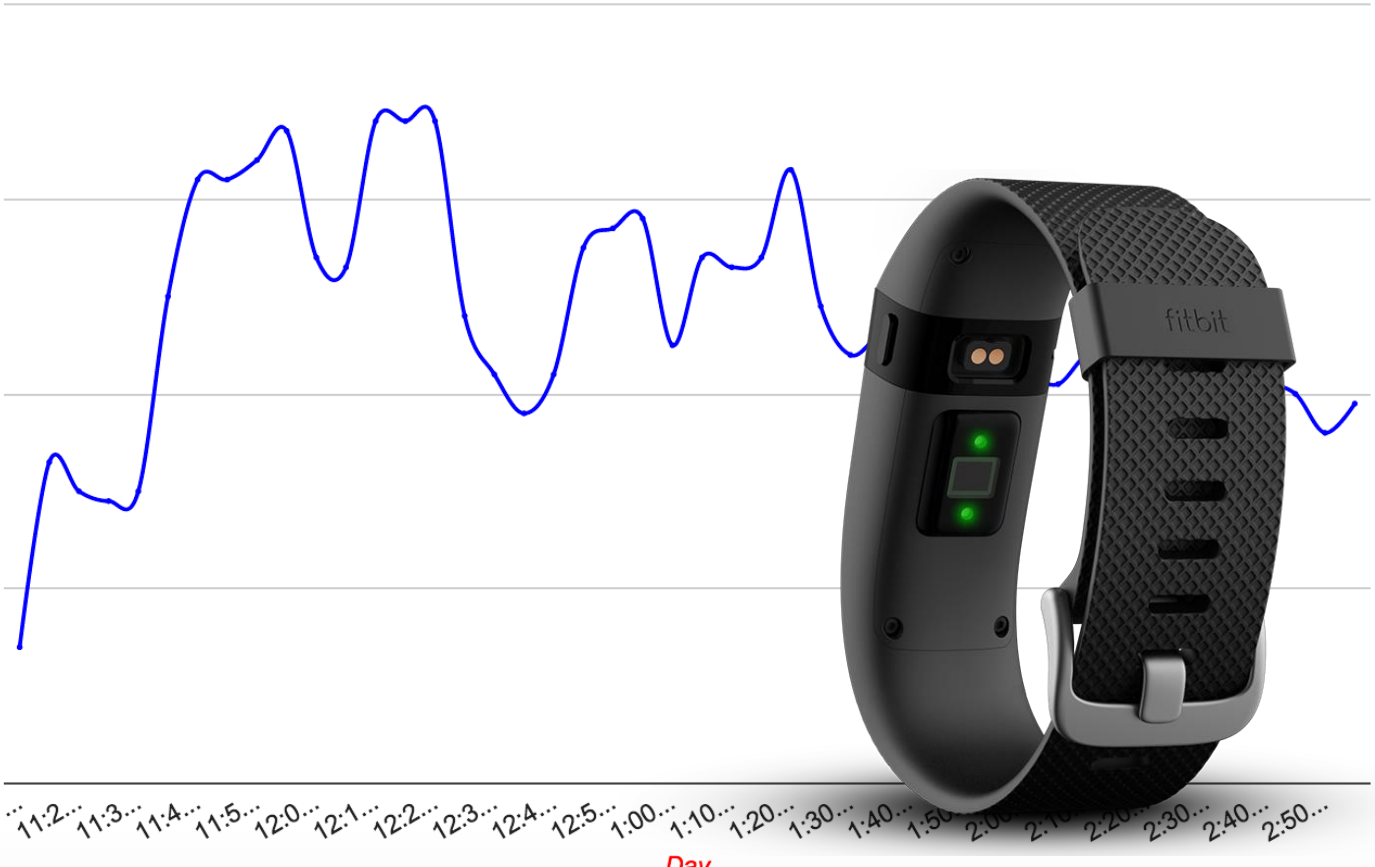
Start 01/22/2015 End 01/23/2015 Last 7 Days Last 14 Days Last 30 Days Last 60 Days

DATA SOURCE

AC ChargeHR

Heart Rate

Seconds | 1 Minute Average | **15 Minute Average** | Daily Ranges



Thanks.

fitabase

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