Improving Diagnosis for Older Adults through In-Home Sensing to Achieve Proactive Health Care

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Disclosure

- The University of Missouri Eldertech sensor work has been licensed to Foresite Healthcare (2013). Dr. Skubic has a small ownership in the company.
- The University of Missouri holds several patents (2014-2021) with Dr. Skubic listed as an inventor.
- Research funding has come from U.S. Federal agencies, with the conflict of interest managed by the University of Missouri, to ensure objective research results.
- *Many collaborators, students, and older adult study participants have contributed to this work.*

Detecting Health Changes with In-Home Sensors

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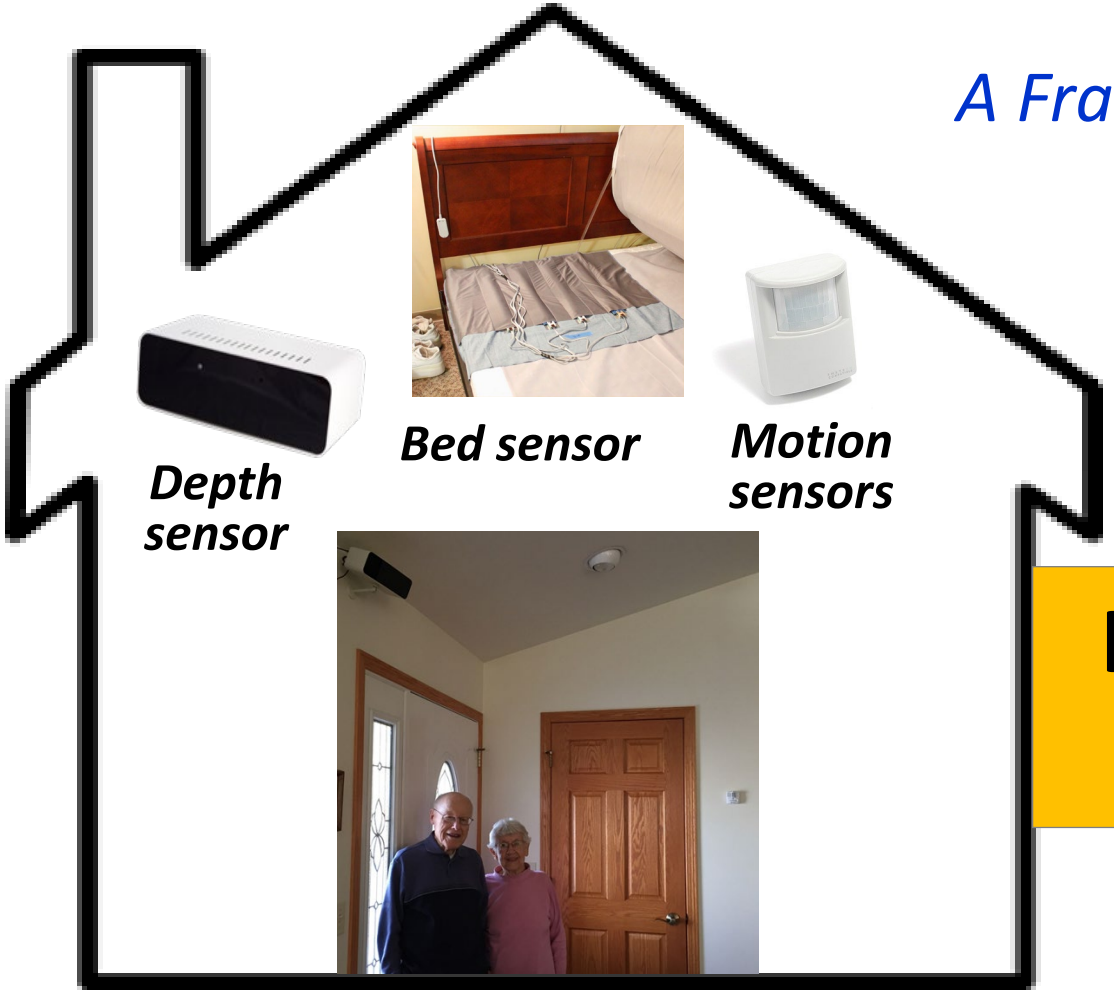
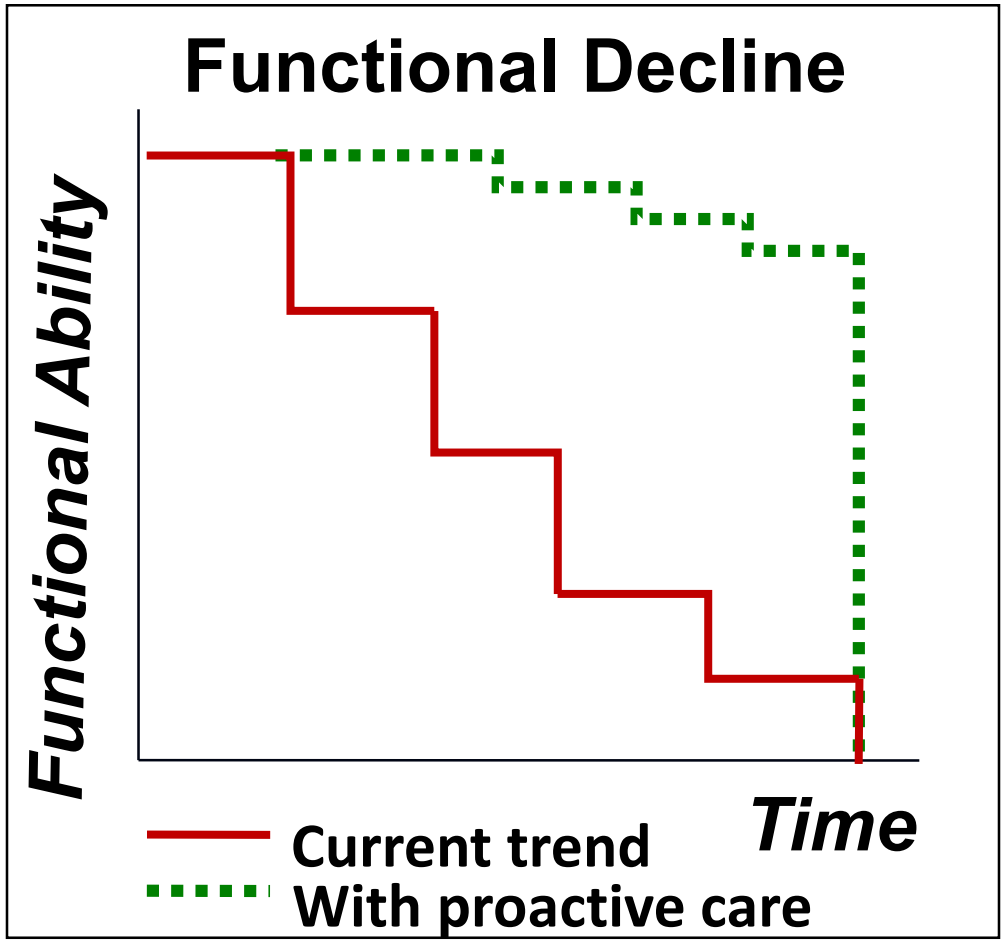
A Framework for Clinical Decision Support



Health alerts
Fall alerts

Nurses
Social Workers

Squaring the Life Curve

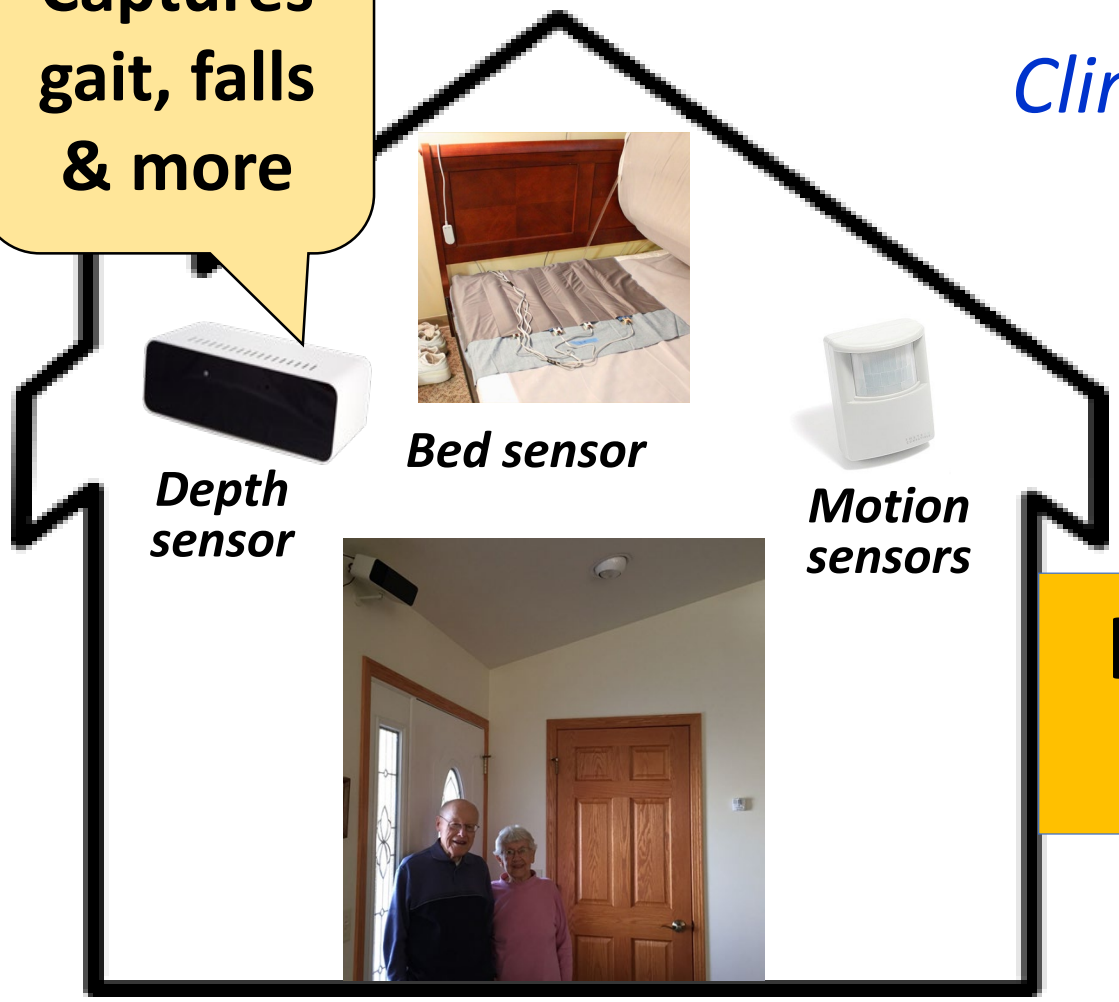


TigerPlace residents with in-home sensors stay 1.7 years longer than those without sensors at TigerPlace

Rantz et al., Nursing Outlook, 2015

Detecting Health Changes with In-Home Sensors

Captures gait, falls & more



Depth sensor

Bed sensor

Motion sensors

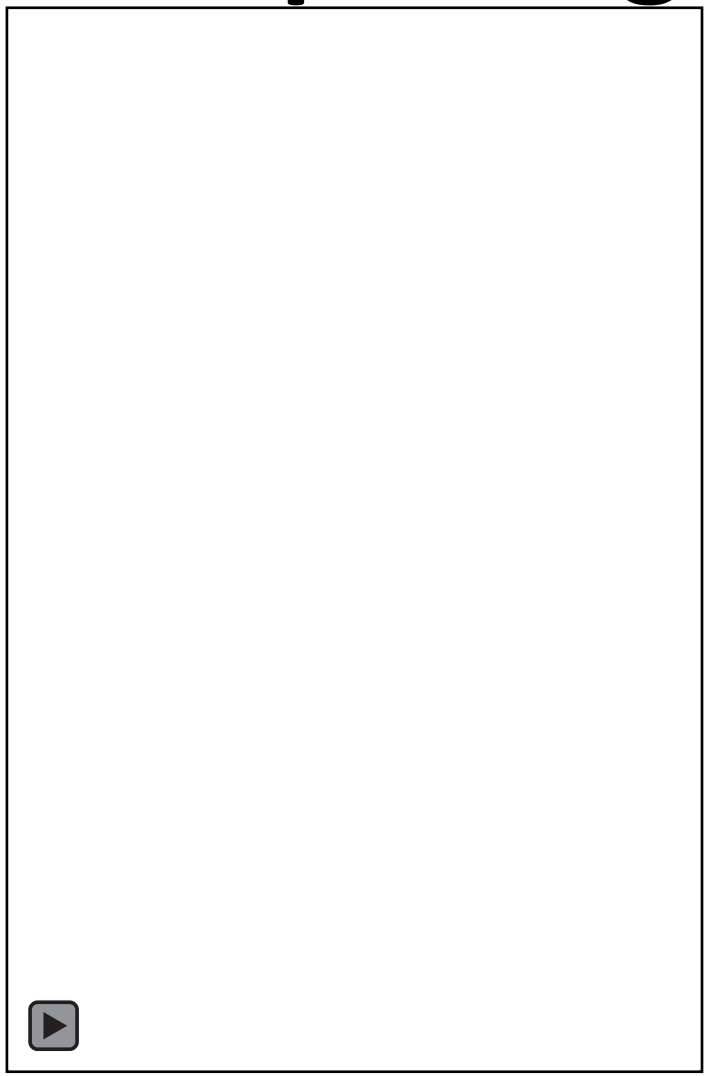
Clinical decision support system

Health alerts
Fall alerts

Nurses
Social Workers

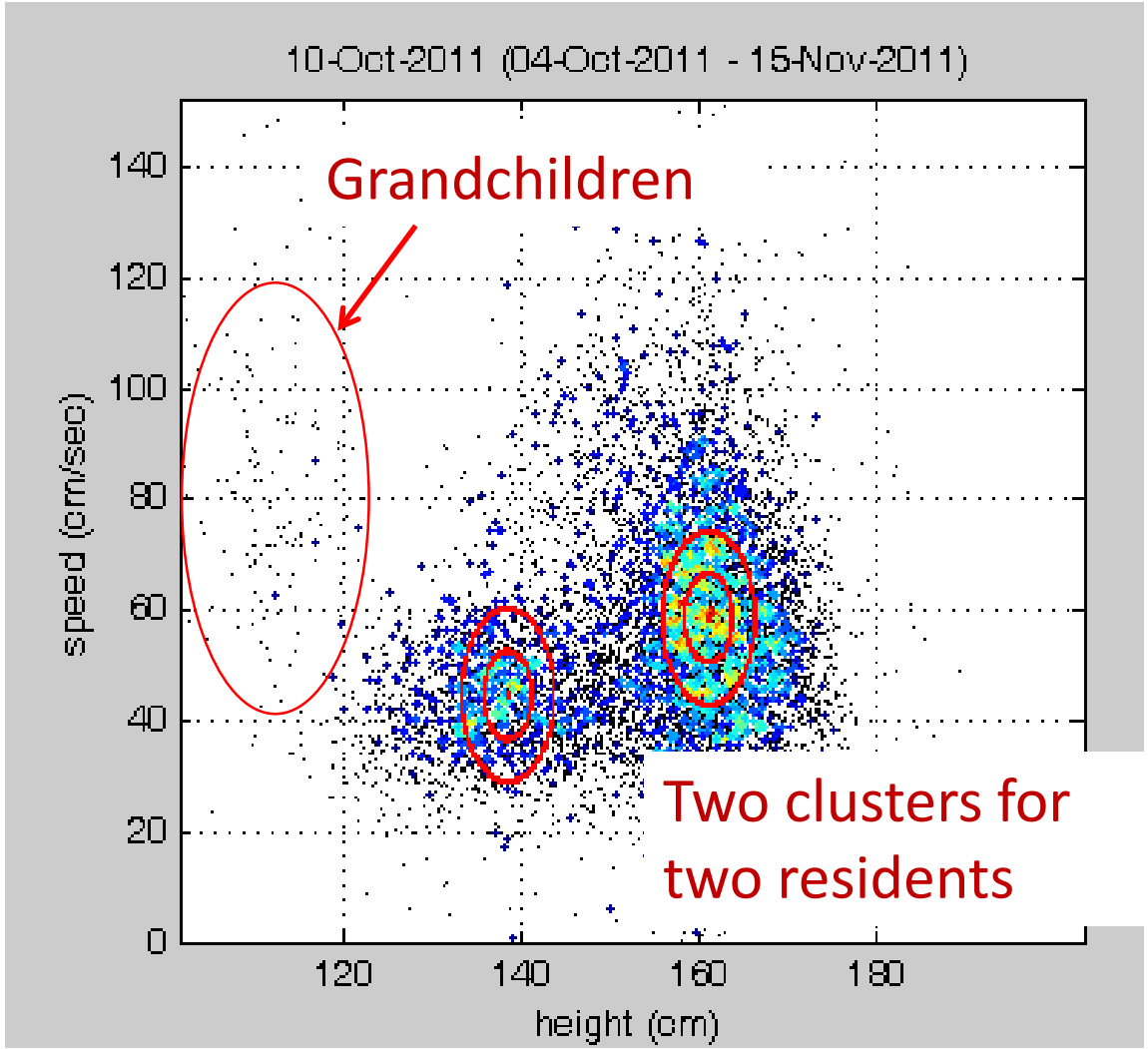
Skubic et al., *THC,* 2009; Rantz et al., *JGN*, 2010

Capturing Gait in the Home



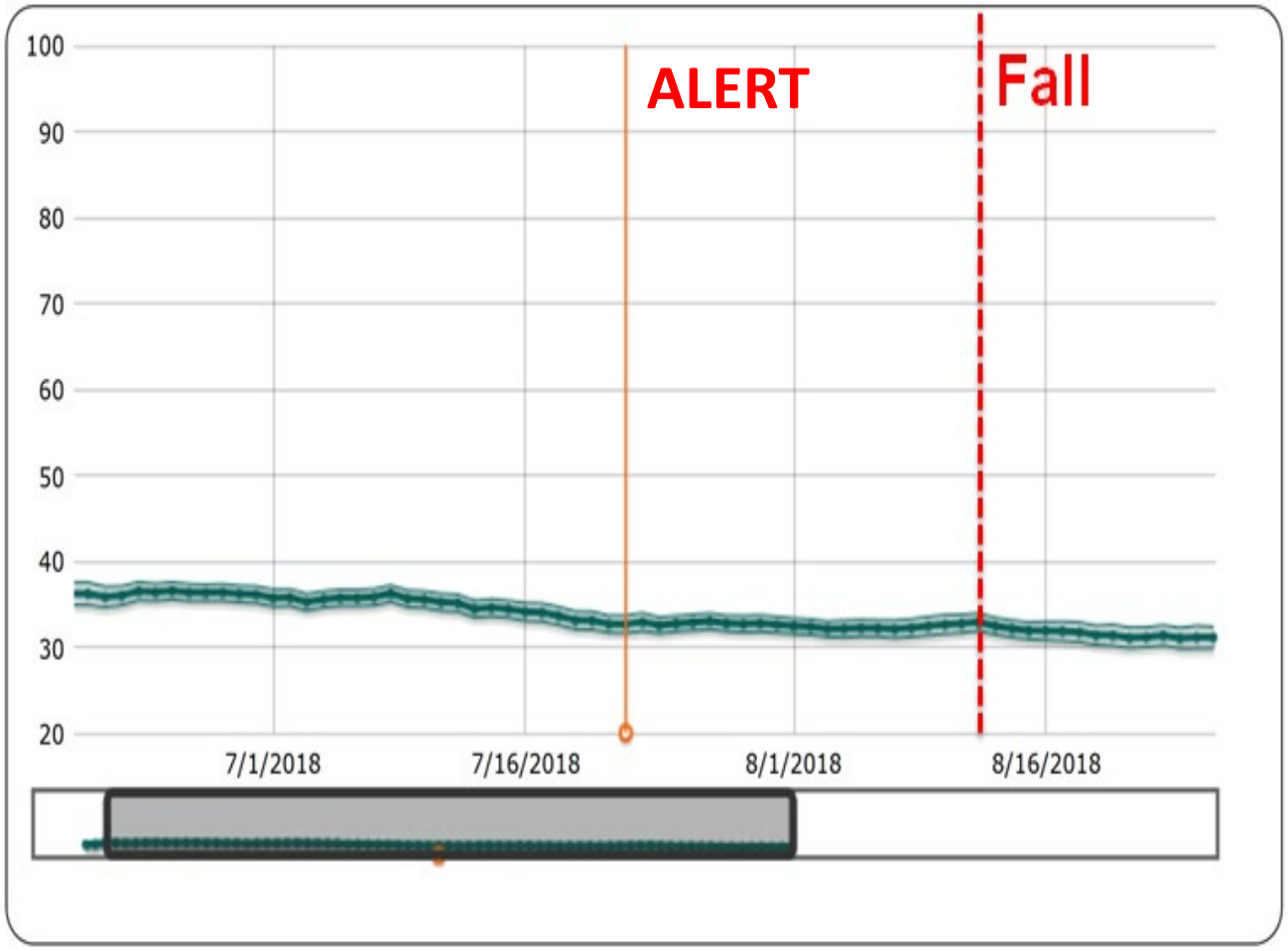
Examples of In-Home Walks

https://www.youtube.com/watch?v=MF6yZyLuuII



Stone & Skubic, EMBC 2012; *TBE* 2013; EMBC 2014.

Tracking Walking Speed and Fall Risk

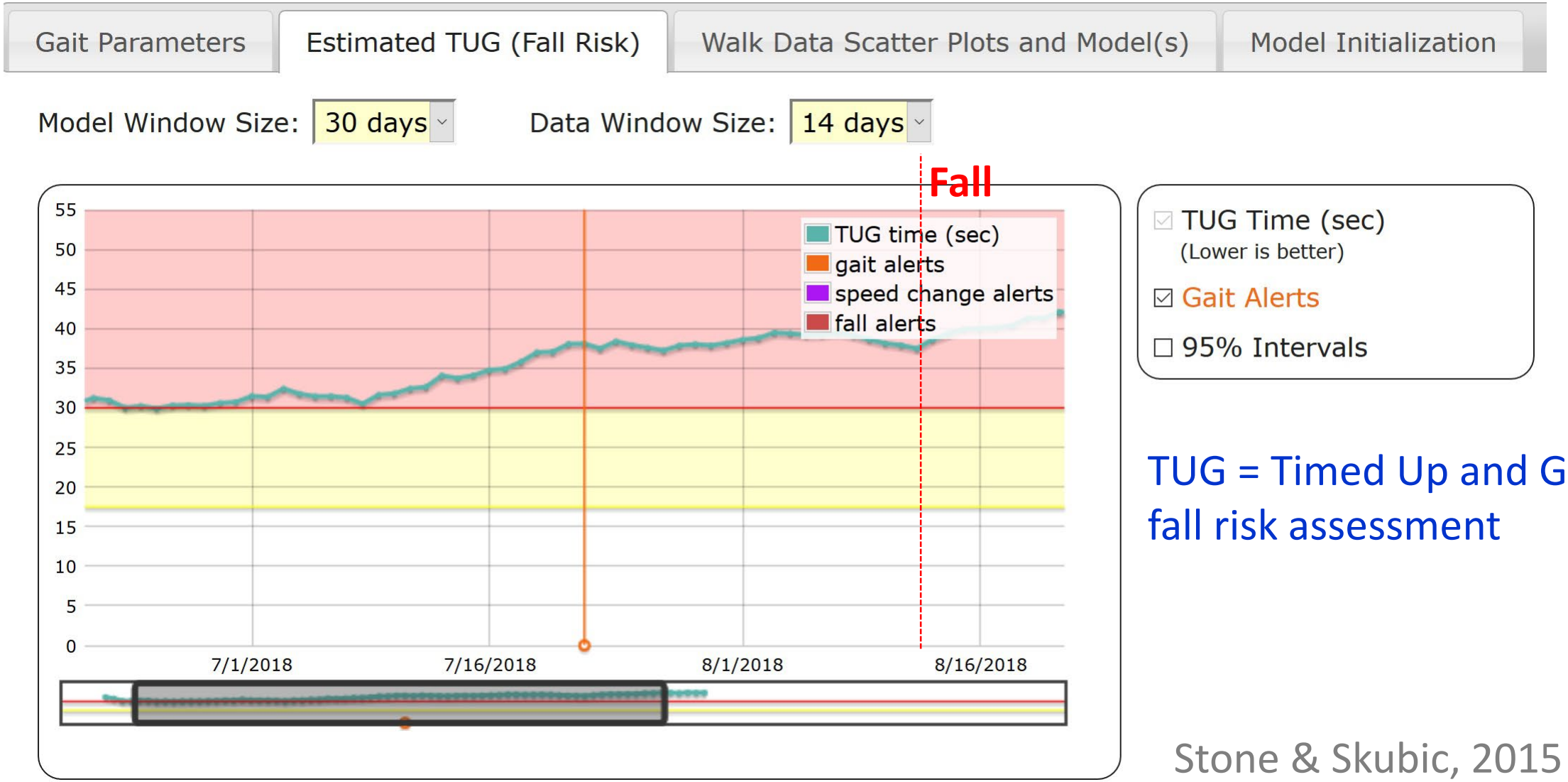


Decrease in walking speed of 5 cm/sec over 7 days

→ 86% probability of falling within the next 3 weeks

Phillips et al., WJNR, 2016

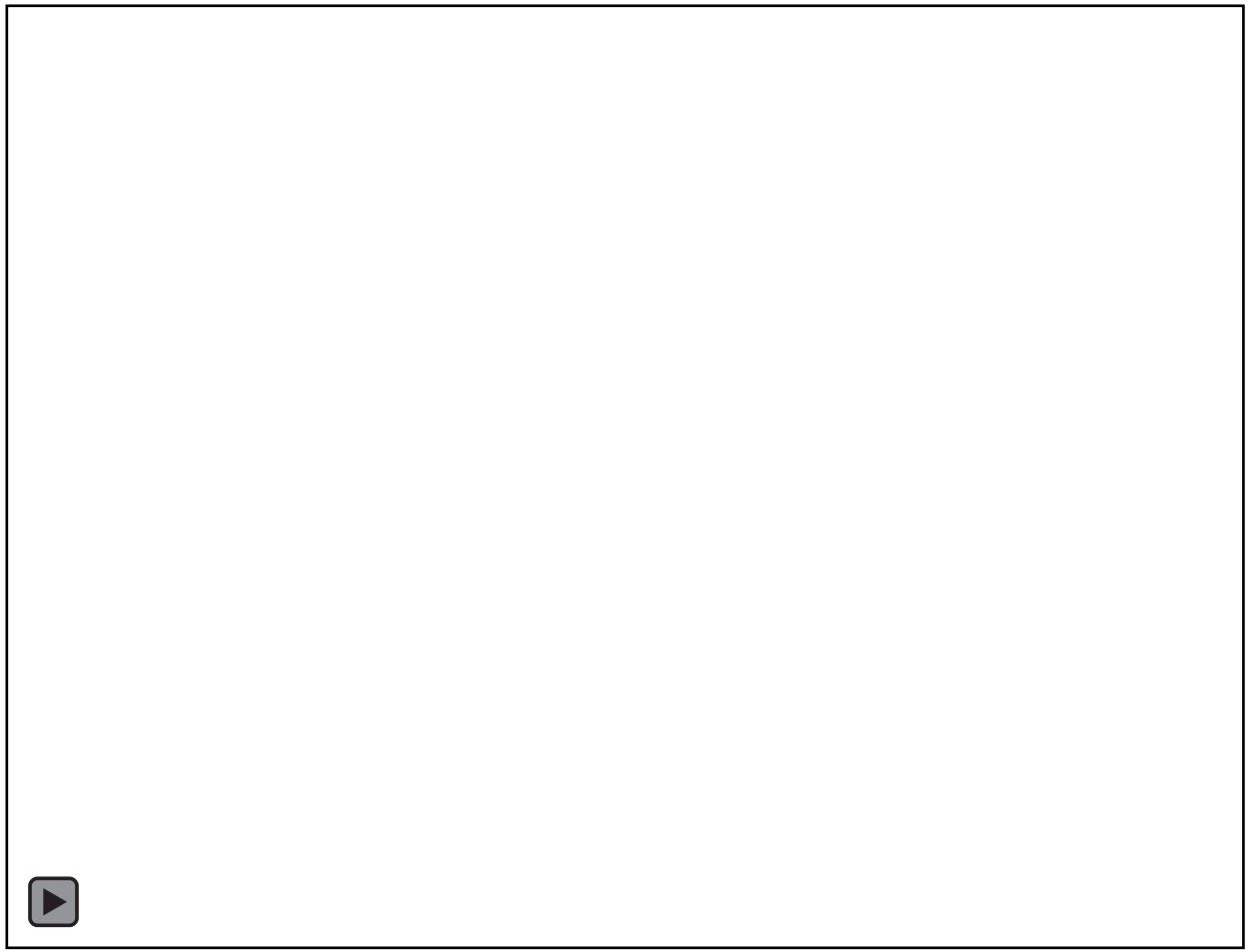
Tracking Fall Risk



TUG = Timed Up and Go fall risk assessment

Stone & Skubic, 2015

Fall Detection in the Home with Depth Sensors



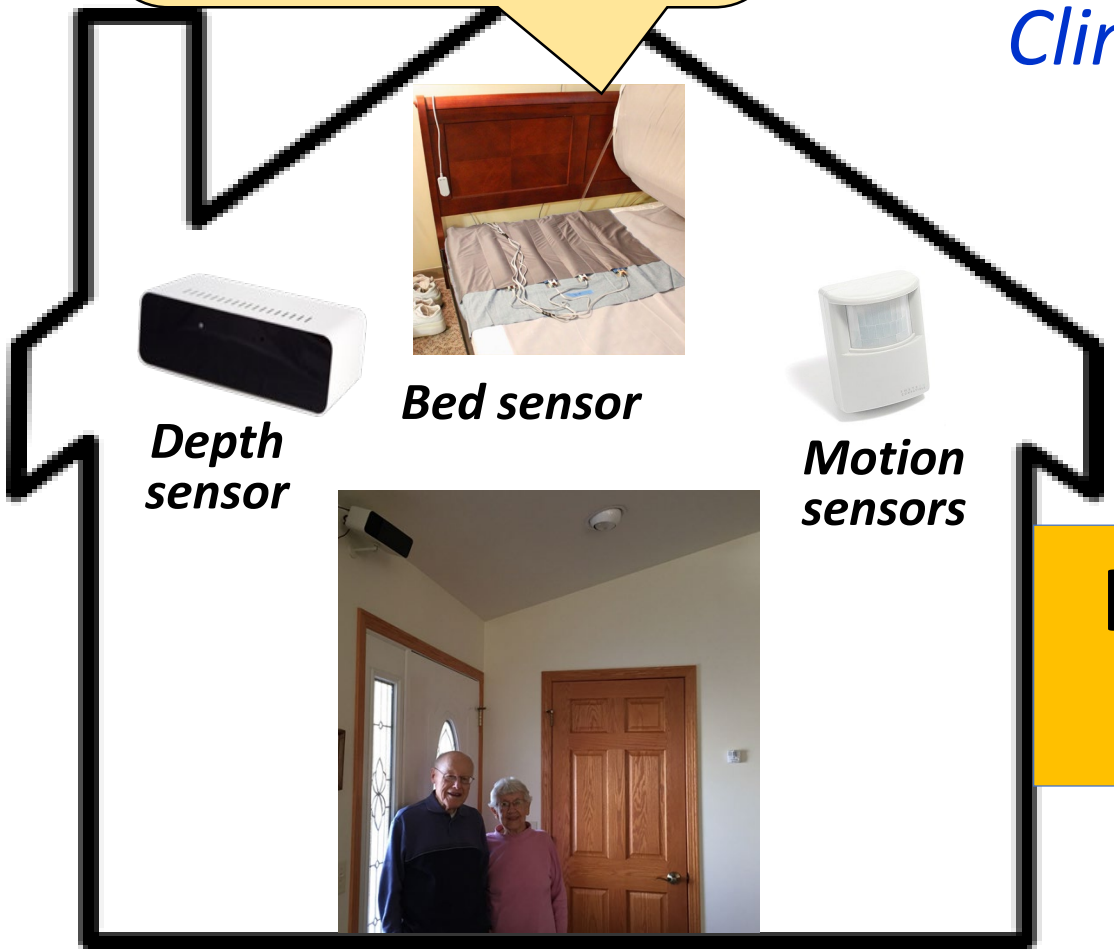
https://www.youtube.com/watch?v=TFB7YOUmHho

Stone & Skubic, 2014, 2015

ting Health Changes
In-Home Sensors

Captures pulse, respiration, bed restlessness & sleep patterns

Clinical decision support system



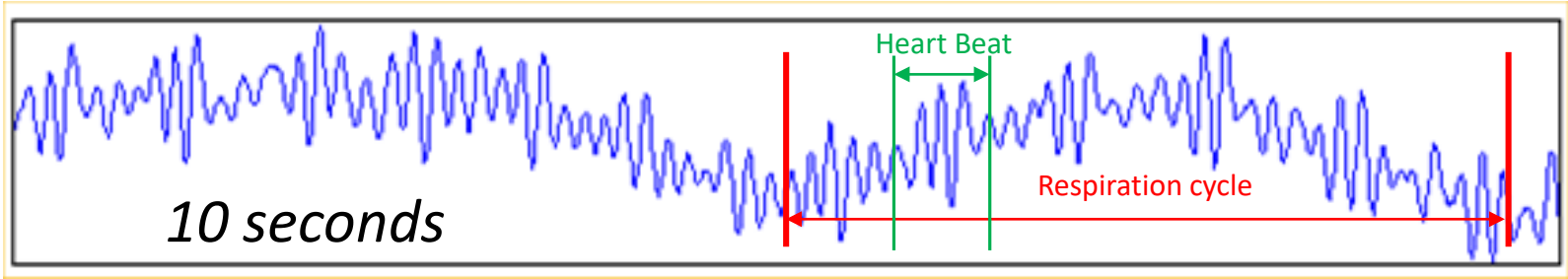
Health alerts
Fall alerts

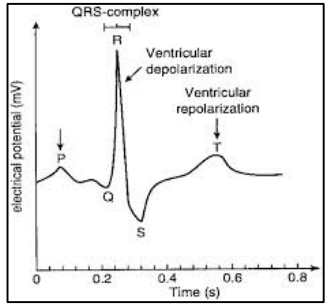
Nurses
Social Workers

Skubic et al., *THC,* 2009; Rantz et al., *JGN*, 2010

MU Hydraulic Bed Sensor

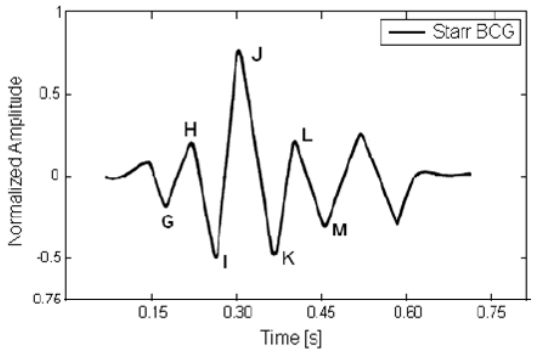
Captures the ballistocardiogram & respiration





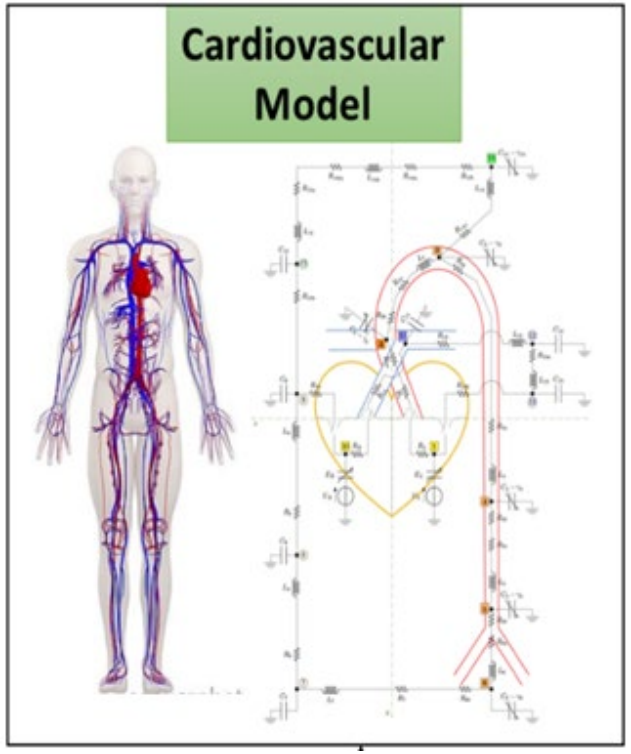
ECG

BCG



Newest Work:

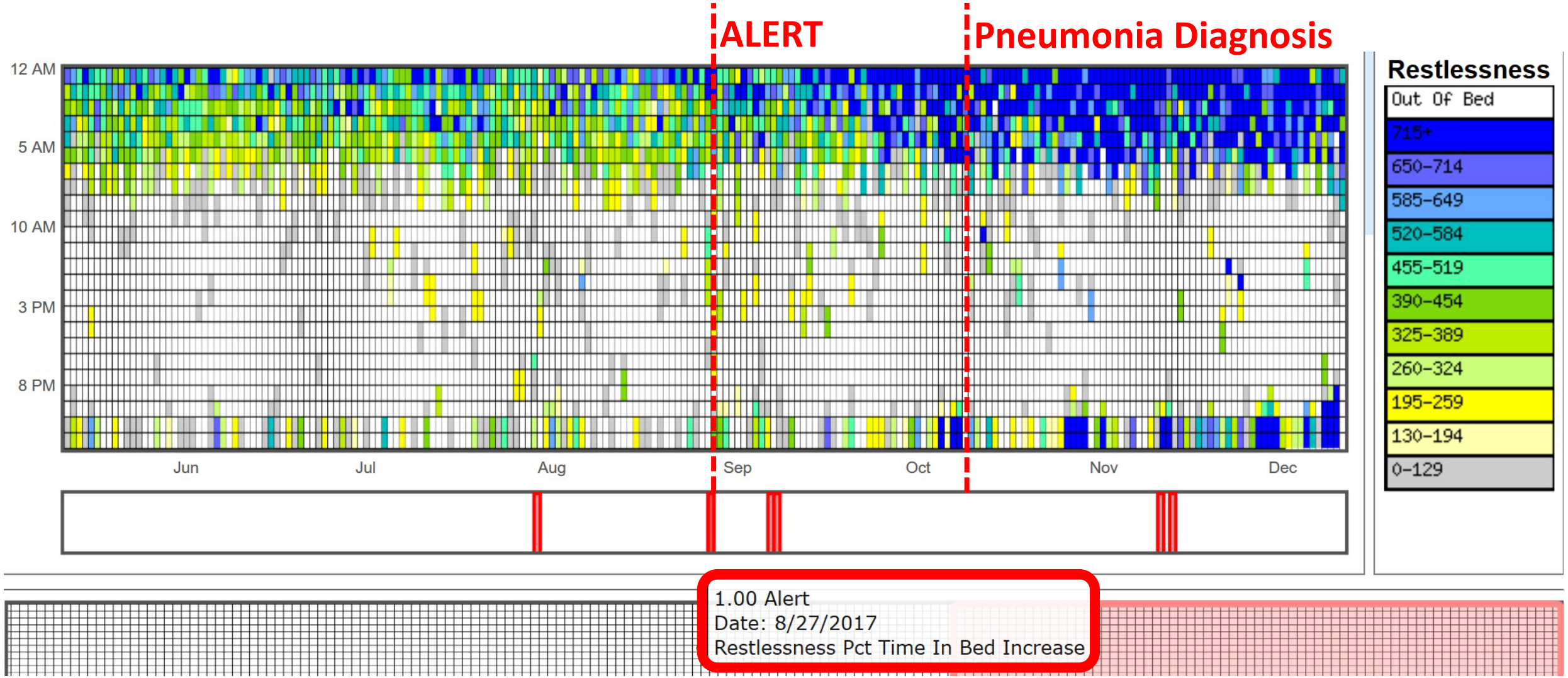
Using a cardiovascular model for clinical interpretation of the BCG waveform



Heise et al., 2011, 2013; Rosales et al., 2017

Guidoboni et al., *TBE*, 2019

Changes in Bed Restlessness Density



Detecting Health Changes with In-Home & Wearable Sensors

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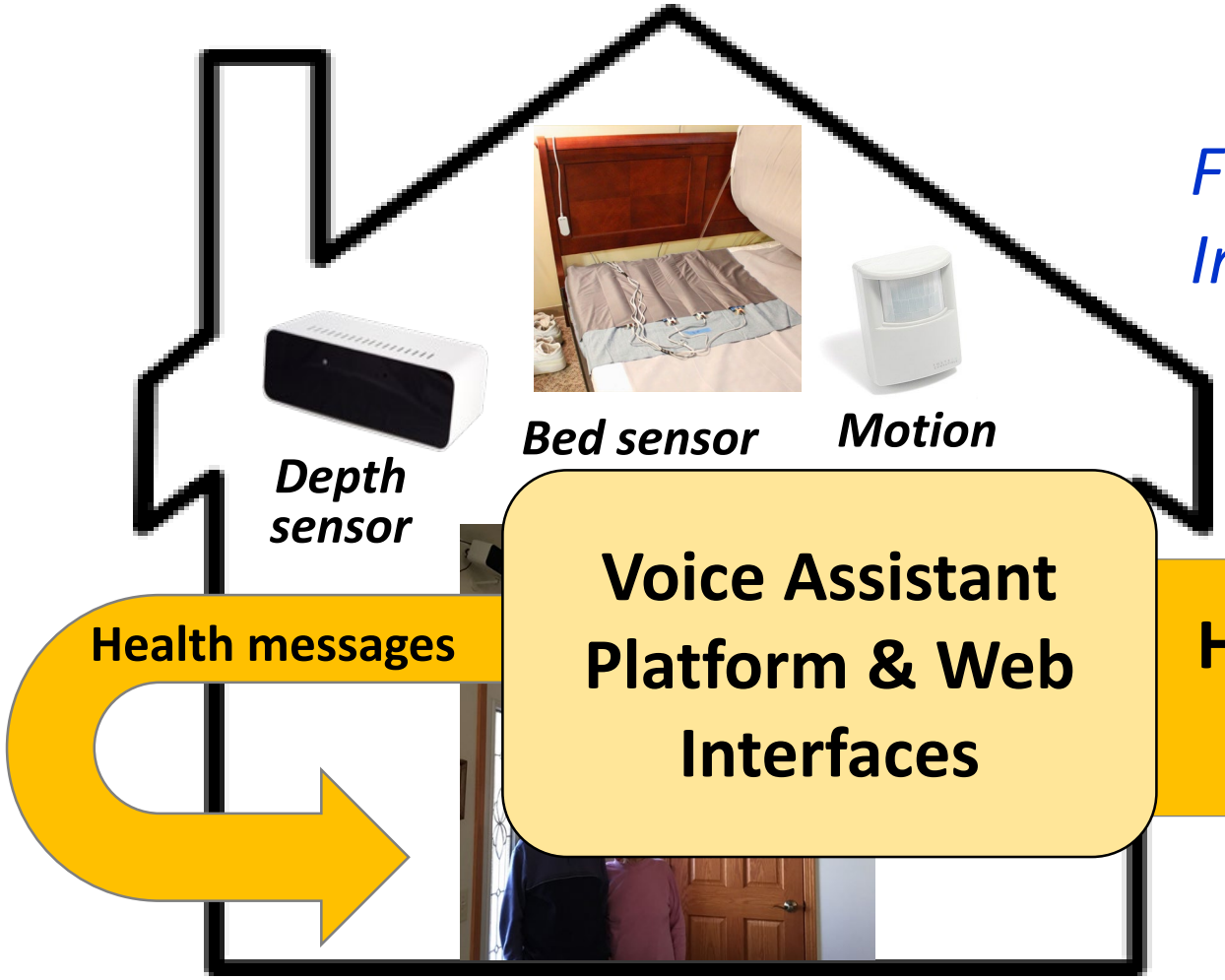
NIH THIL grant, M. Skubic, PI

For Self-Management of Health
In Independent Housing



Family members

Take-Away Message from NIH THIL project

- Consumers see the value of the sensors, especially for fall detection & fall alerts
- Most older adults did not feel the need to use the interfaces themselves, because they were already under the care of healthcare providers.
- Family members are more engaged but are unsure of how to interpret the data and health messages to improve diagnosis

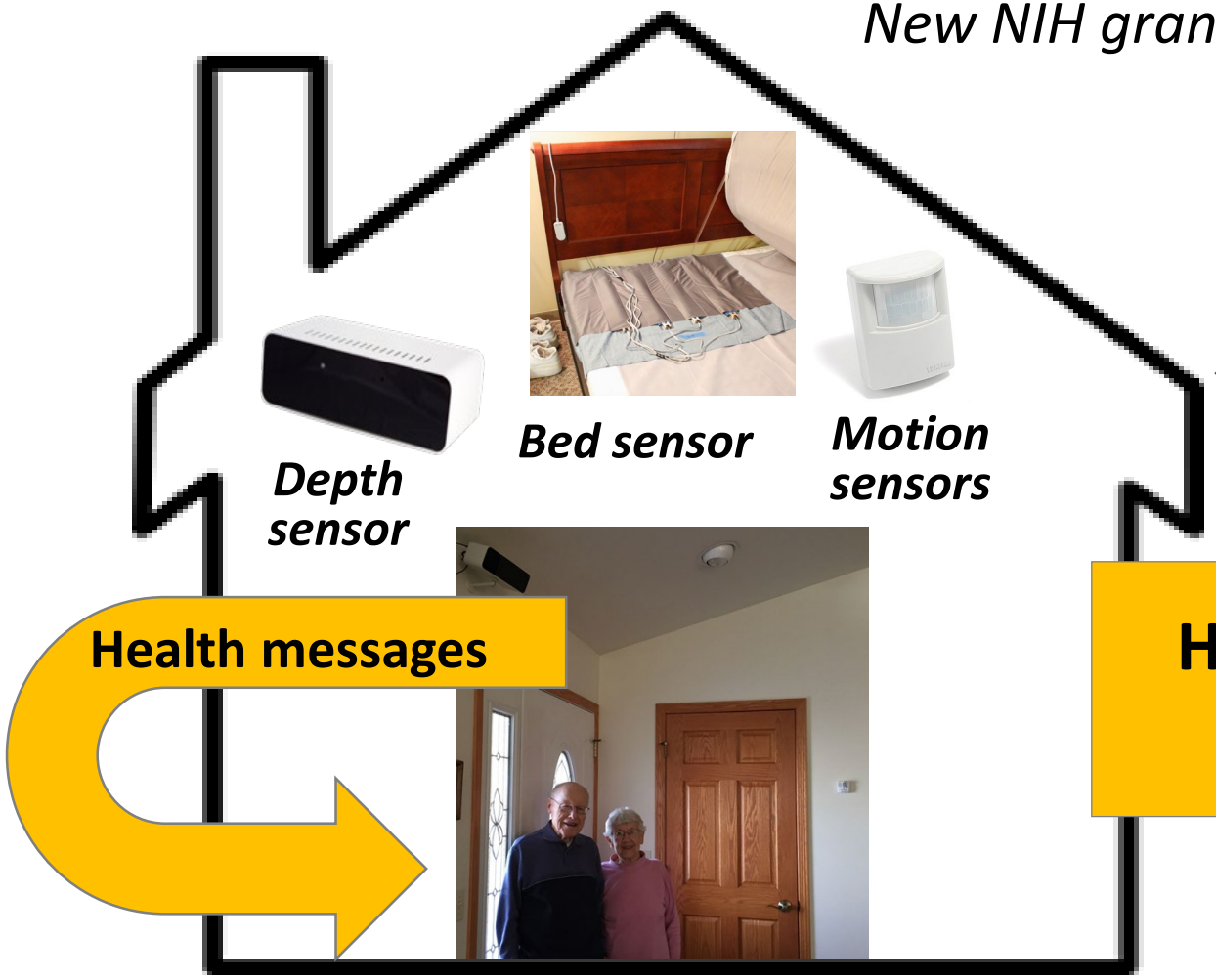
We have tried one approach, but it requires an EHR

Future Directions towards Proactive Healthcare & Earlier Diagnosis

- Shows the need for a Care Coordination team to help seniors and their family caregivers
- Potential for Prevention and Improvement
  - Use the fall risk scores and health messages to maintain and regain function and strength
  - Consumers want health messages with positive changes
  - Use the individual's health conditions, needs & goals for improved personalization

Detecting Health Changes with In-Home Sensors

New NIH grant in rural communities, R. Proffitt, PI



Sensor-Based Care Coordination

Nurses, OTs Social Workers

Health messages
Fall alerts

Family members

Center to Stream Healthcare In Place

Baylor College of Medicine

Universitatis Arizonensis 1885

USC University of Southern California

Caltech

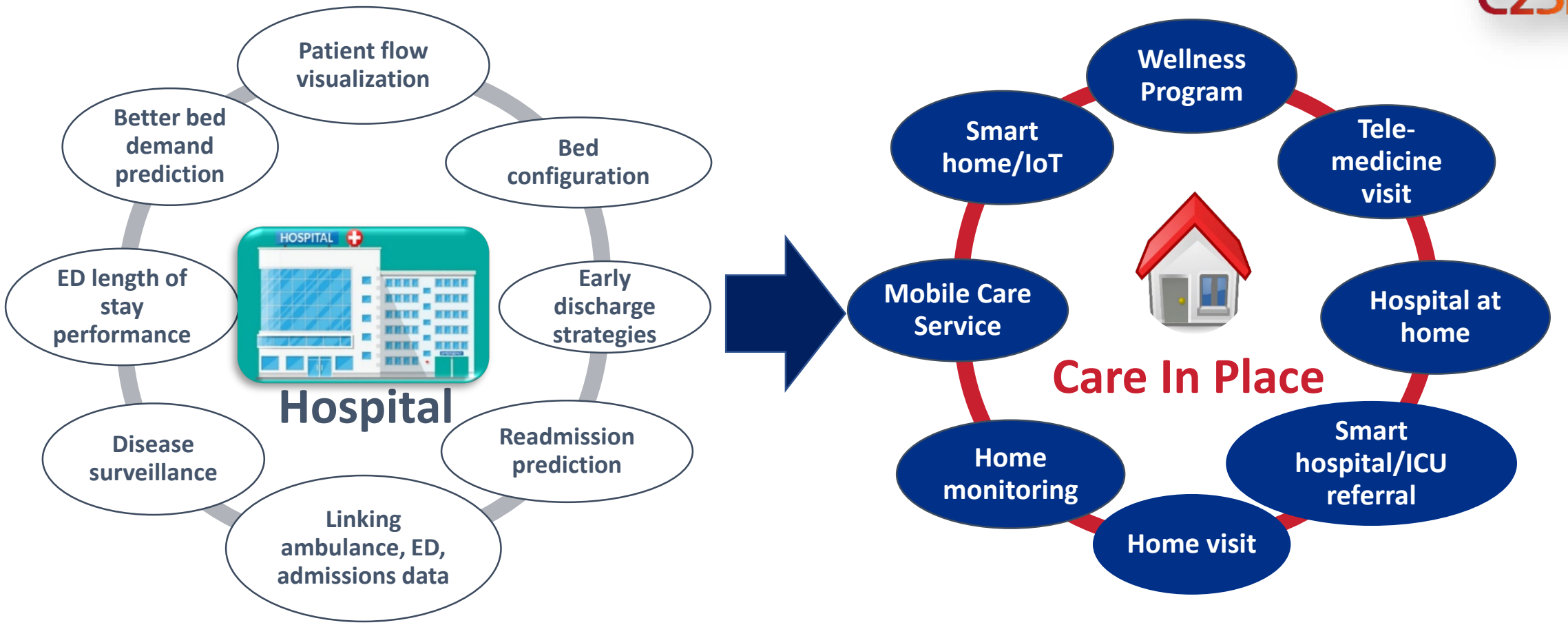
+ UND University of North Dakota

NSF

IUCRC

https://c2ship.org/

The C2SHIP Vision: *Care In Place*



Decentralization of care model: From traditional Hospital centralized healthcare delivery model (LEFT) to Care In Place, a new patient-centered healthcare delivery model (RIGHT).

Research Questions

- What information is clinically relevant?
- How do we detect very early health changes?
- Can we diagnose early to facilitate early interventions?
- Are health outcomes improved?
- Can we do this in the home for Care In Place?