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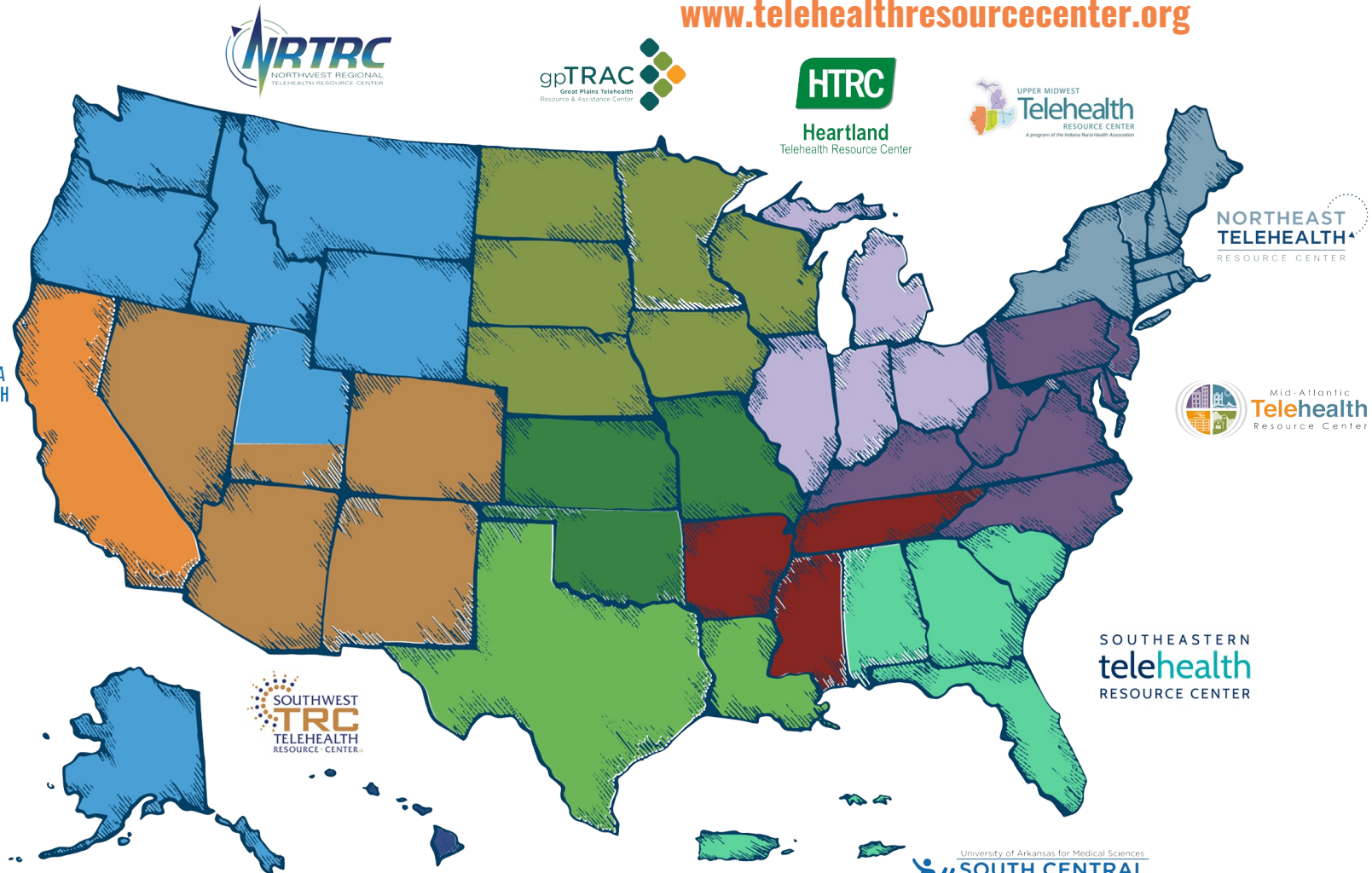
**Digital Health in Homes and
Communities: Emerging
Opportunities for Patient
Engagement**

March 17, 2022



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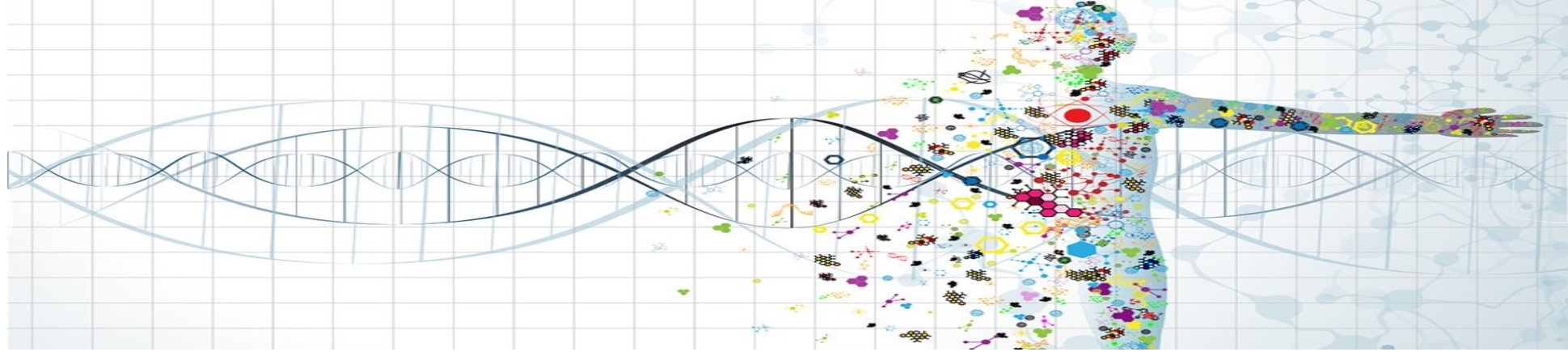
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Digital Health in Homes and Communities: Emerging Opportunities for Patient Engagement

George Demiris PhD, FACMI
University of Pennsylvania



NCTRC Webinar
March 17, 2022

Precision Medicine

- Precision medicine calls for collecting and analyzing large data collected on the unique individual's:
 - behavior
 - lifestyle
 - genetics
 - environmental context



Digital Phenotyping

- moment-by-moment quantification of the individual-level human phenotype *in situ* using data from personal digital devices
- Informed by traditional Ecological Momentary Assessment (EMA)

Behavioral Sensing

- Passive monitoring & Wearable technologies
- Vision: **objectively, remotely, and continuously** measure aspects of patient physiology, behavior and symptoms

Behavioral sensing (cont.)

- Capturing behavior and activities of daily living
- Replacing the need for human observers
- Eliminating reliance on self-report
- Shifting from episodic to continuous monitoring
- Assessment in the real world and not the lab
- Identifying events and trends and patterns

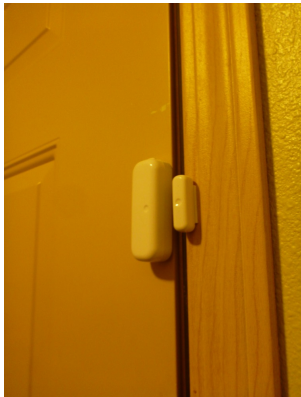
Smart home

- A residence with embedded technology that facilitates passive monitoring of residents to enhance their safety, independence and well-being
- Emergence of IoT devices



Smart Home Initiative

- Community dwelling older adults (65 years or older) in private residence, retirement community, assisted living facility
- Choice of sensor type and data sharing with trusted others



Door/Window sensor

- Door/window activity tracking



Multi-sensor

- Temperature
- Humidity
- Luminosity
- Motion

System Features

does not require retrofitting the home

works passively

individual sensors can easily be replaced when more advanced technologies become available

does not utilize cameras or face recognition technologies

privacy preserving approach

Engaging Users

- **dashboard** for residents and their family members or trusted others to review **actionable information** about
 - mobility, social interactions, sedentary behavior, restlessness at night, frequency and duration of meal preparation, time spent inside vs outside the home
- **alerts** are generated in cases where an adverse event may have occurred.

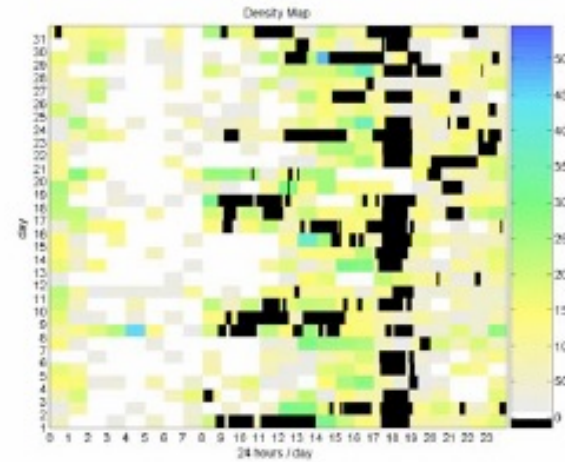
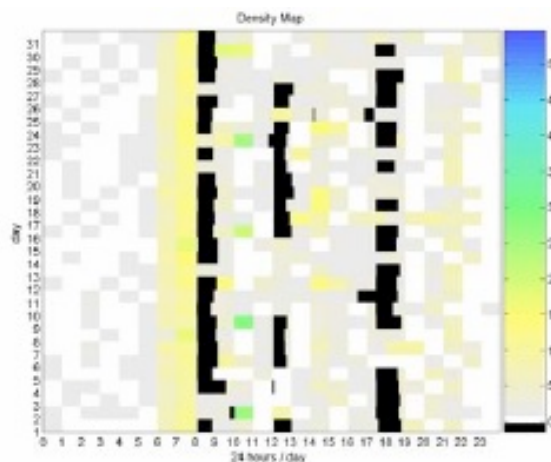
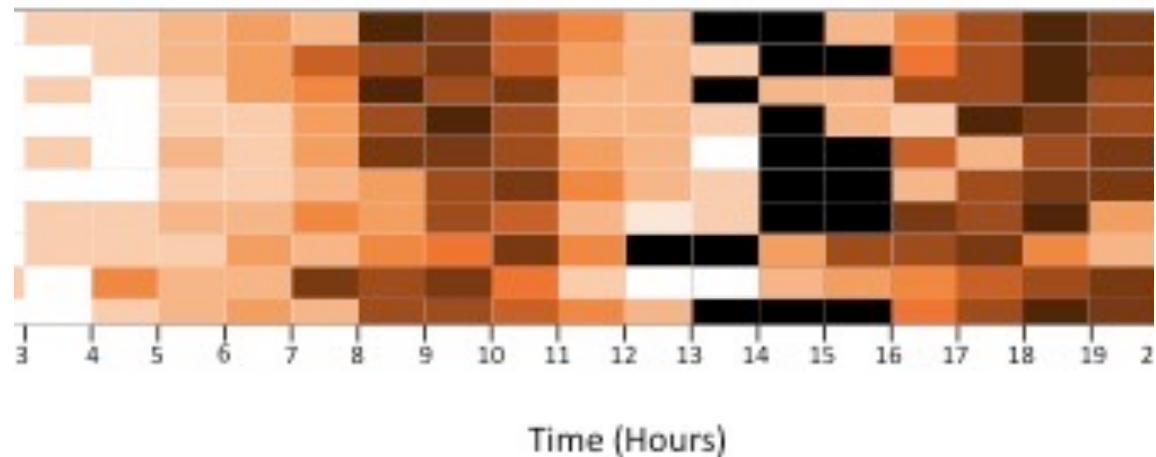
Visualizing Smart Home Data

Various stakeholders

Various information needs and purposes of use

Support efficient and effortless extraction of important information pertaining to events, trends and patterns

Density Map of Sensor Activity Per Hour



Demiris G, Oliver DP, Dickey G, Skubic M, Rantz M. Findings from a participatory evaluation of a smart home application for older adults. *Technol Health Care*. 2008;16(2):111-8.

Wang S, Skubic M, Zhu Y. Activity Density Map Visualization and Dis-similarity Comparison for Eldercare Monitoring. *IEEE Trans on IT in Biomed*. 2012;16(4):607-614.



A technology enhanced fall risk assessment and fall prevention nursing intervention for socially vulnerable older adults with mild cognitive impairment

<http://www.sense4safety.org>

Sense4Safety

- Falls in OA a result of accumulated vulnerabilities
- MCI and housing conditions are each independent risk factors for multiple falls.
- Cognitive impairment is a leading risk factor for falls in OA.
- Over 60% of OA with MCI fall annually – *two to three times* the rate of those without cognitive impairment.
- OA living in low-resource neighborhoods with poor housing conditions have *twice* the risk of falling.

Sense4Safety (cont.)

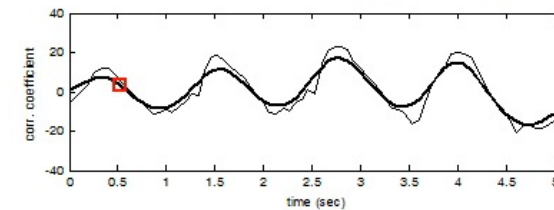
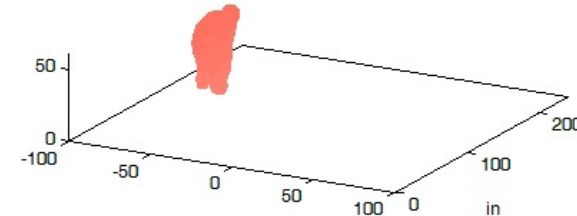
- Technology-supported intervention to:
 - link ‘at risk’ older adults with a nurse tele-coach who will guide them in implementing evidence-based individualized plans to reduce fall-risk
 - identify escalating risk for falls real-time through in-home passive sensor monitoring
 - employ machine learning to inform individualized plans to reduce fall risk



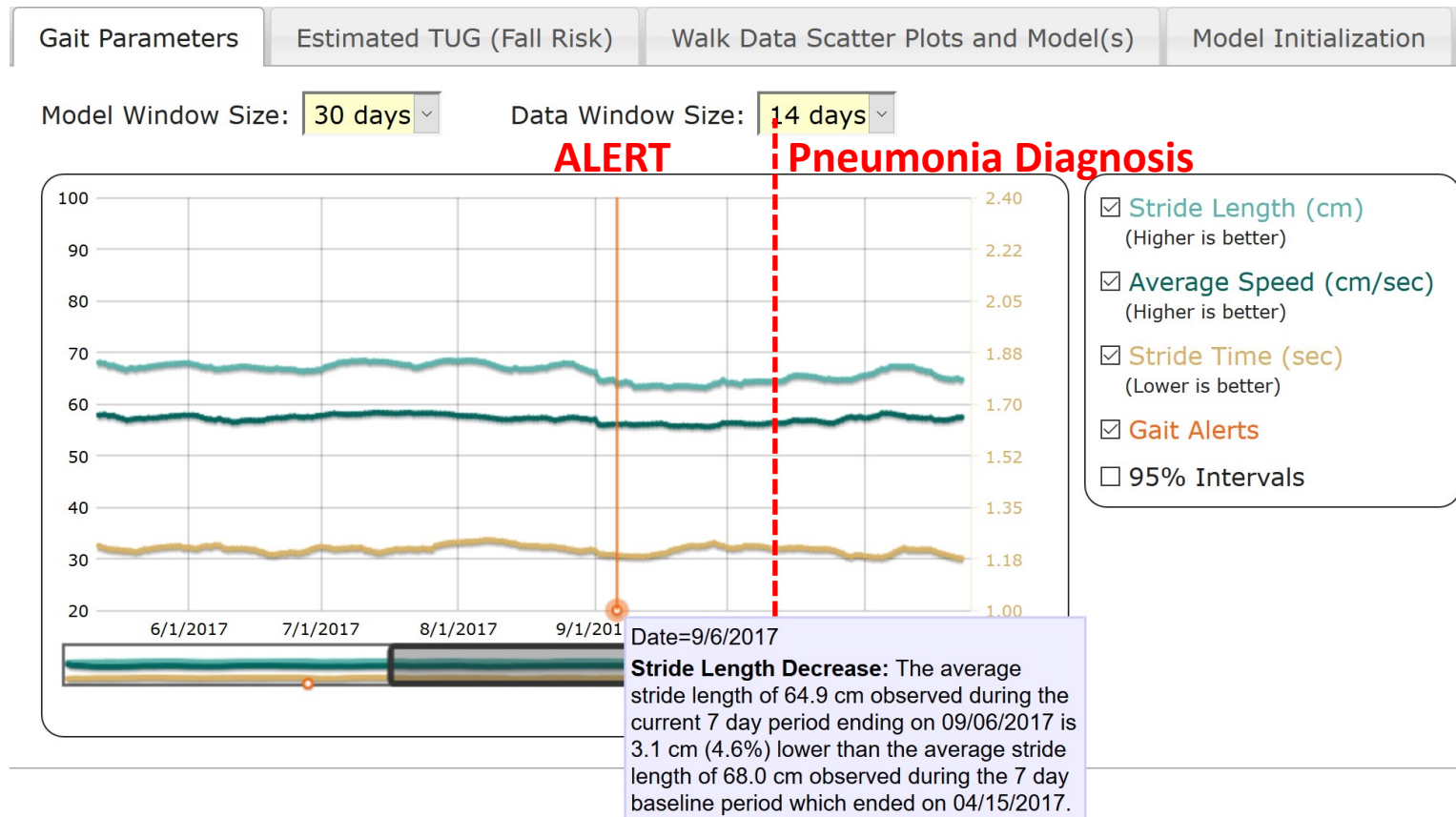
Capturing Gait in the Home Using Depth Data



Stone & Skubic, *JAISE*, 2011, *TBE*, 2013



Capturing Gait Changes

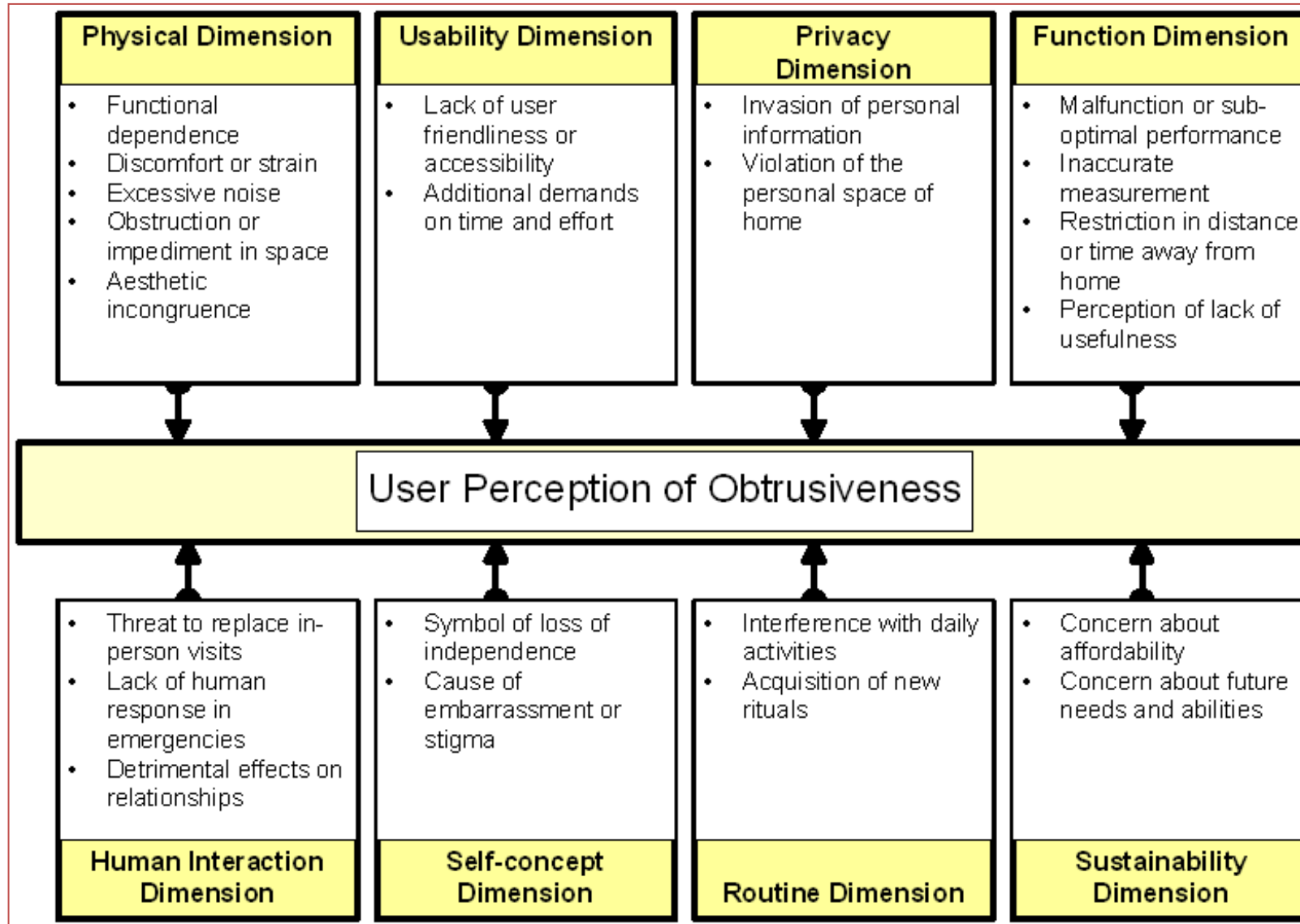


Obtrusiveness

- A summary evaluation by the user based on characteristics or effects associated with the technology that are perceived as *undesirable* and *physically and/or psychologically prominent*



Obtrusiveness Framework



Considerations

- Research
- Policy
- Implications for the Clinical Workforce
- Consumer Education

Research

- Further explore:
 - Impact on health outcomes, cost, efficiency
 - Patient engagement
 - Shared decision making, care coordination
 - New models of patient-centered care delivery
 - Healthcare utilization
 - Accuracy and reliability of data in various settings
 - How data can be standardized
 - Data visualization

Policy

- Guiding interoperability
- Standards around tracking modalities
- Liability
- Privacy Policy
- Reimbursement structures

Implications for the Clinical Workforce

- Integration into clinical workflow
- Interpreting data
- Sifting through large quantities of data
 - Real-time alert systems, artifact
- Delegation of responsibilities for review
- Guidance for identifying tools to recommend

Consumer Education

- How to select accurate, reliable tools
- Interpretation of data
- Discuss and understand expectations
- How not to exacerbate disparities
- Introducing challenges of “*data literacy*” on top of health and digital literacy
 - Users understanding of the use of their data, where stored, who has access?

Contact



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 @GeorgeD5PHL



Our Next Webinar

The NCTRC Webinar Series

Occurs 3rd Thursday of every month.

Telehealth Topic: Innovation & Integration of Telehealth into Population Health

Hosting TRC: Northeast Telehealth Resource Center (NETRC)

Date: April 21, 2022

Times: 11 AM – 12 PM (PT)

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