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

March 17, 2022
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Digital Health in Homes and Communities: Emerging Opportunities for Patient Engagement

George Demiris PhD, FACMI
University of Pennsylvania

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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

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

Capturing Gait Changes

**Alert** Pneumonia Diagnosis

- **Stride Length (cm)** (Higher is better)
- **Average Speed (cm/sec)** (Higher is better)
- **Stride Time (sec)** (Lower is better)
- **Gait Alerts**
- **95% Intervals**

**Stride Length Decrease:** The average stride length of 64.9 cm observed during the current 7 day period ending on 09/06/2017 is 3.1 cm (4.6%) lower than the average stride length of 68.0 cm observed during the 7 day baseline period which ended on 04/15/2017.
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

Physical Dimension
- Functional dependence
- Discomfort or strain
- Excessive noise
- Obstruction or impediment in space
- Aesthetic incongruence

Usability Dimension
- Lack of user friendliness or accessibility
- Additional demands on time and effort

Privacy Dimension
- Invasion of personal information
- Violation of the personal space of home

Function Dimension
- Malfunction or sub-optimal performance
- Inaccurate measurement
- Restriction in distance or time away from home
- Perception of lack of usefulness

User Perception of Obtrusiveness

Human Interaction Dimension
- Threat to replace in-person visits
- Lack of human response in emergencies
- Detrimental effects on relationships

Self-concept Dimension
- Symbol of loss of independence
- Cause of embarrassment or stigma

Routine Dimension
- Interference with daily activities
- Acquisition of new rituals

Sustainability Dimension
- Concern about affordability
- Concern about future needs and abilities
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

• gdemiris@upenn.edu

@GeorgeD5PHL
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