Big Data Challenges in Delivering Health Coaching Interventions to the Home

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Technology for Health Coaching

- Importance of health behavior change
- How technology can amplify the scalability and effectiveness of health interventions
  - Tailoring of materials
  - Timeliness
  - Extend the reach of a coach

Causes of Premature Mortality

- Genetic 30%
- Medical Care Deficiency 10%
- Behavioral 40%
- Social Circumstances 15%
- Environmental Exposure 5%

Evidence-Based Principles

Theory-based coaching

• Develop shared goals with patient preferences
• Assess readiness to change, motivations, triggers, barriers, self-efficacy
• Tailor interactions (action plan, messages)
• Continuous monitoring with just-in-time intervention

Current practice

✓ Human - phone interaction at baseline
✓ Human - phone interaction at baseline
✓ Human phone interaction at baseline
-- Predetermined set intervals for phone calls

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What do coaches actually do?

Motivational Interviewing

• Collaborative (don’t impose)
• Assess motivations to change
• Assess barriers to change
  – What are the triggers?
  – Develop problem solving plan for dealing with those situations
• Develop a tailored shared action plan
• Monitor & provide feedback / encouragement
Examples from Monitoring Older Adults

• Examples of New Behavioral Measures (used in remote coaching research)
  – Activity Monitoring in the Home
  – Cognitive Monitoring
  – Motor Speed
  – Sleep Monitoring
  – Socialization – Skype, phone, emails
  – Physical Exercise
  – Medication Management
  – Depression
Inference of Patient Activities Based on Sensor Data
Models to Infer Sensor Location & Legitimate Pathways

Infer Activities of Daily Living

Pavel et al., The role of technology and engineering models in transforming healthcare, IEEE Reviews in Biomedical Engineering, 6:156-177 (2013)
Activity Monitoring in the Home

Sensor Events
Private Home

Hayes et al., www.orcatech.org
Activity Monitoring in the Home

Sensor Events Residential Facility

- Bedroom
- Bathroom
- Living Rm
- Front Door
- Kitchen

Hayes et al., www.orcatech.org
Measuring Gait in the Home

  - Four restricted view PIR sensors
  - Measure gait velocity whenever a subject passes through the “sensor-line”
  - Deployed for the Intelligent Systems for Assessing Aging Changes (ISAAC) study
  - 200+ subjects monitored for > 4 years
Subject 1

Austin et al, Sept 2011 - EMBC (Gait)
Subject 2

Austin et al, Sept 2011 - EMBC (Gait)
Creating Design Requirements

- Focus groups with elders and caregivers
- Expert interviews with stakeholders
- Technology assessment and interoperability standards review
- Resulting design recommendations
  - Tailored action plans for health interventions
  - Home monitoring
  - Decision support
  - Integration of nurse care managers and family caregivers into the health care team
- Development of use cases

Participatory Design

• Living Lab –
  – Community dwelling seniors
  – Portland area; now Boston
  – Living independently
  – Used to test technologies to support independent living and provide scalable quality care in the home setting
Technology Approaches to Facilitating Health Coaching

- Effective use of resources
  - Wise use of face-to-face, Skype, phone interactions (build rapport, careful assessment)
  - Supplemented by automated or semi-automated messages

- Dynamic user model
  - Behavior change variables
  - Activity / context / health state estimates from sensor data
Dynamic User Model to Support Tailored Messaging

Intake Assessment
- Health Status
- Health Goals
- Motivations
- Barriers
- Readiness-to-Change
- Social Support
- Preferred Name
- Contact Preferences
  - Timing / Media

Dynamic User Model
- Current Goals
- Current Motivations
- Current Barriers
- Change State
- Cognitive Levels
- Adherence to Goals

Monitoring Data
- Computer Game Metrics
- Sleep Mat Measures

Self Report Data
- Physical Activity
- Nutrition
- Novelty Exercises

Message Database
- Greetings
- Feedback Messages
- Recommendations
- Closings
- General Interest News

Family Interface
- Safety monitoring
- Soft alerts
- Team-based care
- Socialization

Tailored Action Plan

Data Trends

Tailored Message Generator

Participant Interface
- Message from Coach
  - Action Plan
  - View of data
  - Access to Cognitive Games
  - Access to Email

Coach Interface
- Select from Panel of Pts
  - Action Plan
  - View of Data
- Editable Message Prompts
  - Access to Email
Semi-Automated Messaging

Study of coaching efficiency with/without assisted messaging

• Coaches (n=6) completed 4 coaching sessions for a panel of 10 (simulated) patients, half using automated system, half using manual system. Coaches were crossed over to alternate system after each session.

• **Efficiency** improved with semi-automated system (mean time to clear patient manual 4:26 min vs 2:39 min (p<.04)

• **Quality** of message judged equivalent on average by both patients and other coaches.

Michael Shapiro, MS Thesis, Oregon Health & Science University
Participant Home Page

- Messages from coach
- Featured story
- Weekly goals
  - Activities
  - Surveys
- Access modules
  - Physical Activity
  - Sleep
  - Socialization
  - Novelty Mental Exercises
  - Cognitive Games
- Coaching Process
- Participant Materials
Physical Activity Module
Automated Coaching for Physical Exercise

- Collaboration with
  - Oregon Health and Science University
  - University California Berkeley
- Pre-recorded video clips for tailored exercise and Kinect Camera
- Real-time feedback based on image interpretation from Kinect skeleton representation
- Monitoring of balance, flexibility, strength, endurance
- Potential for remote interaction
Sleep Module

Assessment
- Sleep Hygiene
- Anxiety
- Circadian Rhythm

Tailored Intervention
Socialization Intervention

- Web cams and Skype software given to participants and their remote family partner
- Frequent spontaneous use among participants
Cognitive Computer Games
(embedded cognitive metrics)
Computer Game to Measure Executive Function
Model Recall, Search, Motor Speed

Recall Next Target → Search for Next Target → Move to Next Target

\[ t_R + t_S(n, d) + t_M \]

Predicting Neuropsych Test Scores

$R^2 = 0.78$

$p < 0.0001$

Characterize Memory Capacity

- Intervening number of events
- Intervening time
- Memory load

Simple Memory Model: Discrete Buffer

M Pavel, et al., www.ORCATECH.org
Interface options for:
- Older adult
- Remote family member
- Community health worker
- Health coach

Steven Williamson, PhD Dissertation,
Oregon Health & Science University
User reactions to tracking

- there is great variability in what factors about their life people would want to track
- what people wish to track will change over time, based upon their age, life circumstances, interactions with friends and family, health status, and general curiosity
- ubiquitous “monitoring” systems may be more readily adopted by end users if they are developed as tools for personalized, longitudinal self-investigation that primarily help end users, instead of or in addition to medical professionals, learn about the conditions and variables that impact their social, cognitive, and physical health.

Beaudin JS, Intille SS, Morris ME
To Track or Not to Track: User Reactions to Concepts in Longitudinal Health Monitoring
J Med Internet Res 2006;8(4):e29
<URL: http://www.jmir.org/2006/4/e29/>
Monitoring Attitudes from Older Adults

• Older adults are willing to trade privacy for increased independence and ability to age in place.
  – Adult children had more concern.

• Cognitive health was most important health concern (quality of life & independence).

Lessons Learned

- **Algorithm Issues**
  - New analytic models for developing behavioral markers derived from sensor data
  - Dynamic user models
  - Tailored message generation
  - Privacy / Security – tailored data sharing
  - User centered design – ease of use

- **Protocol Issues**
  - Need to have a variety of activities for novelty and sustained engagement
  - Coaching (automated and in-person) important
Opportunities for Nursing

- Home Health and Self-Management are domains of Nursing
- New job opportunities
  - Coordination of care to the home
  - Multidisciplinary teams
  - Community health workers
- New research opportunities
  - Need to use technology to make the clinical interventions more tailored & timely
Summary: Considerations when Designing mHealth Behavior Change Interventions

• Make use of sensors and data analytic models
• Remote, just-in-time, continuous care
• Integrate principles of health behavior change
• Usability
• Access issues, culture, literacy, etc.
• Integrate family & informal caregivers into the health care team (untapped resource)
• Security & privacy issues
• Business model
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Questions?

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