FRAMING THE AGING IN PLACE RESEARCH CHALLENGE

Elizabeth D. Mynatt
Professor, Interactive Computing, Georgia Tech
Vice-Chair, Computing Community Consortium
The mission of Computing Research Association’s Computing Community Consortium (CCC) is to catalyze the computing research community and enable the pursuit of innovative, high-impact research.

- **Audacious Thinking:**
  - Community Initiated Visioning Workshops
  - Blue Sky Ideas tracks at conferences

- **Outreach to White House, funding agencies:**
  - Outputs of visioning activities
  - Task Forces – Health IT, Data Analytics

- **Communicating CS Research:**
  - CCC Blog - [http://cccblog.org/](http://cccblog.org/)
  - Computing Research in Action Videos
  - Research “Highlight of the Week”

- **Nurturing the next generation of leaders:**
  - Computing Innovation Fellows Project
  - Leadership in Science Policy Institute

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**THE COMPUTING COMMUNITY CONSORTIUM**
Directorate for Computer & Information Science & Engineering

SMART HEALTH AND WELLBEING (SHW)

CONTACTS
See program guidelines for contact information.

SYNOPSIS

Information and communications technologies are poised to transform our access to and participation in our own health and well-being. The complexity of this challenge is being shaped by concomitant transformations to the fundamental nature of what it means to be healthy. Having good health increasingly means managing our long-term care rather than sporadic treatment of acute conditions; it places greater emphasis on the management of wellness rather than healing illness; it acknowledges the role of home, family, and community as significant contributors to individual health and wellbeing as well as the changing demographics of an increasingly aging population; and it recognizes the technical feasibility of diagnosis, treatment, and care based on an individual's genetic makeup and lifestyle. The substrate of 21st century healthcare will be computing and networking concepts and technologies whose transformative potential is tempered by unresolved core challenges in designing and optimizing them for applicability in this domain.

The goal of the Smart Health and Wellbeing program is to seek improvements in safe, effective, efficient, equitable, and patient-centered health and wellness services through innovations in computer and information science and engineering. Doing so requires leveraging the scientific methods and knowledge bases of a broad range of computing and communication research perspectives.

Some illustrative examples are described here. Protecting patient privacy while providing legitimate anytime, anywhere access to health services will require new security and cryptographic solutions. Personalized medicine will require advances in information retrieval, data mining, and decision support software systems. Continuous monitoring and real-time, customized feedback on health and behavior will rely on remote and networked sensors and actuators, mobile platforms, novel interactive displays, and advances in computing and networking infrastructure. Data collected by sensors, at clinics, and labs need to be anonymized and aggregated for community-wide health awareness and maintenance. Such data, especially collected over populations, can lead to inferences about best practices and cost savings in providing health services. Virtual worlds, robotics, image, and natural language understanding can facilitate better and more efficient delivery of health services. Software-controlled and interoperable medical devices are necessary for providing safe critical care. Healthcare systems and applications must be usable, to preclude or minimize failures due to human error; and they have to be useful, by matching the mental model of users, from provider to patient, so people make appropriate decisions and choices. These examples are meant to convey the breadth of computing areas that

CATALYZING AND ENABLING: HEALTH IT

Directorate for Computer & Information Science & Engineering

Smart and Connected Health (SCH)

PROGRAM SOLICITATION
NSF 13-543

REPLACES DOCUMENT(S):
NSF 12-512

National Science Foundation
Directorate for Computer & Information Science & Engineering
Division of Computing and Communication Foundations
Division of Computer and Network Systems
Division of Information & Intelligent Systems

Directorate for Engineering

Directorate for Social, Behavioral & Economic Sciences

National Institutes of Health
THE CRISIS OF OUR GENERATION

Longevity is such a recent phenomenon that it’s estimated that of all the human beings who have ever lived to be 65 years of age or older, half are currently alive today!

Add to your consideration the increasing number of Americans with disabilities including returning veterans.
WHY ARE WE HERE?

What is possible in the “home” as an extension and complement to the existing healthcare system?

Health not just healthcare, not just disease.

Older adults, people with disabilities, everyone.

Enhancing the quality of life and independence of people.
AGING IN PLACE FRAMEWORKS

- Activities of Daily Living (ADLs)
  - Bathing, eating, drinking, mobility
- Instrumental Activities of Daily Living (IADLs)
  - Preparing meals, paying bills, managing medications, maintaining the home
- Enhanced Activities of Daily Living (EADLs)
  - Social communication, hobbies, new learning, work
- Fraility
- Independence / Quality of Life
# Remote Monitoring by Use Case (In an aging context)

<table>
<thead>
<tr>
<th>Segment</th>
<th>Typical Functions and Activities</th>
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| **Wellness and Prevention**      | • Weight Management  
• Behaviors: exercise, calories consumed, sleep                                                 |
| **Chronic Disease Management**   | • Diabetes: monitor blood glucose  
• Congestive Hearth Failure (CHF): track weight  
• Hypertension: track blood pressure  
• Chronic Obstructive Pulmonary Disease (COPD): measure strength of breath (spirometry)  
• General: medication adherence                                                   |
| **Acute Care, Post-Acute Care, and Rehabilitation** | • PERS  
• Prevent hospital readmissions  
• Monitor physical therapy at home                                                  |
| **Aging at Home (in Place)**     | • Medication optimization  
• Remote monitoring of vital signs and activities of daily living  
• Assistive technologies (e.g., smart home, smart wheelchair)                        |

Raw Sensor Data

- Motion Detectors
- Location Traction
- Load Cells / Bed Sensors
- Contact/Door Switches
- Phone Sensors
- Computer
- Medication Tracker
- Weight Scale

Direct Assessment

- Gait Velocity
- Location Estimation
- Sleep
- Departures Arrivals
- Phone Use
- Computer Interactions
- Medication Events
- Weight

Inference

- Mobility
- Sleep Hygiene
- Socialization
- Depression
- Memory
- Attention
- Medication Adherence
- Physical Impairments

Frameworks

- ADLs
- IADLs
- EADLs
- Fraility
- Chronic disease management
- Independence
- Quality of life
REALITIES OF AGING IN PLACE

• Women and suburbs
• Multiple chronic conditions, disabilities
• Evolving health needs
• System administrators are few and far between
• Messy data compared to traditional medical evidence
• Conflicting priorities: Health vs. Healthcare
• Evidence for accountable care models
WOMEN AND AGING

It’s fitting that the nation’s first baby boomer is female; Kathleen Casey-Kirschling, born just a second after midnight on New Year’s Day 1946 which earned her a title: The country’s first baby boomer.

- More likely to be alone in old age
- 65+ Poverty rates 2Xs higher than males
- Living longer with chronic diseases at 2.5Xs the rates of Males

According to AARP, four million women 50+ live in households with at least 2 females 50+ and are house-sharing to meet the challenges of aging in suburbia.
MULTIPLE CHRONIC CONDITIONS. DISABILITIES. EVOLVING HEALTH NEEDS

There is nothing static about aging.

- Successful aging used to be defined as the absence of chronic conditions but only a small percentage of seniors meet this criteria.
- More than 77% of seniors between the ages of 65 and 79 suffer from one or more chronic diseases. The number rises to 85% for those over age 80.

Reflect on how much your health needs have changed in 30+ years.
SYSTEM ADMINISTRATORS ARE FEW AND FAR BETWEEN

What does technology look like in the home?
• Household appliances replaced every ~10 years as consumers?
• Cell phones replaced every 2 years in healthcare environments?
• Medical devices refreshed every 3-7 years?

Need realistic models for technology adoption and sustainability
MESSY DATA COMPARED TO TRADITIONAL MEDICAL EVIDENCE

Less controlled environment
Diverse data
  both in scope and origin
Many stakeholders

Remember that people are messy too.

• On average, individuals 65 to 69 years old take nearly 14 prescriptions per year, individuals aged 80 to 84 take an average of 18 prescriptions per year
• Adverse drug reactions and noncompliance are responsible for 28% of hospitalizations of the elderly
• 36% of all reported adverse drug reactions involve an elderly individual
• Each year 32,000 seniors suffer hip fractures caused by medication-related problems
CONFLICTING PRIORITIES: HEALTH VS. HEALTHCARE
EVIDENCE FOR (ACCOUNTABLE) CARE MODELS

Aging in Place exists within multiple larger economic contexts.

Providing synergistic health and economic value

TigerPlace
ORCATECH
Elder Tree
HOW DO WE CREATE THE SCIENCE TO DEMONSTRATE THE VALIDITY OF AGING IN PLACE APPROACHES?
POSSIBLE PATHS AHEAD

- Advanced data analytics
- Care coordination
- Healthcare as engineering control system
- Consumer adoption
- Holistic system approaches
- Pilot projects: System demonstrations
WORKSHOP FORMAT: PANEL INSPIRED DISCUSSIONS

- Insights and Realities of Designing for Older Adults and Their Caregivers
- Innovation Needed: Sensing, actuation and system integration technology
- Health transition trajectories: Data to action
- How to integrate Aging in Place in a Learning Healthcare System
- Shaping the future of Aging in Place
- Summary Panel
POST WORKSHOP ACTION

• Executive summary
• Research roadmap:
  – The white paper or road map should provide a list of grand challenges and priorities for next 5, 10, and 15 years.
• Journal publication
• Inform and influence