Collaborative Research Grant Initiative: Mental Wellness in Seniors and Persons with Disabilities

Seed/Bridge Fund Final Report

FEBRUARY 29, 2012 - Dr. Lili Liu
EXECUTIVE SUMMARY

We examined the role of technology for seniors with complex needs. Complex needs are limitations in physical or mental health or social connectedness to the extent that individuals require monitoring. We searched English language literature relating to smart home technologies for the elderly published after 2000, using health care and computer science databases. 1047 papers were extracted from Cinahl, Scopus, IEEE Xplorer, ACM library, and ISI Web of Knowledge databases using the following search terms alone or in combination using the logical operators of “AND” and “OR”: “smart home”, “health”, “gerontechnology”, “assisted living”, “monitoring”, “older adults”, “telesurveillance”, “telemonitoring”, “older adult”, “senior”, “elderly”. We also added 41 hand-selected articles that were provided by the interdisciplinary advisory panel. After removing duplicates a total of 768 articles remained to screen for inclusion. Of these 188 articles met further inclusion criteria for detailed review.

The articles targeted home care (>80%), assisted living (>40%) and continuing care (>20%). Targeted users of technologies were clients (nearly 80%), formal caregivers (40%) and informal caregivers (20%). Almost all technologies described were in the prototype or pilot stages and a small minority (about 5%) were readily available technologies. Only 6% of studies were of experimental type. Dementia care, chronic disease management and detection of changes in health status were the major focus of these studies. The data, for now, indicates that the focus of technologies are on fall detection/management, supporting seniors with cognitive impairments, physiological monitoring for chronic disease management and activity monitoring of clients living at home.

RESEARCH OVERVIEW

Objective(s)
In this project we examine the role of technology in “therapeutic” environments for seniors with complex needs through a literature review. We define complex needs as limitations in physical or mental health or social connectedness to the extent that individuals require monitoring. We reviewed the English literature published after 2000 to identify best-practice examples of technologies designed to enhance the quality of life and safety of older adults living in private or facility-based congregate housing. While these are “homes” for the residents, they are also termed “therapeutic” environments.

Background
The aging population is increasing rapidly, due to rising life expectancy and fertility decline¹, the world population over the age of 60 is expected to triple by 2050². The significant costs associated with the provision of care to this aging demographic, as well as shortages in the health workforce, has spurred both industry³ and academia to undertake research on the efficacy and feasibility of health monitoring and assistance provided in the home environment.

³ Personal Telecare http://www.intel.com/healthcare/telehealth/index.htm?iid=health+telehealth
Oatfield Estates http://www.elitecare.com/technology
medicalert http://medicalert.org/home/Homegradient.aspx
According to reports from the United Nations, most seniors worldwide prefer to age in their own homes despite possible risk to their health. In a survey undertaken by a healthcare financing administration in the U.S., 30% of those over 65 surveyed stated they would “rather die” than enter a nursing home. While most seniors want to age at home this is not always possible. However, placement is not immediate due to bed shortage, placement wait times that can range from weeks to years, and community health service provider shortage. According to a report in Time Magazine, facility-based care for an elderly individual costs, on average, $60K per year in North America, with many facilities requiring an additional entry fee/deposit (Greenwald, 1999). Placement in facility care, especially when it occurs against an individual’s wishes, has been associated with negative effects such as depression, social isolation, and greater dependency in completion of self-care tasks (Abowd, 2002). On the other hand, estimated valuations of care provided by informal caregivers (e.g., family members, friends, neighbours) suggest that it exceeds $190 billion per year (Cook 2006).

In this project Smart Home is described as a home that has a set of sensors to detect the context of the inhabitant and use devices/actuators to improve the elderly inhabitant’s experience at home. Smart-home technologies can enable older adults to live independently at home longer and reduce their reliance on informal or formal caregivers. These technologies have the potential to provide a cost-efficient approach to improve the quality of life and ensure the safety of older adults as they age in their homes. A Smart Home can provide a variety of services from simple task automations, such as room temperature control, to analysis/prediction of location, behavior, or health status of the occupant and subsequent transmission of the collected data for remote monitoring.

There are 4 key applications for smart homes:
(a) Real-estate management: the process of managing tools, equipment and assets to build, maintain, and repair a property;
(b) Home safety and security: using technologies and devices to prevent intrusion to a facility (e.g., video surveillance systems, electronic access control systems, and passive infrared sensors);
(c) Home automation: remote or automatic control of devices, appliances, or systems at home to improve quality of life of the inhabitant (s) or energy management and efficiency based on the environment context; and
(d) Monitoring wellness: monitoring health-status of the inhabitant and perception of user context to maintain his/her well-being.

There are several different processes involved in assisting the elderly and monitoring their health and wellbeing. First, one needs to monitor the inhabitant’s context using a set of sensors (perception). Next, the sensor data must be processed and analyzed to recognize the context of the inhabitant and environment (data analysis and decision making). Finally, the derived knowledge can be used to inform the occupant, by reporting the inhabitant’s situation or triggering alarms (Abowd, 2002; Helal 2005), or to control the environment to improve the occupant’s experience (i.e., using devices and actuators for action automations such as room temperature control (Das 2005) and lighting (Helal 2005; Kleinberger 2007). Furthermore the processed data can be provided to caregivers to aid in health status monitoring and care provision (Cook 2006; Stroulia 2009; Kleinberger 2007).

There are challenges involved in developing assistive environments that can meet a resident’s needs, and satisfy caregiver requirements. Usability, adaptability, accuracy, and accessibility of
such environments are a few to mention. Privacy, security, and training of the end-users are other issues that need to be addressed. In this project we present the results of a comprehensive systematic literature review on smart home technologies for the elderly. We highlight challenges in developing smart environments and identify potential research directions.

Approach and Methods
An interdisciplinary group with representation from the Departments of Computing Science and Occupational Therapy at the University of Alberta as well as government (i.e., Alberta Health Services) collaborated on this project. The group members monitored the progress of literature review with the goal of future knowledge translation. A smaller group of four research assistants (one in computing science, three in occupational therapy) searched, identified and reviewed the literature.

A search of English language literature relating to smart home technologies for the elderly published after 2000 was undertaken utilizing various health care and computer science databases. 1047 papers were extracted from Cinahl, Scopus, IEEE Xplorer, ACM library, and ISI Web of Knowledge databases using the following search terms alone or in combination using the logical operators of “AND” and “OR”: “smart home”, “health”, “gerontechnology”, “assisted living”, “tech*”, “monitoring”, “older adults”, “telesurveillance”, “telemonitoring”, “older adult”, “senior”, “elderly”. We also added 41 hand-selected articles that were provided by the interdisciplinary advisory panel. After removing duplicates a total of 768 articles remained to screen for inclusion.

With the goal to look at the role of technology in therapeutic environments for the elderly with physical and mental health needs, papers were screened for inclusion and were reviewed, if the following three questions were all answered positively:
1. Does the paper address technology use in a supportive housing/assisted living environment? We do not exclude home-base applications as they are likely generalizable.
2. Does the paper address the health (physical and/or mental) needs faced by older adults?
3. Does the paper describe technology (ies) that have been implemented/deployed at least in pilot form? We would definitely prefer to see real-world deployments but we also considered lab applications.

At the end of this process, 188 of the 768 papers met the criteria for inclusion for review.

Key Findings
- The bulk of technologies described in the literature are designed for implementation or use in homes, assisted living, or continuing care facilities. We define each of these in our final paper.
- With respect to target groups, the technologies described in the reviewed papers are typically designed for a particular end-user. Smart technologies are being designed to support individuals, their caregivers (formal and informal) or both.
- Technologies can be categorized into five types depending on their purposes:
  o Fall detection: these can be user-activated alarms, wearable fall detectors or video-based fall detectors.
    - Primary technologies for fall prevention
    - Secondary technologies focus on early detection of falls
    - Tertiary technologies address reducing morbidity caused by fall-related injuries
o Cognitive impairments: these technologies support clients with dementia or other cognitive impairments. Interfaces in a smart home can compensate for a client’s deficits, e.g., medication management reminders
o Physiological monitors: these can be used to capture physiological data that inform clinical decisions
o Activity recording and analysis: these can be done through the use of sensors
o Smart homes and assistive environments: we describe 12 examples including the Smart Condo™ at the University of Alberta

Conclusions
In the past 10 years, significant contributions have been made to the development of smart homes and domestic healthcare monitoring systems for seniors with mental health and other complex needs.

IMPLICATIONS FOR POLICY OR PRACTICE
A major current challenge is to integrate the health data that is collected through these technologies to allow formal and informal care providers to plan and better care for clients. Most technologies are designed to address safety and risk issues of clients. However, there remains social, moral, privacy and legal issues that need to be addressed prior to broader, more mainstream application and adoption.

DIRECTIONS FOR FURTHER RESEARCH
The results of this research are being applied to our team’s work in the area of technologies for health care aides and their home care teams. Specifically, we are examining the applications of mobile information communication technologies to enhance the care, efficiency and communication when they work with clients living with complex conditions in their homes.

We are also embarking on research that will examine the ethical implications of using technologies with clients in their homes, whether these are the community or in a facility. In particular we are interested in the approaches that informed consent can be carried out with clients who have complex needs, and the balance of ethical principles when we weigh a client’s need for safety and risk for loss of privacy.

From the computing science perspective, research is being conducted on approaches to integrate data from a variety of sources into meaningful outputs that allow everyday practitioners to make care plans, and also allow clients and their families to self-manage to the level they desire.

Finally, this literature review has provided a foundation from which a team can create a plan to interact with the industry, and to engage vendors at the design phase of technologies so that clients’ needs are considered early in the usability testing.

KNOWLEDGE DISSEMINATION AND TRANSLATION ACTIVITIES
The preliminary results have been presented at one location conference in Edmonton in December 2010, and one international conference in the US in November 2010. We plan to submit our manuscript to a peer-reviewed journal in March 2012. In addition, we intend on presenting the results at Found in Translation conference, March 8, 2012, Edmonton (hosted by CRGI).
**PrINCIPAL APPLICANT (TEAM LEADER)**

<table>
<thead>
<tr>
<th>Name</th>
<th>Position Title</th>
<th>Topics of interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lili Liu, PhD</td>
<td>Professor &amp; Chair, Department of Occupational Therapy, Faculty of Rehabilitation Medicine, University of Alberta</td>
<td>Aging in place, Smart Homes, Seniors with Complex Needs, Rehabilitation, Homecare</td>
</tr>
</tbody>
</table>

**Project Partners (Team Members)**

<table>
<thead>
<tr>
<th>Name</th>
<th>Position Title</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eleni Stroulia, PhD</td>
<td>Professor, Computing Science, University of Alberta</td>
<td>Co-investigator, supervise computing science graduate student, data analysis, manuscript preparation, dissemination</td>
</tr>
<tr>
<td>Ioanis Nikolaidis, PhD</td>
<td>Professor, Computing Science, University of Alberta</td>
<td>Co-investigator, supervise computing science graduate student, data analysis, manuscript preparation, dissemination</td>
</tr>
<tr>
<td>Linda Seale</td>
<td>Librarian, Health Sciences, University of Alberta</td>
<td>Assist with literature search on electronic databases</td>
</tr>
<tr>
<td>Angela Sekulic, OT(C)</td>
<td>M.Sc. (OT) student (thesis route)</td>
<td>Research assistant, database search, data analysis, data synthesis and interpretation, manuscript preparation</td>
</tr>
<tr>
<td>Katie Woo, OT(C)</td>
<td>M.Sc. (OT) student (thesis route)</td>
<td>Research assistant, database search, data analysis, data synthesis and interpretation, manuscript preparation</td>
</tr>
<tr>
<td>Ran Ran Zhang</td>
<td>M.Sc. (OT) (project route)</td>
<td>Research assistant, web and grey literature search, synthesis of results</td>
</tr>
<tr>
<td>Corinne Schalm</td>
<td>VP, Shepherd’s Care Foundation</td>
<td>Expertise in keyword generation, interpretation of results</td>
</tr>
<tr>
<td>Beth Wilkey</td>
<td>Director, Supportive Living, Shepherd’s Care Foundation</td>
<td>Expertise in keyword generation, interpretation of results</td>
</tr>
<tr>
<td>Suzanne Maisey</td>
<td>Director of Quality Improvement Projects, Shepherd’s Care Foundation</td>
<td>Data interpretation</td>
</tr>
<tr>
<td>Sharla King, PhD</td>
<td>Director, HSERC, University of Alberta</td>
<td>Manuscript preparation</td>
</tr>
<tr>
<td>Koosha Golmohamadi</td>
<td>PhD Computing Science student</td>
<td>Research assistant, database search, data analysis, data synthesis, manuscript preparation</td>
</tr>
<tr>
<td>Carmen Grabusic</td>
<td>Alberta Seniors</td>
<td>Expertise in keyword generation, interpretation of results</td>
</tr>
</tbody>
</table>

**Publications and Presentations**

- A paper is being edited and will be submitted to a peer-reviewed journal in March 2012.
ABOUT THE ALBERTA ADDICTION AND MENTAL HEALTH RESEARCH PARTNERSHIP PROGRAM

The Alberta Addiction and Mental Health Research Partnership Program is comprised of a broad-based multi-sectoral group, representing service providers, academic researchers, policymakers and consumer groups, working together to improve the coordination and implementation of practice-based addiction and mental health research in Alberta.

The mission of the Research Partnership Program is to improve addiction and mental health outcomes for Albertans along identified research priority themes, by generating evidence and expediting its transfer into addiction and mental health promotion, prevention of mental illness, and innovative service delivery.

The Research Partnership Program sets out to increase Alberta’s excellence and output of addiction and mental health research findings, and to better translate of these findings into practice improvements.
REFERENCES


