*e*HOME-*i*CARE (**e**lectronic **HO**me **M**onitoring to **E**mpower, *i*nform **C**aregivers **A**nd **R**obotic **E**ffectors)

The *e*HOME-*i*CARE Vision
Caregiving is a complex behavior for which humans are uniquely suited and technological equivalents remain in their infancy. We believe that technology can supplement and, someday, stand-in for human caregivers.

Our Goals
The goals of *e*HOME-*i*CARE are to: 1) develop an integrated suite of technologies to monitor and predict dynamic changes in the health and well-being of older adults living at home; and 2) use this information to intervene by informing caregivers or providing respite care through direct technologically-driven interventions.

Through our work with strategic partners, we are developing an integrated suite of technologies to continuously monitor the home environment and assess the status of its resident. The path to predictive algorithms mixes passive monitoring with intermittent psychological and physiological assessments. The passive measures include: gait parameters, location, sleep patterns, phone and computer usage and medication events. The intermittent assessments include cognitive measures, common biometrics (e.g., heart rate, blood pressure), caregiver and individual self-reports, as well as instrumented measures of locomotion. We will use the intermittent experimental data to develop multiple computational models of the continuous data. These models will distinguish between normal variations in daily activity and the evolution of changes that reflect the need to intervene. The outputs of these models will aid decision makers (caregivers, case managers, health care providers) and drive effectors (devices that provide direct, automated caregiving).

The *e*HOME-*i*CARE Team
We are an interdisciplinary team of clinicians, researchers and engineers with broadly overlapping expertise in aging and dementia, basic brain sciences, physiological measurement, big data, quantitative modeling, signal processing, embedded design, medicine, medical economics, medical administration and grant writing. Every member has publications in peer-review journals and most of us have shouldered major caregiving duties. As collaborators, we gather from universities, health authority, government institutions, big business, small business, and research institutes, including, for example, University of Victoria, Island Health, IBM and ORCATECH. Partnerships with technology incubators and health industry would significantly advance our vision and yield opportunities for tangible commercial outcomes that arise from supporting community dwelling older adults with cognitive needs.

Cheryl Beach, PhD, PT
Project Director, Community Care Initiatives, Island Health Authority, Victoria, BC
Dr. Beach oversees projects related to technology in the community. In her role she has been the Island Health clinical lead for the Home Health Monitoring provincial project supported by the BC Ministry of Health and TELUS. She oversees innovative technology projects in partnership with CanAssist at the University of Victoria, as well as the implementation of remote monitoring technologies to support families and caregivers, such as CareLink Advantage. Dr. Beach is also involved in quality improvement and research projects related to the Resident Assessment Instrument-Home Care (RAI-HC) and RAI 2.0. She has worked primarily in the areas of home care, neurological rehabilitation, and neurosurgery in both Canada and Australia. Cheryl's clinical, educational and research interests have been primarily in the areas of geriatrics, neurological rehabilitation and home care, including falls prevention for older adults.

Andrew R. Mitz, MS Electrical Engineering, PhD Neuroscience
Staff Scientist, National Institutes of Health, Bethesda, MD
For the past 30 years, Dr. Mitz has combined engineering with neurophysiology to support an internally recognized team of research neuroscientists in the NIMH Laboratory of Neuropsychology. He is an expert in basic research tools for non-human primate research studies as well as a basic scientist with publications that examine the role of frontal cortex in movement, planning, decision-making, valuation and reward-guided behavior. Dr. Mitz spent 24 of these years raising a son with Phelan-McDermid syndrome, a syndrome characterized by motor and intellectual disabilities, and autistic behavior. Early on, Dr. Mitz developed a language-training device for his son (US Patent #5266034). Dr. Mitz is a champion for a new approach to developing effective caregiving support technologies.

Stuart MacDonald, PhD, Cognitive aging
Associate Professor, Dept. of Psychology, University of Victoria
Dr. MacDonald's research focuses on cognitive aging and early identification of those at risk for cognitive decline and disease, such as Alzheimer's. He examines patterns and predictors of cognitive decline in the elderly, paying particular attention to variability, or inconsistency, in responses over time. Recently he expanded this research to include variability in brain activity, measured with Near Infrared Spectroscopy (NIRS). Dr. MacDonald leads the PREVENT study at the university. The goal of this project is to search for markers, both biological and behavioural, that predict the onset of Alzheimer's disease. He and his team can detect evidence of decline up to ten years prior to standard diagnosis. Early detection brings new opportunities for intervention to both help individuals and stem health-care expenditures.

Scott MacDonald, PhD, Epidemiology and Biostatistics
School of Health Information Science, University of Victoria.
Scott Macdonald is a Professor at the School of Health Information Science and Assistant Director (Research) at the Centre for Addictions Research of BC (University of Victoria). He has over 30 years research experience in quantitative research and has conducted studies with a wide range of research designs, including randomized control trials, cohort and case-control designs , he has published over 100 papers. His areas of interest include: substance use and injuries, violence and collisions; alcohol policy; and workplace programs related to substance use. He will assist in this proposal with the design and analyses of data.

Yvonne Coady, PhD, Computer Science
Associate Professor, Computer Science Department, University of Victoria
Dr. Coady leads a research group, the Mod(ularity) Squad, in the Department of Computer Science.   She and her team work with industry stakeholders, community partners and interdisciplinary campus groups. Dr. Coady is Chair of the Academic Steering Committee for CanAssist, a University of Victoria based engineering team that develops innovative technologies for persons with disabilities. She and her Post Doc, Dr Celina Berg, recently won the Cognition Challenge, co-sponsored by Johnson & Johnson and the Canadian Consulate in San Francisco, for the design of innovative technology to assist families living with Alzheimer's and dementia.

Debra Sheets, PhD, MSN, RN, FAAN, Gerontology and Nursing
Associate Professor, School of Nursing, University of Victoria
Dr. Sheets' research interests focus on gerontology and geriatric nursing—and in particular caregiving, dementia, community-based aging programs and services, and healthy aging. Currently, she serves as Co-Investigator for the Canadian Longitudinal Study on Aging (CLSA), a national, long-term study that will follow approximately 50,000 men and women between the ages of 45 and 85 for at least 20 years. Recently completed projects include a national evaluation of 14 family and informal caregiver projects in 8 states and an evaluation of the Enhanced Seniors Team (EST) which was launched to improve care for frail, at-risk older adults being seen in the Emergency Department.

Carl V. Asche, MBA, MSc, PhD, Health Economics and Outcomes Research
Research Professor of Medicine and Pharmacy, University of Illinois

Dr. Carl Asche is the Director of the Center for Outcomes Research at the University of Illinois College of Medicine at Peoria, where he is a Research Professor both in the Departments of Medicine (Peoria) and Pharmacy Systems, Outcomes & Policy (Chicago). He is also a research affiliate with the University of Victoria Centre on Aging. His research focuses on the use of comparative effectiveness research and cost-effectiveness analysis in health care decision making. His academic work has comprised of being the author or co-author of over 75 papers appearing in the medical and economic literature. He is the editor of the forthcoming book entitled, "Applying Comparative Effectiveness Data to Medical Decision Making: A Practical Guide" (Adis, 2015). He has presented his research at seminars and conferences both nationally and internationally. He has served on numerous national and international health economics focused editorial, grant review, advisory boards and committees. Dr. Asche's research is funded by a variety of state/federal agencies and health system providers.

Sandra R. Hundza BSc (PT), PhD, Physiotherapy, Neurophysiology
Associate Professor, Department of Exercise Science, Physical and Health Education, University of Victoria
Dr. Hundza has an extensive clinical background in physiotherapy in the area of geriatrics as well as neurology and orthopaedics. In the Motion and Mobility Rehabilitation Laboratory, Dr. Hundza and collaborators employs neurophysiological, biomechanical, cognitive and motor behavioural measures for the study of gait, posture, and balance in older adults and other clinical populations, for the purpose of identifying preclinical indicators of fall risk and cognitive and mobility decline as well as to develop and enhance effective rehabilitation strategies to promote functional mobility and fall prevention.

Marc Klimstra, BKin, BEd, MSc Biomechanics, PhD Neuromechanics,
Assistant Professor, Department of Exercise Science, Physical and Health Education, University of Victoria
Dr. Klimstra explore how technologies apply to diagnosis of injury or decline, and offer new opportunities for recovery, rehabilitation or improvement, across the spectrum from disabilities and aging to high performance athletes. Klimstra and his colleagues are currently conducting research into the neuromechanics of gait in aging adults. By studying the nervous system, cognition and the mechanics of walking in older individuals, he and his collaborators aim to find pre-clinical markers of falls risk. He is also involved with a multidisciplinary international research team focused on improving caregiving for dementia through in-home monitoring using a host of biometric sensing technologies.

Ravi V. Chacko, BS Biomedical Engineering
MD/PhD Candidate, Washington University (St. Louis)
Ravi has over 10 years of research experience in the biomedical sciences. He is currently working on developing novel approaches to stroke rehabilitation using advanced signal processing analysis of electrocorticography (ECoG) and electroencephalography (EEG) recordings. Ravi co-founded the student run biodesign incubator at Washington called "Idea Labs". His organization provides resources for teams of clinicians, medical students, graduate students, and undergraduate engineers to design and implement solutions to medical problems identified by the clinical community.

PARTNERS

SimpleC Companion (http://www.simplec.com/companion/)
Dan Pompilio, CEO, Simple C
SimpleC is a small business dedicated to improving the lives of seniors. The SimpleC Companion™ is an intuitive touch-screen application that promotes memory, engagement, and better communication for seniors. During key times throughout the day, the Companion delivers scheduling reminders for activities, mealtimes as well as behavioral interventions for under stimulation, sundowning and agitation.

CURRENT PROJECTS

Technology Supports for Community--Dwelling Older Adults with Dementia and Family Caregivers. Funded by: Island Health.
This study explores the perceptions of care managers and home care clients about technology to support individuals with dementia. It also begins the first phase of using an integrated system of home care technologies to collect both continuous passive data and intermittant cognitive/physiological for building multilayer/multi-dimentional models.

Modeling Changes in Mobility, Cognition and Daily Activities to Predict Care Needs in Community Dwelling Older Adults Living with Cognitive Impairment. Funded by: Island Health.
This project will develop a comprehensive multivariate predictive modelling approach that integrates data from multiple sensors to provide a more predictive metric for adverse events or changes in health status than current in-home monitoring systems. First, we will use a comprehensive multivariate predictive modeling approach combing the predictive power of multiple inputs across many domains of health such as sleep patterns, daily activities, and gait and mobility parameters to identify changes in care status. Second, we will employ measurement of intra-individual variability in addition to assessment of mean-level changes. Measures of intra-individual variability have been shown to be sensitive predictors of the integrity in many domains of health and risk for adverse events. Lastly, we will innovatively combine in-home integrated data collected both continuously and intermittently.

Modeling changes in assessments to predict needs and guide care planning in home care.
Funded by: Technology Evaluation for the Elderly (TVN).
This study will develop a *predictive* frailty measure for seniors receiving home care by applying advanced analytic methods to data from the Resident Assessment Instrument Homecare (RAI-HC). Specifically, we propose to: 1) develop predictive models of frailty that can inform decision-making, 2) implement the frailty measure with healthcare professionals working with home care clients, and 3) explore the impact of the frailty intervention on clinical decision-making regarding transitions of care services utilization and health outcomes. Our intent is to reduce unnecessary or premature transitions.

Advancing Unobtrusive In-Home Monitoring to Support Caregivers: Can the lowly computer mouse extend aging-in-place, Funded by: Island Health.
This proof-of-concept study will quantify patterns of computer mouse movements in an unobtrusive, objective, reliable and automated way. The data analysis techniques will be developed at the University of Victoria, based on an existing data set of 20 individuals (10 with no cognitive impairment and 10 diagnosed with Minimal Cognitive Impairment) previously collected by ORCATECH (Portland, Oregon) over a span of 6 months. Our goal is to extend this study to broader home instrumentation of individuals serviced by Island Health, refine and extend the analysis techniques to other unobtrusive home measurements, and develop algorithms to respond to adverse events.