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Artificial Intelligence and Technology Collaboratory for Healthy Aging

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Perelman SCHOOL OF MEDICINE
UNIVERSITY of PENNSYLVANIA

ADVANCING DIAGNOSTIC EXCELLENCE FOR OLDER ADULTS THROUGH COLLECTIVE INTELLIGENCE AND IMITATION LEARNING

Gary Weissman, MD, MSHP

Diagnostic errors are common in the primary care setting and lead to direct patient harms, increased healthcare costs, and decrease patient satisfaction. Older adults are especially at risk for such diagnostic errors because of their higher comorbidity burden, medical complexity, increased rates of frailty and cognitive impairment, and decreased representation in clinical datasets and research studies. Artificial intelligence (AI) and machine learning (ML) methods have good face validity for offering clinical decision support (CDS) in this setting to promote diagnostic excellence. However, there is little data to suggest that any particular diagnostic CDS is transparent, reproducible, equitable, and effective at improving the diagnostic process. Therefore, our objective is to create a diagnostic CDS system for use in primary care clinics to facilitate the diagnostic process, present suggestions about important features of the history and exam to consider that are tailored to patient characteristics, and promote diagnostic excellence for older adults. This proposal overcomes existing limitations to training diagnostic CDS systems in primary care where there is a broad diagnostic scope and tremendous clinical uncertainty around training labels. To accomplish this, we will rely on imitation learning and collective intelligence to build AI/ML models that provide predicted suggestions into diagnosis and tests based on expected behaviors from peer clinicians caring for similar patients. These models will be trained using existing data from the electronic health record and deployed in a pilot study across diverse primary care clinics to assess their diagnostic accuracy and acceptability to clinicians, patients, and their caregivers.

https://pair.upenn.edu/

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KENNESAW STATE UNIVERSITY

GLUCOCHECK: A NON-INVASIVE & AI-ASSISTED BLOOD GLUCOSE MONITORING DEVICE FOR OLDER ADULTS

Maria Valero, PhD, MsC

The GlucoCheck project presents a significant advancement in the realm of diabetes management, with a specific focus on enhancing the quality of life for older adults. In light of the escalating global prevalence of diabetes and its associated complications, the imperative for non-invasive, accurate, and user-friendly blood glucose monitoring has never been more pronounced. Diabetes poses severe health risks, particularly for older adults, making effective and comfortable glucose monitoring paramount. Existing methods, characterized by frequent finger-pricking and subcutaneous needle implants, entail discomfort, infection risks, and potential tissue damage, particularly in individuals with diminished skin elasticity and compromised immune responses. GlucoCheck emerges as a pioneering solution, harnessing near-infrared spectroscopy (NIR) technology augmented by AI. This device offers a non-invasive means of consistently monitoring blood glucose levels by simply wearing it on one's finger. Importantly, GlucoCheck integrates AI algorithms that adapt to individual skin attributes, including color and texture, enhancing precision across diverse demographics.

This project's core objectives encompass rigorous validation of GlucoCheck's efficacy, with a primary emphasis on older adult demographic. Comparative analyses will be conducted, aligning GlucoCheck's measurements with conventional blood glucose monitors to ascertain accuracy and reliability. Our mission is underscored by the desire to deliver an efficacious, user-centric device tailored to the unique requirements of older adults. The project's outcomes will furnish valuable insights that drive refinements in GlucoCheck, propelling us closer to positively impacting the livesof millions of individuals grappling with diabetes.

http://iotas.kennesaw.edu/

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Tony C. Carnes, PhD

REAL-TIME REMOTE MONITORING OF CONFIRMED MEDICATION ADHERENCE

Medication non-adherence is responsible for up to $300 billion of avoidable healthcare costs in the United States with patients over 60 years of age consuming 50% of dispensed prescription drugs. This project enables real-time, remote monitoring of medication ingestions and enhances patient and caregiver feedback to help patients stay adherent and thus extend the time they are able to age grace fully at home.

The existing FDA-cleared IDCap system detects ingested medication signals using a watch or lanyard-style reader worn by the patient and forwards information to a server through an app on a patient's smart phone. In this proposal we are looking to remove the individuals' worn reader from the system and replace it with a series of readers placed in multiple locations in a person's home to ensure ingestion detection without the user changing their usual behavior. Additionally, the new readers will interface with Alexa to facilitate audible and visual reminders and confirmations of medication ingestion. If the end user allows, remote care providers will be able to participate in the adherence journey and intervene when needed.

https://etectrx.com/

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Maryam Zolnoori, PhD

A SPEECH-PROCESSING ALGORITHM FOR AUTOMATIC SCREENING OF AFRICAN AMERICAN PATIENTS WITH MILD COGNITIVE IMPAIRMENT AND EARLY DEMENTIA IN HOME HEALTH SETTINGS

Mild cognitive impairment (MCI) and early-stage dementia (ED) are prevalent concerns, impacting one-in-five adults over age 60. Alarmingly, a significant percentage of these cases remain undiagnosed, leading to missed timely interventions. Our data emphasizes that African American seniors are particularly vulnerable, with existing disparities in healthcare access, biases, and varying health literacy levels exacerbating the situation. A novel observation we intend to leverage is the correlation between linguistic shifts and the onset of cognitive issues. Language, a foundational element of cognition, exhibits early perturbations during cognitive decline. The nuances of these changes can vary across racial boundaries, influenced by dialectic variations such as African American Vernacular English. In this pivotal study, our objective is to architect a diagnostic tool to detect nascent signs of MCI-ED by analyzing African American patients' verbal communications during regular health consultations. By meticulously recording, processing, and extracting linguistic and phonetic features from these conversations, complemented by additional clinical data, we aim to devise a potent screening algorithm. This initiative aligns seamlessly with the National Institute on Aging's focus on early identification of cognitive impairment in the elderly. The prospective outcome, an innovative algorithm, holds promise to enhance timely MCI-ED diagnosis efficacy, especially among African American individuals, thereby optimizing care quality and addressing longstanding disparities.

https://www.nursing.columbia.edu

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A DEVICE FREE WIFI SENSING SYSTEM TO ASSESS DAILY ACTIVITIES AND MOBILITY IN LOW-INCOME OLDER ADULTS WITH AND WITHOUT COGNITIVE IMPAIRMENT

Jane Chung, PhD, RN

Low-income older adults face an increased risk of cognitive impairment and dementia. Cognitive impairment affects the ability to perform and manage daily activities and mobility behaviors. Detecting the changes in these abilities early is crucial but often difficult among low-income older adults due to limited resources. Our goal is to meet the unmet needs of low-income older adults by creating a cutting-edge system that uses Wi-Fi signals to localize and recognize different patterns of in-home activities and mobility. We employed machine learning algorithms to process the Channel State Information of the collected Wi-Fi signals and extract different activity and mobility features. Our system has demonstrated its ability to automatically categorize and quantify various in-home activities with accuracy rates ranging from 80% to 90%, depending on the activity type. Our project also collected self-reported physical function and psychosocial health data, and older adults' feedback on Wi-Fi sensing technology acceptance and implementation. This innovative project leverages Wi-Fi sensing technology and machine learning to detect changes in the levels and patterns of daily activities, empowering older adults experiencing cognitive decline. By providing an accessible and cost-effective solution, we can enhance monitoring capabilities, enabling better support for vulnerable older adults and promoting their quality of life and brain health.

https://www.nursing.emory.edu/

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Xinyu Zhang, PhD

NON-INTRUSIVE, FINE-GRAINED IN-HOME DAILY ACTIVITY TRANSCRIPTION FOR ALZHEIMER'S MONITORING

Recent research identified a strong correlation between onset of Alzheimer's disease (AD) and changes in fine physical activities, e.g., movement and dwelling time across locations, daily routines like medicine/water intake. Early detection of such indicators is crucial in compiling better treatment and slowing the progression. Conventional methods for monitoring the activities of daily living (ADL) rely on observation or self-report, which are time consuming, error-prone, and require strict patient compliance. This project aims to transcend such limitations and bridge the key technology gaps in bringing ADL sensing close to clinical practice. The project focuses on the development of EgoADL, a system that uses non-intrusive smartphone/smartwatch sensors to sense ADL. EgoADL builds on a novel self-supervised sensor fusion model that trains itself without user intervention. Instead of classifying among a small known set of ADLs, it directly transcribes raw multi-modal sensor signals into text logs of ADLs which can be interpreted by clinical practitioners or AI models. EgoADL will be the first to use non-visual sensors to transcribe fine ADLs (e.g., human-object interaction) with near-vision precision, in real-time and in a privacy-aware manner. The sensing data can facilitate follow-on clinical and AI analytics, potentially enabling early detection of chronic diseases and safe aging in place. Ubiquitous health monitoring is particularly important for rural and underserved communities, who either do not have access to or cannot afford prolonged hospitalization. EgoADL will be verified through a pilot study in UCSD's and Upenn's healthy aging facilities.

http://xyzhang.ucsd.edu/index.html

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Aidong Zhang, PhD

FAIRNESS AND ROBUST INTERPRETABILITY OF PREDICTION APPROACHES FOR AGING AND ALZHEIMER'S DISEASE

Machine learning (ML) approaches have been increasingly used for facilitating clinical decision-making in Alzheimer's Disease (AD) and AD related dementia (ADRD). However, recent research has shown that existing ML techniques are prone to unintentional biases towards protected attributes such as age, race, sex, gender, and/or ethnicity. Moreover, although deep learning (DL) models have been a great success in many applications including AD/ADRD prediction, DL models are usually expressed in a way that is not interpretable. Thus, ML approaches using health data may incur ethical and trustworthiness concerns that may result in the unfair treatment of patients. As decision-making systems for aging and AD/ADRD become popular, a major challenge is how to ethically integrate AI/ML methods into the lives of people, given that ethical principles may often be violated in existing methods. This has become an important issue for both the ML community and the AD/ADRD community. Moreover, ML approaches that are not transparent can be prone to repeating discriminatory patterns from prior data or generating new ones based on biased learned patterns. This project develops electronic health records (EHRs) based ML methods for Penn Medicine EHR AD/ADRD datasets that are fair, generalizable, and interpretable solutions that would help inform the clinician for AD/ADRD diagnosis and care management. We focus on studying fairness and interpretability, two important factors for making AI methods trustworthy, particularly during deployment or use of the methods. We study how bias affects our prediction models. Also, we will develop explainable methods to increase clinical interpretability.

https://engineering.virginia.edu/

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TALKING TECH WITH DEMENTIA CARE DYADS: IMPROVING A SELF-ADMINISTERED TOOL TO SUPPORT INFORMED DECISION

Clara Berridge, PhD, MSW

The proposed project is to enhance the Let's Talk Tech (LTT) intervention that is delivered as a web application. LTT is the first of its kind self-administered tool to help families meaningfully engage people living with mild dementia in digital technology use planning to enable optimal use to support dementia caregiving at home. Let's Talk Tech is an education and communication intervention that supports decision making and planning for technology use. It includes the following components: education accessible to people living with mild AD/ADRD and care partners about multiple technologies, facilitation of dyadic communication, and documentation of the person living with dementia's preferences. LTT has demonstrated in a pilot promising preliminary feasibility and efficacy on targeted measures for informed shared decision making about technologies. This project will implement what was learned from the pilot study about ways to further expand its reach, relevance, and sharing with the entire care network. Aim 1 is to enhance Let's Talk Tech to achieve wider relevance and equitable access with 4 new features. Aim 2 is to implement EHR integration and patient-controlled sharing of LTT's preference summaries, and Aim 3 is to assess clinician acceptability of viewing dyad's LTT preferences in a test instance the EHR. This will expand the intervention's reach and functionality, employ standards to promote interoperable sharing of documented preferences, and further test and iteratively improve LTT.

https://socialwork.uw.edu/news/project/lets-talk-tech/
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Vaaji

PREVENTION OF PATCH POISONING IN ELDERLY ALZHEIMER'S PATIENTS

Sandeep Patil, MD, PhD

Patients with Alzheimer's are prone to medication errors with serious consequences. Some errors, however, may be preventable if detected early. This project will develop smart patch technology to track errors in real time to prevent adverse outcomes.

Fatalities or emergency hospitalizations can occur due to transdermal patch overdose/poisoning by placing more than the prescribed number on the body.

Transdermal therapies typically have excess drug over what is intended to be delivered during the period when the patch is specified to be on body. Thus, an overdose can also happen if a new patch is placed without removing the older patch. A wide range of overdose symptoms occur with most commonly used drugs [cholinergic drug patch(s)] for Alzheimer's. In severe cases, these include rapid dehydration, and renal failure, and/or low heart rate potentially leading to sudden cardiac arrest and death.

Early detection of one or more excess patches AND prompt removal within a defined period protects against effects of overdose. A prototype patch(s) will be built with a signaling tag that can be easily detected by a fixed reader. We will then assess the performance of this prototype patch system as Healthy Volunteers move freely in different sections of the Home Care Suite. Successful implementation of this technology will contribute to healthy aging at home and improve the well-being of the patients and their caregivers.

https://vaaji.io/

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Julie Faieta, PhD

HEALTH APP REVIEW TOOL: CONNECTING THOSE AFFECTED BY ALZHEIMER'S TO NEEDED TECHNOLOGY SUPPORT

The goal of this project is to connect those affected by Alzheimer's disease and related dementias (ADRD) with effective apps using an intelligent decision-making aid, the Health App Review Tool (HART). The HART is comprised of a User Assessment and App Assessment, that together characterize the features of health apps relative to the needs, abilities, and preferences of individuals with ADRD and their informal caregivers. The HART assesses the goodness of match between user and app variables in order to guide app selection.

The first phase of this pilot project will be used to develop a web-base and app interface to house the HART. The dedicated interface is necessary in preparation for real-world and wide-spread use of the HART. There will be a user interface displaying the HART assessment questions, a back end that completes the scoring process, and a results display. In addition, we will establish a cloud-based library of app scores that can be downloaded and compared to new HART users in the future. The second phase of the project will be a usability study to gather feedback and insight on the HART interfaces for those impacted by ADRD.

The Health App Review Tool (HART) is expected facilitate clinicians, caregivers, and community organizations to select the best apps to meet the unique needs of individuals with ADRD and their caregivers. Improving access to person centered, easy to use technology guidance is intended to increase the impact and equity of app-mediated care.

https://www.shrs.pitt.edu/rst

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