



**Penn**  
UNIVERSITY of PENNSYLVANIA

Artificial Intelligence and  
Technology Collaboratory  
for Healthy Aging

## PILOT AWARDEES 2025-2026

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## DETECTION OF ADVERSE DRUG EVENT USING NLP AMONG OLDER ADULTS WITH HEART FAILURE

**Min Ji Kwak, MD, MS, DrPH**

Adverse drug events (ADEs) in older adults with heart failure are a serious public health concern. These drug-related complications can be life-threatening and significantly reduce quality of life. To capture ADEs correctly, doctors need to carefully review a patient's symptoms, medical history, prescription changes, and past records. However, this can be difficult to do thoroughly during a busy clinic visit.

An automatic tool using an Artificial Intelligence tool can help by scanning a patient's past medical records for signs of an ADE. This tool can be built into electronic health records to provide real-time assessments. While current AI models typically handle only one task at a time—like identifying medications—ADE detection requires a more advanced system that can process multiple tasks and make complex decisions.

To address this, we are developing a specialized AI framework called AIDE4HF. This system will leverage existing tools to detect ADEs in older adults taking heart failure medications. Our project has two main goals:

1. Create a high-quality dataset of ADEs related to heart failure medications in older adults.
  2. Develop and test a powerful AI system that can accurately detect these ADEs.
- This research is a collaboration between UTHealth McGovern Medical School and UTHealth McWilliams School of Biomedical Informatics. By combining expertise from multiple fields, we aim to create a model that closely mimics real clinical decision-making and has the potential to be widely used in medical practice.



## A NOVEL DIGITAL TWIN FOR CHRONIC CARE COORDINATION AND HEALTHY AGING

**Katherine Kim, PhD, MPH, MBA**

Chronic illnesses such as diabetes and hypertension challenge goals of healthy aging, with burdens on individuals, family caregivers, and the healthcare system. Uncontrolled chronic illnesses are a risk factor for cognitive decline, Alzheimer's disease and related dementias, and frailty. We need solutions for older adults to age with independence, to lead healthier lives, and to maintain access to their healthcare services when needed. The questions we want to answer are: What are all the possible behavioral, lifestyle, and medical treatment options for people with chronic illness? When and how should those interventions be rolled-out for the best outcomes over time as people age (trajectories)? How could you weigh all the potential scenarios and make the best decisions?

We use data from remote monitoring, clinical care, and healthcare utilization, to develop Health Digital Twins (HDTs) for community-dwelling older adults with diabetes and/or hypertension and insights for both the individual and healthcare providers. Digital twins can be defined as (physical and/or virtual) machines or computer-based models that are simulating or "twinning" the life of a physical entity (an object, process, human, or a human-related feature). We generate HDTs via deep phenotyping and application of two state-of-the-art AI methods to take advantage of the pros and limit the cons of each: a generative model using variational autoencoder and a large language model coupled with retrieval-augmented generation. HDTs leverage population level data across urban and rural settings and combines it with a patient's unique data, to deliver personalized recommendations.



**Weill Cornell  
Medicine**

## **SCALABLE SUBTYPING FOR PERSONALIZED ASSESSMENT OF LATE-LIFE SOCIAL DISCONNECTION**

**Nili Solomonov, PhD**

Social disconnection is a growing public health crisis in the US, with half of adults reporting social isolation. It predicts accelerated brain aging, poor adherence to medical care, and decline in cognition and daily functioning. Still, there are no gold-standard, evidence-based methods to assess social disconnection in healthy older adults, highlighting the need for new approaches.

Here, we propose SOCIAL-Q ("Scalable Online Classification and Individual Assessment for Loneliness Quantification"): a scalable tool for quantification and classification of an individual's social-emotional profile and their risk of social disconnection. This approach will provide a scalable, rapid, and precise assessment of individuals' social-emotional functioning. It will also guide development of scalable interventions to increase social connectedness and improve well-being in healthy older adults.

To achieve this goal, we will leverage exciting developments in machine learning and computer vision including "large language models" (LLMs) for speech tracking and emotion detection from vocal prosody. We will combine these advances with multimodal subtyping methods we developed to design an automated AI-powered tool that will estimate an individual's socio-emotional profile based on a brief multimodal assessment.

Findings from SOCIAL-Q will inform scalable, personalized, interventions aimed at increasing social connectedness that can be delivered in community settings to healthy adults (e.g., senior centers).



## USING AI TO PREDICT DEPRESSION & BURDEN AD/ADRD CAREGIVING CONVERSATIONS

**Nancy A. Hodgson, PhD,  
RN, FAAN**

Clear communication between clinicians and caregivers of people living with dementia (PLWD) is essential to delivering quality dementia care. Objective, empirical assessment of these clinical communications can support the timely evaluation and management of care needs for PLWD and their caregivers but is currently too time-consuming and prone to clinician bias.

This is a secondary analysis of data collected during an implementation study evaluating the translation of an evidence-based dementia program. Conversational speech data from 125 hour-long (on average) sessions between clinicians and dementia caregivers along with repeat assessments of caregiver depression and burden will be leveraged to predict clinically meaningful treatment outcomes, (caregiver burden, depression and PLWD healthcare utilization) via a machine learning (ML) model.

The study aims to: 1) use an ML model to identify patterns in clinical conversations linked to dementia caregiver depression and burden, 2) detect patterns predicting PLWD healthcare utilization (e.g., 911 calls, hospitalizations) and 3) analyze ML outputs to enable early, targeted interventions. This third aim will be guided by an advisory group of healthcare providers and dementia caregivers. The results will demonstrate the potential of ML and data science to improve health outcomes for over 11 million U.S. dementia caregivers. The long-term goal is to develop a scalable technology-based intervention to address caregiver depression and burden, reduce costly care, and enhance quality of life.



**Bin Huang, PhD**

# **BrainCheck** **IOWA**

## **AI-DRIVEN CHATBOT TO NAVIGATE COGNITIVE CARE PLAN FOR PERSONS WITH AD/ADRD**

With the growing cost and care burn of Alzheimer's disease and Alzheimer's disease-related dementias (AD/ADRD), there is an urgent need to provide personalized care support to patients and their caregiver, thereby slowing disease progression, reducing expenses, and improving quality of life. Cognitive care planning (CCP) is a promising approach to systematically assess the needs of patients and caregivers and generate care plans with personalized recommendations to address neuropsychiatric/neurocognitive symptoms and functional limitations, and provide care resources. BrainCheck has developed a digital tool, BrainCheck (BC) Plan, to facilitate the integration of CCP into routine care. However, a lack of continuous support at home can make it difficult for patients and caregivers to follow through with care plans in daily life. To address this gap, we propose to develop a companion AI chatbot, BC Connect, that provides real-time, personalized assistance to patients and caregivers at home, helping them to navigate their care plans and answer questions as they arise. By leveraging a fine-tuned large language model alongside a knowledge base on dementia care, BC Connect will ensure to provide accurate and reliable information, mitigating the risk of misinformation common with AI systems. The study aims to: (1) identify common questions patients and caregivers face at home, (2) develop the BC Connect prototype, and (3) evaluate its usability and acceptability through real-world field testing. This innovation has the potential to improve the quality of care to persons with AD/ADRD while empowering families with the resources and ongoing support they need.



## **WATCH (WARNING ASSESSMENT AND ALERTING TOOL FOR COGNITIVE HEALTH)**

**Kyra O'Brien, MD, MSHP**

Early detection of cognitive impairment, including dementia, is beneficial for patients and their families because it helps them access needed care supports. Screenings for many health conditions are done in primary care, but it is difficult to do screenings for cognitive impairment in this setting. This is because the time required to do a cognitive screen can be challenging to fit into a typical primary care appointment. The goal of this project is to make it easier for primary care providers to detect early signs of cognitive impairment in real-time. We aim to develop a prediction model that uses data from the electronic health record (EHR) and video and audio from the primary care visit to estimate a patient's risk of having undetected cognitive impairment. We will build off an existing cognitive impairment prediction model called the EHR Risk of Alzheimer's and Dementia Assessment Rule (eRADAR). We will use this model to recruit Penn Medicine primary care patients to participate in a recorded research visit, where we will conduct a cognitive and physical exam. Video and audio data from these visits will be combined with the EHR data to generate new predictive models. We aim to see if the addition of video and audio data to the prediction model improves detection of conditions such as Alzheimer's disease and related dementias. This will build the basis for future work aiming to integrate the new predictive model into primary care clinics and test its effectiveness in promoting early detection of cognitive impairment.



## **DETERMINANTS OF ACCESS TO AND OUTCOMES FOLLOWING SPECIALIZED PALLIATIVE CARE FOR PATIENTS WITH ADRD**

**Emily Moin, MD, MBE**

Through the PennAITech program, we will link electronic health record data from all patients at the University of Pennsylvania Health System (Penn Medicine) with inpatient encounters from 2017 – 2023 to claims data from the Centers for Medicare and Medicaid Services (CMS) from 2018 – 2024. The central goal of creating these linkages is to identify determinants of access to and outcomes following specialist palliative care (SPC) for patients with ADRD and other serious illnesses. Engaging SPC clinicians in the longitudinal management of patients with ADRD and other serious illnesses is a key priority, yet patients with ADRD less commonly receive SPC than do patients with cancer and other illnesses, and more commonly experience hospitalizations and inadequate symptom control. To surmount these inequities in care delivery requires filling key knowledge gaps related to the extents to which patients with ADRD experience novel and more holistic patient-centered outcomes than have commonly been measured, and whether patients at risk for poor outcomes can be reliably identified so as to target SPC resources toward them. We will achieve this central goal and address these knowledge gaps through completion of three specific aims. First, we will quantify differences in SPC consultation among Medicare and Medicaid beneficiaries with vs. without AD/ADRD admitted to Penn Medicine hospitals. We will first assess SPC access using the gold-standard approach we have pioneered of measuring signed SPC notes in the electronic health record (EHR), and second using the proportions with Z51.5 billing codes (“encounter for palliative care”) in CMS data. While this claims-based approach is commonly used due to its efficiency, there are many reasons to believe it may not possess favorable operating characteristics, thereby yielding biased conclusions when used as a measure of SPC receipt. Comparing its sensitivity, specificity, calibration, and other measures to our gold standard will elucidate this approach’s utility overall and specifically among patients with ADRD. Second, we measure changes in calculating a key patient-centered outcome – hospital-free days (HFDs), or days alive and living outside a hospital through 6 months of follow-up – using only EHR data vs. supplementing with CMS data among patients with ADRD and other serious illnesses. We hypothesize that adding CMS data to EHR data will produce more robust and accurate quantification of this critical outcome relative to either method alone. Third, we will build an Artificial Intelligence (AI) model to predict which patients with (1) ADRD and (2) all serious illnesses are at risk for low numbers of HFDs, thereby guiding the allocation of SPC services in practice enabling prognostic enrichment of patients with ADRD in future trials of palliative care interventions using this endpoint.



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## UNDERSTANDING AGING AND ADRD DISPARITIES USING A REPRESENTATIVE EPIGENETIC CLOCK

**Rory Boyle, PhD**

Disadvantaged groups may experience accelerated biological aging, due to the cumulative impact of repeated experiences with socioeconomic adversity and marginalization. This may cause early physical and cognitive health deterioration leading to disparities in aging and Alzheimer's disease and related dementias (ADRD) outcomes, as evident in associations of epigenetic clocks with worse aging and ADRD outcomes.

Epigenetic clocks apply machine learning to DNA methylation profiles from blood samples to estimate biological aging. Black American adults show accelerated epigenetic aging compared to White American adults and socioeconomic factors contribute to this racial disparity. However, epigenetic clocks have been developed using non-representative datasets consisting predominantly of White adults and therefore may not provide accurate estimates of epigenetic aging in other racial and ethnic groups.

We will use machine learning to develop and validate a representative epigenetic clock (REpiClock) to more accurately predict epigenetic age in Black adults. As the accuracy of epigenetic age estimates may be influenced by the genetic distance of a target individual from the average genotype of the training dataset, we will apply a data-driven method to correct epigenetic age predictions for the individual's genetic distance from the training set. In a deeply-phenotyped biobank, we will assess the relationship of the REpiClock with ADRD pathology, using plasma biomarkers, and ADRD risk and aging outcomes, using electronic health record data. This will allow us to establish whether a representative, genetic distance-corrected epigenetic clock, more precisely estimates disparities in epigenetic aging and whether these disparities underlie disparities in ADRD pathology and risk.



## AI-BASED TOOL FOR MIXED DEMENTIAS

**Vijaya Kolachalama, PhD**

Diagnosing dementia can be challenging because many different types often occur together, making it difficult to identify what is truly causing a person's symptoms. For example, someone with both Alzheimer's disease and vascular dementia may not respond well to treatments designed just for Alzheimer's. Misdiagnosis can lead to ineffective or even harmful treatments, especially in older adults with complex medical histories. That's why it's so important to have tools that can accurately identify all the underlying causes of dementia. Our research team has developed an artificial intelligence (AI) model that can analyze a wide range of information, from brain scans and cognitive tests to medical history, to help determine what type or types of dementia a person may have. We tested this model on data from over 50,000 people and showed that it can reliably distinguish between different dementia types, even when multiple conditions are present. In some cases, neurologists using our AI tool improved their diagnostic accuracy significantly. Our next step is to build and test this AI tool in real-world healthcare settings. With support from the a2 Pilot Award, we will partner with two hospitals to test the tool on a diverse group of patients. The goal is to create a reliable, user-friendly platform that helps doctors make better decisions about diagnosing and treating dementia, ultimately improving patient care.



## AN EXPLAINABLE DEEP LEARNING FRAMEWORK FOR BRAIN AGE PREDICTION IN AD

**Mehmet Kurt, PhD**

The biology of aging is a complex biological process that has yet to be fully understood. Recently, due to the growth in data availability and advances in deep learning techniques, brain age has been demonstrated as an effective biomarker for studying the brain aging process in the presence and absence of neurological disorders. This "brain age" provides a global estimate of how the subject's brain deviates from the average brain of a similar age. In the PennAITech project, we will extend brain age predictions to brain anatomy by providing age for different brain regions. We will also improve the transparency and accountability of this tool by explaining brain age in terms of clinically relevant image features, e.g., explaining brain age by highlighting brain regions that indicate accelerated aging. By identifying individual patterns of brain aging and specific areas of accelerated aging, clinicians using this tool can tailor individualized interventions and prognostic strategies. This subject-specific approach can improve outcomes by addressing specific risk factors and vulnerabilities.



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