Imaging Genomics Based Brain Disease Prediction

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Country

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Title of project or programme

Imaging Genomics Based Brain Disease Prediction

Source of funding information

NIH (NIA)

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Start date of award

01/09/2015

Total duration of award in years

2

The project/programme is most relevant to:

Alzheimer's disease & other dementias

Keywords

Acquired Cognitive Impairment... Aging... Alzheimer's Disease... Alzheimer's Disease including Alzheimer's Disease Related Dementias (AD/ADRD)... Basic Behavioral and Social Science... Behavioral and Social Science... Bioengineering... Biomedical Informatics Research... Biomedical Information Resources and Informatics Research... Biotechnology... Brain Disorders... Dementia... Genetics... Human Genome... Neurodegenerative... Neurosciences... Prevention

Research Abstract
? DESCRIPTION (provided by applicant): Mild cognitive impairment (MCI) is a prodromal stage of Alzheimer Disease (AD), and the existing studies have suggested that the individuals with amnestic MCI tend to progress to probable AD at a rate of approximately 10% to 15% per year. Early prediction of MCI patients with high risk of conversion to AD is of great importance for timely therapy and possible delay of the disease. Recent advances in acquiring multi-dimensional and longitudinal brain imaging and genome-wide array data provide exciting new opportunities to study the influence of genetic variation on brain structure and function. Integrating such multi-dimensional and longitudinal imaging genomic data holds great promise for a system biology of the brain to better understand the complex neurobiological mechanism of conversion of MCI to AD. However, the unprecedented scale and complexity of these neuroimaging genomic data sets have presented critical computational challenges for achieving the full transformative potential from comprehensive joint analysis of these heterogeneous and longitudinal data sets. This project aims to address these emerging challenges for early prediction of MCI-to-AD conversion with four aims. Aim 1 is to develop a novel sparse bi-multivariate learning model based system biology framework for analysis of genome-wide association results across a large number of the structural and functional phenotypes derived from neuroimaging scans of the whole brain. Our new methods are designed for bi-multivariate analysis of high-throughput genomic data and complex Quantitative Traits (QTs) related to MCI-to-AD conversion by utilizing the system biology knowledge. Aim 2 is to further extend the learning approaches in Aim 1 with the new structured sparse models to the multi-dimensional data integration methods to identify the heterogeneous biomarkers from multiscale interrelated imaging genomic data for outcome prediction. Meanwhile, we will utilize the joint multi-task learning scheme to identify the stable genetic and phenotypic biomarkers that are associated with cognitive functions decline and MCI-to-AD conversion simultaneously. Based on the studies in Aims 1 and 2, Aim 3 is focused on revealing the longitudinal biomarkers of the changes of MCI progression or cognitive impairment by a new structured low-rank multi-task regression model. These biomarkers can fully differentiate longitudinal profiles of relevant QTs and better capture genetic associations with QT changes over time. Aim 4 is to evaluate and validate our proposed machine learning and bioinformatics algorithms on both synthetic data and real imaging genomic data. The results of this project will be able to efficiently improve our understanding of the complex neurobiological mechanism underlying the MCI-to-AD conversion. The identified biomarkers will finally enhance the early and accurate prediction of MCI-to-AD conversion such that the clinical treatment can be provided in time.

Lay Summary
PUBLIC HEALTH RELEVANCE: Patients with Mild Cognitive Impairment (MCI) are at high risk for developing Alzheimer’s disease (AD). Identifying MCI individuals with high likelihood of conversion to AD is of great importance for timely therapy and possible delay of the disease. Existing research works mainly focus on the studies using single genetic or neuroimaging data

source and seldom consider the longitudinal data profiles. To address these limitations, this project focuses on 1) the development of novel bioinformatics and machine learning models for solving the computational challenges of analyzing the emerging multi-dimensional and longitudinal imaging genomic data, and 2) identification of biomarkers with prediction power on MCI-to-AD conversion from the large and complex heterogeneous imaging genomic data with the comprehensive system biology knowledge guidance.

Further information available at:

Types:
Investments > €500k

Member States:
United States of America

Diseases:
Alzheimer's disease & other dementias

Years:
2016

Database Categories:
N/A

Database Tags:
N/A