

SYMPOSIUM PRESENTATION 3: PHYSICAL AND MENTAL HEALTH

Application of artificial intelligence and digital technology to overcome dementia

J. K. Kim (Convener)

Participants: Seung Wan Kang (Korea), Donghyun. Kim(Korea), Solomon Han (Korea). **ISSUE** Dementia is a neurodegenerative brain disease that one-tenth of the elderly suffers from as a representative geriatric disease. With the increase of the elderly population and the improvement of the quality of elderly life being re-examined, the development of technologies for preventing, diagnosing, and treating dementia is becoming significantly important. Recently, digital technologies such as artificial intelligence are being actively applied to the medical field, and methods applicable to improving the quality of life of the elderly are being studied in various fields. This session will introduce the application of digital technology as gerontechnology and digital technologies that are actively researched in dementia prevention, diagnosis, and treatment. **CONTENT** The current symposium is designed to shed light on some of these different facets. We will examine 1.) PET-validated EEG-Machine Learning Algorithm Predicts Brain Amyloid Pathology in Pre-dementia Alzheimer's Disease, 2.) Development for diagnosis and prognosis of dementia: Advancing amyloid (A)-Tau (T)-neuronal degeneration (N)-vascular (V) neuropathology system using brain imaging, and 3.) Development of non-face-to-face dementia prevention management program based on artificial intelligence. **STRUCTURE** Kang first presents the AI-based EEG brain scanning with the accurate classification of beta-amyloid accumulation in the brain and high accessibility. Secondly, Kim presents development for diagnosis and prognosis by multi-facets of brain imaging data. Lastly, Han presents the development of a dementia prevention management program based on AI. **CONCLUSION** The different talks show the multiple facets that need to be considered in research on dementia using digital technologies. They suggest using AI in the diagnosis and prognosis of dementia is an innovative development by adjusting novel technologies. They also highlight that remote care will be essential for the elderly population. Still, there are restrictions for fully remote diagnosis and therapeutics; if the technology presented at this session advances, it is expected that telemedicine and treatment will be possible shortly.

Keywords: dementia, AI, remote mental care, prevention, diagnosis, prognosis

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PET-validated EEG-Machine learning algorithm predicts brain amyloid pathology in pre-dementia alzheimer's disease

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Purpose: Developing reliable biomarkers is important for screening Alzheimer's disease (AD) and monitoring its progression. Although EEG is non-invasive direct measurement of brain neural activity and has potentials for various neurologic disorders, vulnerability to noise, difficulty in clinical interpretation and quantification of signal information have limited its clinical application. There have been many research about machine learning (ML) adoption with EEG, but the accuracy of detecting AD is not so high or not validated with A β PET scan. We developed EEG-ML algorithm to detect brain A β pathology among subjective cognitive decline (SCD) or mild cognitive impairment (MCI) population, and validated it with A β PET. **Methods:** 19-channel resting-state EEG and A β PET were collected from 311 subjects: 196 SCD(36 A β +, 160 A β -), 115 MCI(54 A β +, 61A β -). 235 EEG data were used for training ML, and 76 for validation. EEG features were standardized for age and sex. Multiple important features sets were selected by 6 statistics analysis. Then, we trained 8 multiple machine learning for each important features set. Meanwhile, we conducted paired t-test to find statistically different features between amyloid positive and negative group. **Results & Discussion:** The best model showed 90.9% sensitivity, 76.7% specificity and 82.9% accuracy in MCI+SCD (33 A β +, 43 A β -). Limited to SCD, 92.3% sensitivity, 75.0% specificity, 81.1% accuracy (13 A β +, 24 A β -). 90% sensitivity, 78.9% specificity and 84.6% accuracy for MCI (20 A β +, 19 A β -). Similar trends of EEG power have been observed from the group comparison between A β + and A β -, and between MCI and SCD: enhancement of frontal/ frontotemporal theta; attenuation of mid-beta in centroparietal areas. The present findings suggest that accurate classification for beta-amyloid accumulation in the brain based on QEEG alone could be possible, which implies that QEEG is a promising biomarker for beta-amyloid. Since QEEG is more accessible, cost-effective, and safer than amyloid PET, QEEG-based biomarkers may play an important role in the diagnosis and treatment of AD. We expect specific patterns in QEEG could play an important role to predict future progression of cognitive impairment in the preclinical stage of AD. Further feature engineering and validation with larger dataset is recommended.

Keywords: EEG-Machine learning, brain amyloid pathology, pre-dementia alzheimer's disease

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The role of neuroimaging: Quantitative approach for prognosis/staging/analysis in dementia study

D. Kim, E. Y. Kim

Purpose While the total number of people with dementia is rapidly growing, the treatment or clinical interventions are limited yet. Neuroimaging (brain MRI and PET) is currently essential to interpret the state of an individual's brain health. An accurate and efficient interpretation of neuroimaging is thus needed for health care providers and researchers. Our research team aims to support all the relevant personnel to make better decisions by providing quantified analysis results using AI-based neuroimaging technologies. This talk will discuss recent advancements in AI-powered technologies for diagnostic, prognostic, clinical intervention, and treatment planning. **Method** We have utilized both the South Korea neuroimaging dataset (CABI, Catholic Aging Brain Imaging database) and open-source neuroimaging dataset for the technology development. We have developed MRI(T1w, FLAIR) and PET(amyloid, tau, FDG) analysis technology to quantify brain properties using AI. Those AI-based technologies include 1) T1w multilabel segmentation algorithm, 2) FLAIR white matter hyperintensity segmentation algorithm, and 3) amyloid/tau/glucose uptake measurement tool from PET. These neuroimaging techniques are used to quantify the level of atrophy, vascular burden, or substance deposition in the brain to provide dementia biomarkers for accurate diagnosis or prognosis based on objective measurements. **Results and Discussion** Each technology was highly robust and much faster than a legacy algorithm in the neuroimaging field. A large-scale T1w MRI data could be analyzed for their visual atrophy scales automatically in a short time. Quantitative PET analysis provides helpful information to support clinical decisions faster and more reliable. Finally, all those AI-based technologies together could be used to build a prognosis prediction tool for dementia converter in a couple of years. The AI technology for neuroimaging analysis is needed to better understand the status and prognosis in the near future for middle to later adulthood.

Keywords: neuroimaging, dementia, prognosis, staging, quantitative analysis

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SUPERBRAIN (The South Korean study to PrEvent cognitive impairment and protect BRAIN health through lifestyle intervention in at-risk elderly people.) : A randomized controlled feasibility trial

S. Han

Purpose : As life expectancy increases worldwide, dementia has rapidly become a huge public health problem. A recent meta-analysis of population-based observational studies revealed that modifying risk factors may prevent or delay dementia by up to 40%. Under the situation there is a limit to the number of people who can receive intensive multidomain interventions at facilities, not only an effective dementia prevention programs that can be implemented at the facility, but also an effective home-based program is essential to reach more elderly people in need. SUPERBRAIN was developed for a facility-based multidomain intervention (FMI) program and a homebased multidomain intervention (HMI) program suitable for older Koreans. The purpose of SUPERBRAIN is to assess the feasibility of the FMI and HMI programs in at-risk older Koreans to prevent cognitive impairment and protect brain health through intervention program. **Method**: We aimed to evaluate the feasibility of multidomain intervention tailored to the Korean context. In an outcome assessor-blinded, randomized controlled trial, participants without dementia and with one or more modifiable dementia risk factors, aged 60-79 years, were randomly assigned to the facility-based MI (FMI; n=51), the home-based MI (HMI; n=51), or the control group receiving general health advice (n=50). The 24-week intervention comprised vascular risk management, cognitive training, social activity, physical exercise, nutrition guidance, and motivational enhancement. The FMI participants performed all intervention programs at a facility three times a week. The HMI participants performed some programs at a facility once every 1-2 weeks and performed others at home. The primary outcome was feasibility measured through retention, adherence, and at least no differences from the control group in the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS). **Results & Discussion**: In the FMI and HMI groups, the retention rates were 88.2% and 96.1%, and adherence to the intervention was 94.5% and 96.8%, respectively. The primary outcome was feasibility measured through adherence, retention rates, and changes in the total scale index score of the RBANS with the normative data of Korean adults throughout the study. The RBANS total scale index score improved significantly in the FMI (5.46 ± 7.50 , $P = 0.004$) and HMI (5.50 ± 8.14 , $P = 0.004$) groups compared to the control group (-0.74 ± 11.51). The FMI and HMI are feasible and there are indicators of efficacy. Meanwhile, compared to the control group (54.18 ± 136.01 ng/mL), plasma cortisol levels were significantly decreased in both the FMI (-5.29 ± 154.01 ng/mL, $P = 0.049$) and HMI groups (-15.29 ± 172.09 ng/mL, $P = 0.03$) at the study endpoint. Serum brain-derived neurotrophic factor (BDNF) levels were significantly increased in the FMI group compared to the control group (11.83 ± 20.06 ng/mL vs. -1.62 ± 19.01 ng/mL, $P = 0.02$). Therefore, it is possible that the multidomain intervention may be effective in improving cognitive function through inactivation of the hypothalamic-pituitary-adrenal (HPA) axis and enhance brain plasticity.

References

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Facility-based and home-based multidomain interventions including cognitive training, exercise, diet, vascular risk Management, and motivation for older adults: a randomized controlled feasibility trial by

Keywords:: dementia, prevention, lifestyle, feasibility, randomized controlled trial
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