Machine-learning based EEG biomarker for early screening of amnestic Mild Cognitive Impairment (aMCI)

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INTRODUCTION

- aMCI is a prodromal stage of dementia with a high risk of progression into dementia.
- It is crucial to discriminate aMCI from age-related physiologic cognitive decline for early screening of dementia.
- In addition, aMCI screening tool requires appropriate, less expensive technology.
- This poster introduces a novel **QEEG biomarker adopting various machine-learning algorithms.**

METHODS

Subjects, EEG acquisition

- **Subjects**
  - 382 community-based subjects with normal brainwave patterns.
  - 182 subjects with aMCI (memory score under 16 percentiles)
- **EEG acquisition**
  - EEG signals were recorded through a digital 19-channel scalp EEG device.

EEG feature extraction

- Various sensor level and source level features were generated from a single EEG data for analysis (refer to figure 1. below)

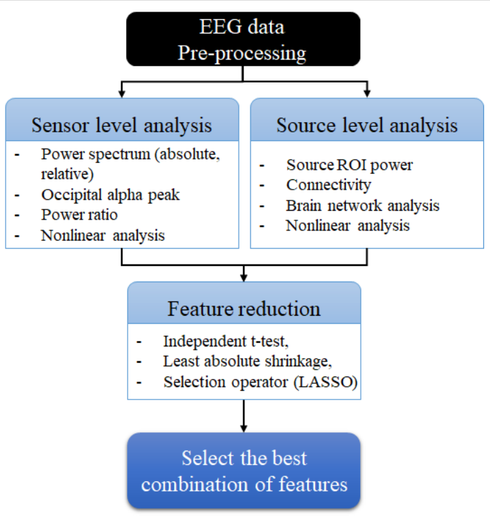

Figure 1. EEG feature extraction

- Independent t-test and Least Absolute Shrinkage and Selection Operator (LASSO) were used to select the best combination of the features.

Probability index score

- Probability index score calculation algorithm for aMCI was developed through logistic regression method combined with penalized linear regression method, applied on 73 aMCI and 75 community-based normal subjects.
- Five-fold validation was performed to find the best model for largest Area Under Curve (AUC).
- The developed model was applied to the online platform (iSyncBrain ™, iMediSync Inc., Seoul, Korea).
- Probability index score could be ranged from 0 to 100.
- Scores reflect severity of the memory impairment due to the underlying pathologic progression (Figure 2).

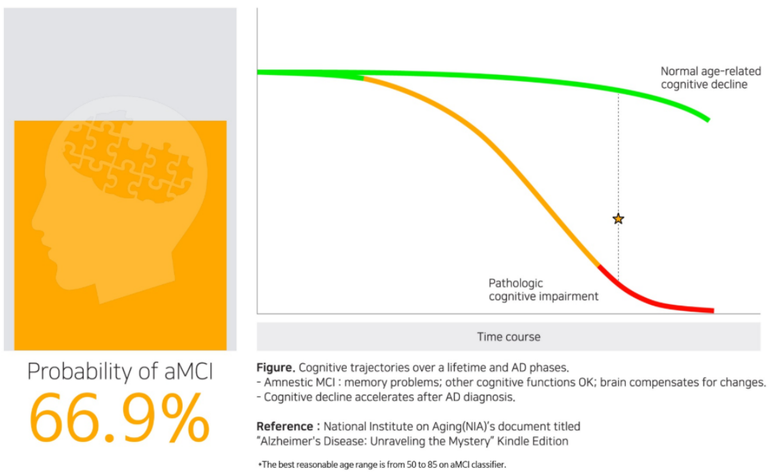

Figure 2. Probability index score

RESULTS

- The probability index score for aMCI was validated with independent EEG dataset with hidden labels from 3 different hospitals in Korea.
- The test set consisted of 307 community-based normal and 109 aMCI subjects.
- When an index score of 60 was applied at the cut-off value for discrimination of aMCI from age-related normal memory declined, the sensitivity was 93% and specificity was 90%.
- AUC was 0.93 (95% CI: 0.89 – 0.96)

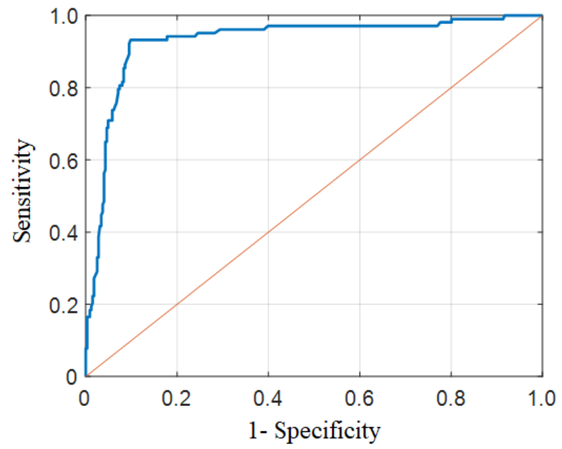

Figure 3. the ROC curve

CONCLUSIONS

- QEEG analysis showed significant difference between the aMCI and normal age-related memory decline.
- Individual EEGs have high variability. Hence, use of a single EEG feature or a single machine-learning algorithm would be insufficient for discrimination of the aMCI and normal age-related memory decline.
- However, the QEEG based biomarker algorithm proposed on this poster returning **aMCI probability index score shows a promising discrimination capability**.
- Therefore, careful selection of EEG features and curation of different machine-learning and statistical models is recommended.
- This EEG biomarker should be tested a larger population of aMCI and normal subjects. Furthermore, continuous revision and upgrades are encouraged.