Predicting Optimal Treatment Regimen for Patients With Neovascular Age-Related Macular Degeneration Using Machine Learning

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Figure 1. Distribution of Patients by Treatment Regimens

- The dataset consisted of all eyes in AVENUE and STAIRWAY, including eyes treated with ranibizumab (Figure 1)
- 324 patients were included in this analysis
- The ranibizumab 0.5 mg Q4W arms of AVENUE and STAIRWAY were pooled

Figure 2. An Imaginary Scenario of Predicting an Optimal Regimen for a Patient

- Benchmark features are age, sex, baseline BCVA, baseline CST, and treatment regimen
- In addition to the benchmark features, image-derived features extracted by pretrained segmentation algorithm from SD-OCT are added
- The model performance is evaluated by R2 score in nested cross-validation (5-fold, repeated 10 times)
- Besides R2 score, a metric called mean difference (Equation 1) is calculated to evaluate the discriminative capability of the models regarding treatment regimens

Table 1: Mean Difference Between the Maximum and Minimum Prediction Over All Possible Treatment Regimen Assignments

- XӨ is the i-th patient's input features other than treatment arm
- TӨ is the set of treatment regimens
- The mean difference value varies between models, with no obvious relationship between R2 score and discriminative capability of models regarding treatment regimens
- The results of this study highlight the potential of the method of predicting an optimal treatment regimen using a regression model
- To fully understand the advantages and the limitations of our proposed method, validation at a larger scale is warranted

Table 2: Model R2 (SD)

- XGBose achieved the highest performance with benchmark features and image features

Table 3: Benchmark Features

- XGBoost model with full features achieved the highest performance
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References

Methods

- An optimal regimen is defined to be the least frequent regimen that can maintain the highest possible best-corrected visual acuity (BCVA) letter score for an individual patient
- The problem of predicting the optimal regimen is converted to a regression problem of predicting the BCVA letter score using treatment regimen as input
- Machine learning models were developed on baseline characteristic data from the AVENUE (NCT02484690) and STAIRWAY (NCT03038880) trials

Data

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Development of Machine Learning Model

- The problem of predicting the optimal regimen is converted to a regression problem of predicting the BCVA letter score at month 9 using treatment regimen as input
- Because the treatment regimen is randomly assigned in a clinical trial, the model can be used for causal inference (Figure 2)

Conclusion

- The standard of care is monthly or bimonthly intravitreal injection of an anti-vascular endothelial growth factor agent
- Faricimab is a newly US Food and Drug Administration–approved treatment for nAMD and diabetic macular edema
- For patients with nAMD, faricimab may be able to extend the treatment interval to every 8 weeks, 12 weeks, or 16 weeks
- Machine learning has the potential to predict individual drug response

Key Clinical Question

Can a machine learning model predict the optimal treatment regimen of ranibizumab or faricimab for patients with neovascular age-related macular degeneration (nAMD) using baseline characteristics?

Introduction

- AMD is a retinal disease that is a leading cause of vision loss among people older than 50 years of age
- The standard of care is monthly or bimonthly intravitreal injection of an anti-vascular endothelial growth factor agent
- Faricimab is a newly US Food and Drug Administration–approved treatment for nAMD and diabetic macular edema
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