

Evaluation of Machine Learning Approaches in Predicting the Initial Treatment Strategy in Patients with Multiple Sclerosis Jieni Li, PhD, MPH¹, Lin Ying, PhD², Yinan Huang, PhD³, and Rajender R. Aparasu, PhD, FAPhA¹

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BACKGROUND

- Multiple sclerosis (MS) is an autoimmune Study design and data source disorder of the central nervous system that • This retrospective observational cohort study used the 2015affects about 1 million individuals in the 2019 Merative MarketScan® Commercial Claims and United States. Encounters data.
- With the approval of multiple disease-**Study population** modifying agents (DMAs) in recent years, \bullet Adult (18-64 years) MS patients with ≥ 1 DMA prescription therapeutic options for multiple sclerosis (MS) were identified from 2016 to 2019. patients are constantly evolving.
- Considering the benefits of early intervention, • The heDMAs group included natalizumab, alemtuzumab, and choosing between the two initial treatment ocrelizumab. Meanwhile, the meDMAs cohort included (moderate-efficacy strategies diseaseinterferon interferon beta-1b, beta-1a, modifying agents [meDMAs] vs. high-efficacy teriflunomide, dimethyl fumarate, and glatiramer acetate. disease-modifying agents [heDMAs]) could be **Covariate Selection** crucial for MS management. Andersen Behavioral Model was used for covariates selection.
- Evidence from previous studies identified that Predisposing factors included: Age, Sex, and Region patient characteristics, such as age and disease • Enabling factors included: Index year, Employment status, severity, could influence the choice of DMAs. Plan indicator and Metropolitan statistical area (MSA)
- Although machine learning (ML) models are Need factors included: Elixhauser Comorbidities, MS-related disease prognosis and used for often Symptoms, MS-related Symptomatic Medications, Annualized progression, the application of ML in relapse rate, and Healthcare utilization remains selection predicting treatment **Selection of ML Methods** underexplored.
- To the best of our knowledge, ML algorithms • Extreme gradient boosting (XGBoost) model have not been applied to examine the treatment Rule-based ML model (Prediction rule ensembles, RBM) strategies in MS.

OBJECTIVE

• This study evaluated the ML approaches in predicting the initial treatment strategy (heDMAs vs. meDMAs) for MS patients.



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METHODS

Exposure

Random forest (RF) model

Development and Evaluation of ML Models

- ML Models were trained by 91 baseline factors using 70% of the randomly split data.
- Model hyperparameters were tuned with the 10-fold crossvalidation.
- RF model: ntree, maxdepth, and mtry
- XGBoost model: ntree, maxdepth, and learnrate
- RBM: ntree, maxdepth, and learnrate
- Validated ML models on the rest of 30% of data
- Model performance (Area under the curve [AUC]) and top 10 important predictors were reported.

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Table 1. Performance of ML Models

	Test AUC	Accuracy	F-1	G-Measure
Random Forest	0.8393	0.7531	0.6155	0.6365
XGBoost Model	0.8495	0.8221	0.5557	0.5666
Rule-based Model	0.8393	0.8117	0.4287	0.4806
	Train AUC	Specificity	Precision	Sensitivity
Random Forest	0.8436	0.7302	0.4905	0.8259
XGBoost Model	0.9623	0.9343	0.6901	0.4652
Rule-based Model	0.8578	0.9742	0.7823	0.2953

Table 2. Performance of ML Models

Random Forest	XGBoost Model	Rule-based Model
Numbers of MS-related outpatient visits	Numbers of MS-related outpatient visits	Number of MS-related outpatient visits
Index year	Index year	Index year
Number of MRI procedures	Age	Elixhauser Comorbidities Score
Age	Elixhauser Comorbidities Score	Sensory symptom
Number of MS-related symptoms	Sensory symptom	Bladder/bowel symptoms or sexual dysfunction
Elixhauser Comorbidities Score	Sex	Headache
Region	Headache	Back problems
Insurance plan	Any emergency room visits	Fatigue medications
Number of MS-related medications	Back problems	Visual symptoms
Sensory symptom	Number of MRI procedures	Any emergency room visits

- Out of 10,003 eligible MS patients, 22.92% initiated heDMAs.
- selection of initial treatment strategy.

DISCUSSION & CONCLUSIONS

- utility of using ML models in clinical decision-making.
- treatment outcomes to optimize individualized care in MS.

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RESULTS

Observed in two ML models Observed in three ML models

• The model performance measures were comparable in XGBoost (AUC 85%, accuracy 82%, and F1 score 56%), RF model (AUC 84%, accuracy 75%, and F1 score 62%), and RBM model (AUC 84%, accuracy 81%, and F1 score 43%). • The number of MS-related outpatient visits, MS-related symptoms, and comorbidities were commonly found to be important factors influencing the

• All three ML approaches, XGBoost, RF, and RBM, had a comparable performance in predicting the initial treatment strategy in MS, emphasizing the

• Future research should focus on expanding the application of ML in predicting