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Computational Phenotyping In CPAP Therapy: Using Interpretable Physiology-Based Machine Learning Models To Predict Therapeutic CPAP Pressures

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Abstract:
Introduction: When using home sleep studies, there is a need to determine therapeutic (AHI < 5) CPAP pressures with which to begin therapy. Our practice is to combine a predictive equation with the interpreting sleep physician's clinical judgement. This approach produces therapeutic pressure recommendations within ± 2 cmH_2O of the eventual therapeutic pressure in 85% of patients. We sought to determine if the use of a machine learning model, using readily available variables from a home sleep study, could integrate the predictive equation and the physician's judgement and produce a similarly accurate therapeutic CPAP pressure recommendation.
Methods: We used cross-sectional analyses of patients (N = 7,794), ages 15-99 (M ± SD = 54 ± 13.9 years) who completed a diagnostic home sleep apnea test. Interpretable physiological and clinical features were derived from the dataset and used to predict the therapeutic CPAP pressure based on the therapeutic pressure settings prescribed by each patients interpreting physician. Predictive performance was evaluated using randomized 10-fold cross-validation. Machine learning techniques including Random Forests and Deep Neural Networks were optimized to model the relationship between the interpretable features and optimal therapeutic CPAP pressures.
Results: Random Forests achieved the best performance for predicting the optimal therapeutic CPAP pressure ± 2 cmH_2O, with an average accuracy of 97.8%. The top-10 variables ranked by Gini coefficient included BMI, AHI, neck circumference, ODI, longest apnea, age, snoring time, and others with established associations with sleep apnea. OLS regression was performed to estimate the strength of the relationship between the machine learning predicted CPAP pressure and the clinically prescribed CPAP pressure, resulting in an R-squared value of 0.888. The P-value for the F-test of overall significance of the regression analysis was observed to be < 0.05, confirming the R-squared estimate was statistically significant.
Conclusion: Interpretable machine learning models show promise as another means for determining therapeutic CPAP pressures. Following the initial prescription, this approach enables novel applications for AI to assist with monitoring and refining CPAP pressure settings on a longitudinal basis.
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