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Machine Learning-Based Prediction of Long-Term Treatment Demand for Patients with Chronic Retinal Diseases

Mathias Gallardo, PhD[1], Marion R. Munk, MD, PhD[2], Thomas Kurmann, MSc[1], Sandro De Zanet, PhD[3], Agata Mosinska, PhD[3], Isıl Kutlutürk Karagoz, MD, PhD[2], Carlos Ciller, PhD[3], Martin S. Zinkernagel, MD, PhD[2], Sebastian Wolf, MD, PhD[2], Raphael Sznitman, PhD[1]

Affiliations:

[1] AIMI, ARTORG Center, University of Bern, Bern, Switzerland
[2] Department for Ophthalmology, Inselspital, University Hospital, University of Bern, Bern, Switzerland
[3] RetinAI Medical AG, Bern, Switzerland

Corresponding author: Mathias Gallardo, Mathias.Gallardo@gmail.com

Abstract

Chronic retinal diseases such as Neovascular Age-related Macular Degeneration (nAMD), Diabetic Macular Edema (DME) and Retinal Vein Occlusion associated with a macular edema (RVO related ME) are leading causes of vision loss in the worldwide population. The Treat-and-Extend (TER) protocol, one of the most spread treatment, includes periodic intravitreal injections of medication with varying time intervals, which are extended or reduced by the clinicians depending on the disease activity. This is inferred mainly with an Optical Coherence Tomography (OCT) scanning of the central retina region. Given the very heterogeneous treatment demand and treatment need of each individual patient, improving the treatment individualization remains necessary, to reduce also the burden on patients and the health care system. In this work, we propose to predict at an early treatment stage the long-term treatment demand of a patient using machine learning. Eyes are grouped into low, moderate and high treatment demanders, using the average treatment interval. Our approach relies on two Random Forest binary classifiers to infer the probability of a patient being a low or high treatment demander respectively. These classifiers are trained with some patient data and morphological features extracted from the OCT volumes using existing algorithms of retina and layer segmentation and biomarker presence detection. The

two classifiers (low vs others and high vs others) are evaluated with a 10 cross-validation ensuring that no patient was present in both training (nAMD: ~339 eyes, RVO & DME: ~300) and test sets (nAMD: ~38, RVO & DME: ~33). Our experiments show that it is possible to predict well, after the three first visits, a low and a high treatment demander and across several pathologies (nAMD: mean AuC of 0.79 and 0.79 for low and high demanders; DME & RVO: mean AuC of 0.76 and 0.78 for low and high demanders). We also observe that classification performances at the first visit for low demands are promising. Presented results support that machine learning can help clinicians in the individualization of treatment plans.