A Data-Driven Natural Language Processing Platform for Clinician-Led Exploration of Retinal Fluid Dynamics in Neovascular AMD

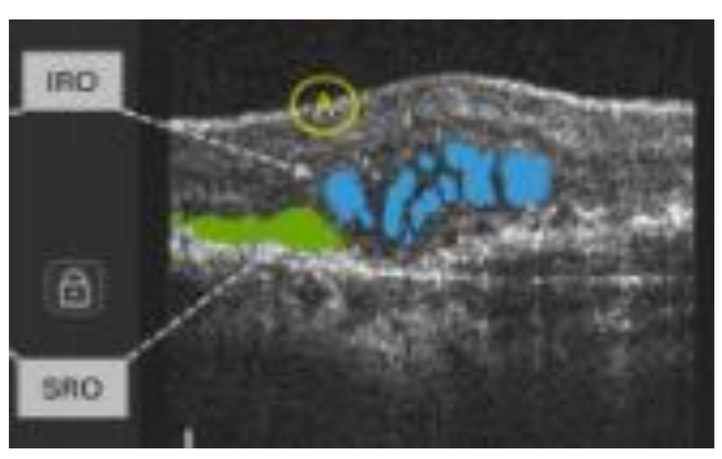
Dinah Zur, MD[1], Marganit Gonen-Shahar, MSc[1], Anat Loewenstein, MD MHA[1], Gidi Benyamini[2], Moshe Havilio, PhD [2], Ronen Tal-Botzer, PhD [3], Neta Bar, PhD [3]

[1] Ophthalmology Division, Tel Aviv Sourasky Medical Center, Faculty of Medical & Health Sciences, Tel Aviv University; . [2] Notal Vision Ltd. [3] Evolution Intelligence Inc.

Background:

- **Automated OCT algorithms** are becoming widely available and provide accurate longitudinal information on retinal fluid dynamics
- **Real-World nAMD Data Complexity**
  - Large and diverse data sources, incl. demographics, visual acuity, volumetric retinal fluid OCT parameters, treatments (injection dates, intervals, types)
  - Highly variable baseline characteristics and treatment responses
  - Longitudinal data with significant heterogeneity
  - Inconsistent follow–up time points

Figure 1:
Example of OCT scan with automatically detected intra- and subretinal fluid (blue and green, respectively).



Purpose:

To develop an AI-powered, clinician-friendly interface for real-time nAMD data exploration: An intuitive, NLP-driven system that enables clinicians to explore and analyze large-scale real-world nAMD datasets using simple queries—no coding experience required

Methods:

Developed based on TLVMC real-world nAMD dataset
- 710 eyes of 548 nvAMD patients
- 7,262 VA exams
- 5,675 OCT voume scans (analyzed with NOA)
- 11,260 anti-VEGF injections

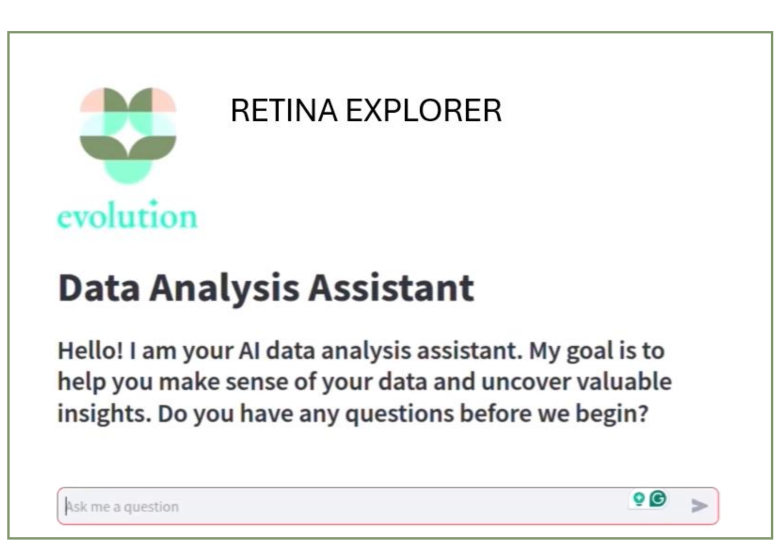


Figure 2:
Web-based secured interface of the "RETINA EXPLORER" platform, allowing queries as clinician-friendly natural language search

Categorization - Clinician Expertise

- Fluid volume categories based on fluid amounts as SRF/IRF/ PED/ 1/3/6mm
- Responder classification by fluid response and fluctuations
- Visual acuity categories and longitudinal change
- Treatment intensity categories (drug type, injection intervals)

AI-Enhanced Natural Language Querying

- OpenAI language model to accurately interpret nAMD-specific queries
- Enable clinician-friendly natural language search

Web-Based Interface

- Built with Streamlit for an interactive, user-friendly experience
- Accessible intuitive navigation, without coding
- Supports visualized treatment patterns, aims data-driven decision-making

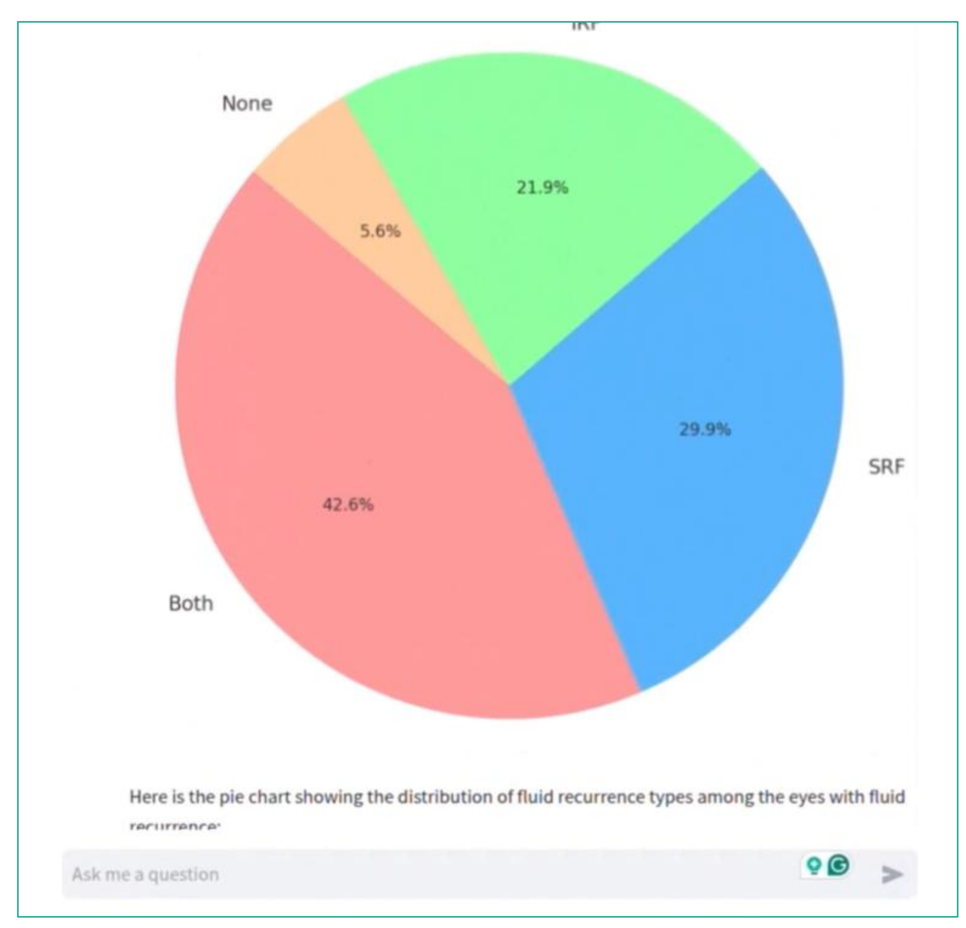


Figure 3:
Example of output as visuals, displayed as a pie graph showing fluid distribution in a patient subgroup.

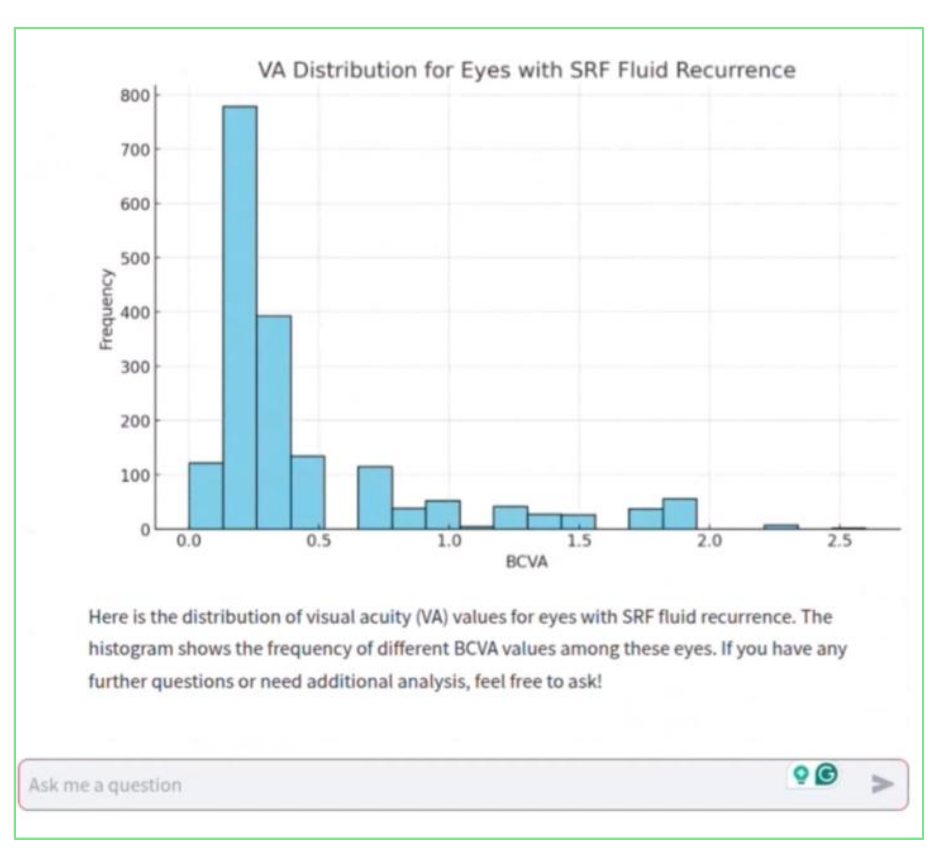


Figure 4:
Example of results, displayed as a histogram showing visual acuity distribution in a subgroup of patients with SRF recurrence in the first treatment year.

Conclusions:
We developed a natural language processing platform enabling real-time exploration of complex nAMD datasets without coding. The platform facilitates independent data analysis by retina specialists, enhancing clinical decision-making based on real-world evidence. The method is based on structured Data Categorization, and incorporates clinician-defined fluid volume dynamics, treatment response patterns, and longitudinal visual acuity changes.
Future Directions: We aim to implement decision tree models to identify meaningful patient subgroups and optimize personalized treatment strategies through advanced AI-driven pattern recognition.