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Dr. AI will see you now...

On February 4, 2022, Ivan Potapenko defended his thesis "Artificial intelligence in age-related macular degeneration" at the Faculty of Health and Medical Sciences, Copenhagen University. The research, completed at the Department of Ophthalmology, Rigshospitalet, was supervised by Morten la Cour, Steffen Hamann, Josefine Fuchs, Javad Nouri Hajari.

Key points:

- Clinics will need to treat 50% more patients with AMD in the next 10 years.
- AI is safe and reliable for follow-up of AMD patients.
- Over half of these patients can be followed without human intervention.
- Noisy clinical training data does not impede AI performance.

Introduction

Effective treatment of patients with neovascular age-related macular degeneration (AMD) frequently requires long-term follow-up over several years. As the population ages, this growing patient group will put pressure on an already burdened public healthcare system. Staff expansion on its own is unlikely to be a viable solution; thus, innovative strategies are needed to address this issue.

In this thesis, we established the extent of the problem by modeling the number of actively treated patients and designed an artificial intelligence (AI) system to autonomously follow AMD patients.

The need for novel approaches

The direct impact of the increased AMD prevalence on the number of actively treated patients had not been previously estimated. We surveyed treatment data of 9,737 patients over 12 years. We found that the fraction of patients remaining in active treatment after initial diagnosis followed exponential decay, with a half-time of 3.6 years. This correlation appeared to be disease-specific and independent of factors such as treatment regimen and drug choice. A mathematical model based on this correlation was highly accurate in historical data (R^2=0.99; **Figure 1**). Our model predicted a linear increase of 50% in the number of actively treated patients during the coming decade. The predicted growth will mainly be driven by the demographic shift amplified by the long-term nature of treatment.

Artificial intelligence to the rescue

To address the projected patient increase, we designed an AI-based system for autonomous AMD follow-up. The system comprised two parts: an AI model to detect activity on optic coherence tomography scans and a deterministic logic to follow clinical guidelines for treatment (**Figure 2**).

The AI model was trained on noisy data taken directly from a clinical database without manual re-labeling. This previously unpublished approach allowed for the inclusion of 105,000 examinations. Up to 96% accuracy was achieved, on par with models trained on manually curated data. The deterministic logic integrated the AI model's output with patient history and clinical parameters to generate regimen-compliant treatment decisions. The algorithm was designed to handle advanced concepts such as regimen adherence, chronic edema, and concurrent ophthalmic disease. The flexibility of the two-component structure allows for later adjustment of the clinical algorithm or transition to another regimen without the need to re-train the AI model.

When validated on 200 prospectively collected cases, the system demonstrated safety on par with regular follow-ups at our clinic (92% and 88% safe decisions, respectively; p=0.33). We estimated that up to 60% of the department's AMD patient population could be followed by the system without human intervention.

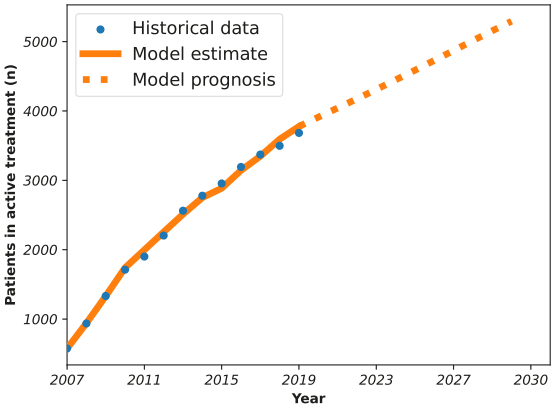

Figure 1. Number of actively treated AMD patients: model versus historical data

Looking forward

Considering the anticipated rapid growth in the treated AMD patient population, the emphasis in the coming years will be on novel follow-up strategies. As such, our proposed autonomous AI system is safe and flexible. The system can manage a large number of patients without the involvement of clinicians and can ease the pressure on public ophthalmology services in the future.

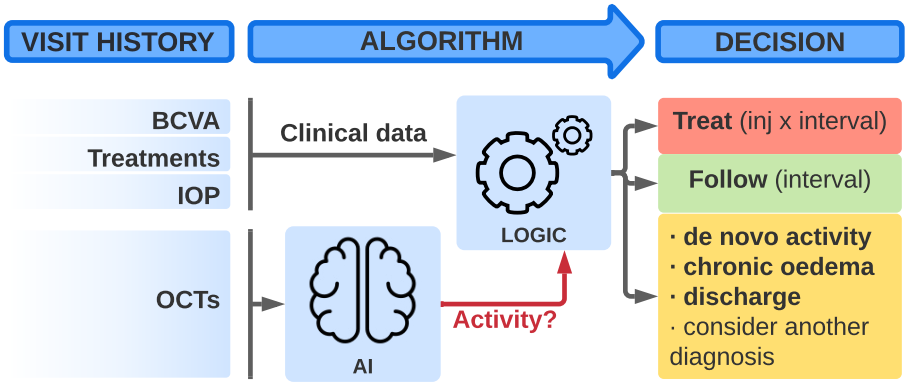

Figure 2. The design of the AI system for follow-up of AMD patients

References

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