Utilizing Artificial Intelligence to Predict Post-Operative Outcomes in Ophthalmic Surgeries: A Systematic Review

Liam Connors[*], Abdullah Al-Ani[&], Athithan Ambikkumar[&], Karim Punja[&], and Patrick Gooi[&]

[*]Cumming School of Medicine, University of Calgary

[&]Division of Ophthalmology, Department of Surgery, University of Calgary

UNIVERSITY OF CALGARY

INTRODUCTION

- Recent developments in Artificial Intelligence (AI) and machine learning promise to revolutionize various fields of medicine, including ophthalmology.
- The predictive ability of these algorithms using large datasets is well-suited to forecast patients' post-operative outcomes.
- AI also has the potential to identify important pre-operative risk factors and guide both surgical planning and decision-making.
- Current methods of predicting post-operative outcomes to optimize surgical decision-making rely largely on linear regression. These methods are limited in their application to large datasets with many variables[1].
- Despite its potential, the body of literature surrounding the implementation of AI in the prediction of ophthalmic surgical outcomes has yet to be evaluated using a systematic methodology.

PURPOSE

To provide an overview and narrative analysis of the state of current literature regarding the utilization of AI to predict post-operative outcomes in patients undergoing ophthalmic surgery.

METHODS

A systematic search of MEDLINE, Embase, Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials, Compendex, IEEE, Web of Science, and Scopus was performed. An iterative web search through grey literature was completed.

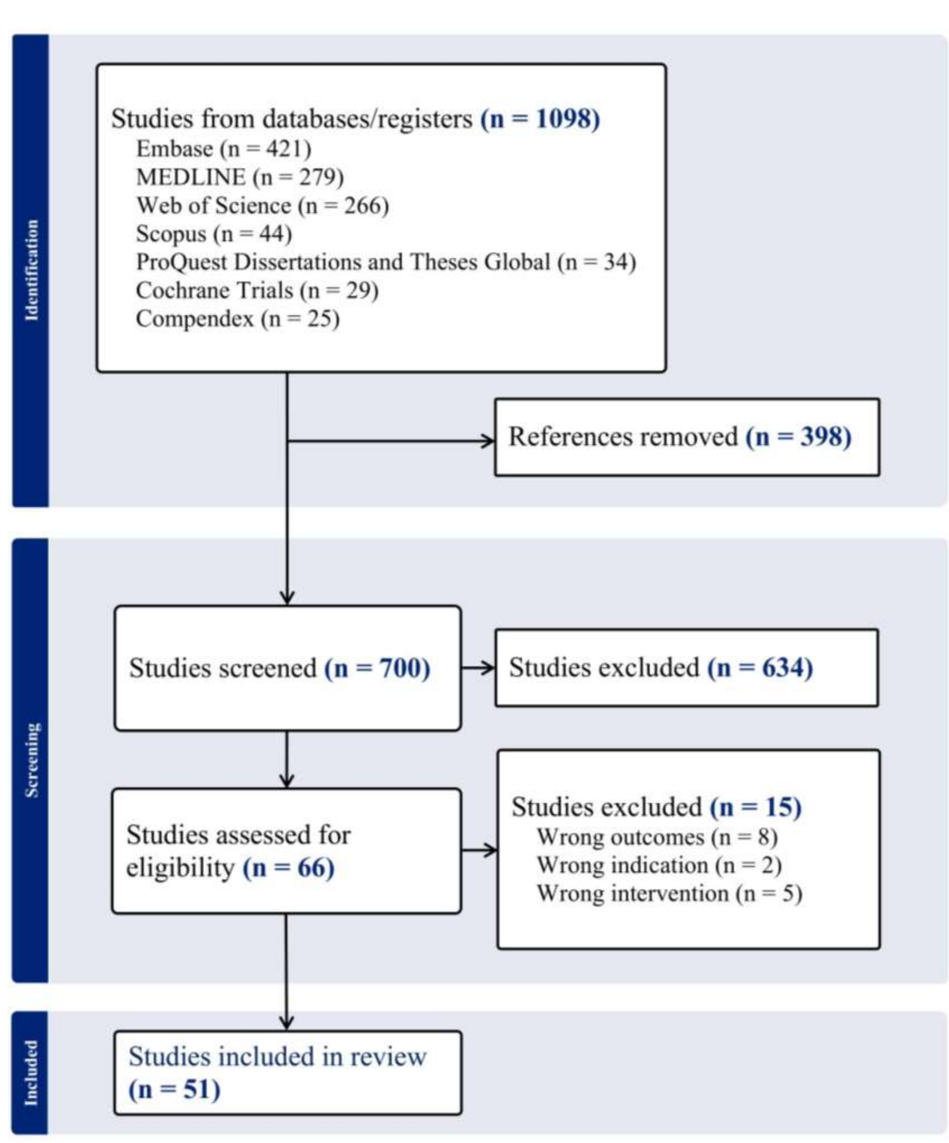

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart of study selection process.

Inclusion criteria

- Primary studies using AI to predict outcomes after ophthalmic surgical procedures.

Exclusion criteria

- Studies of laser procedures, intra-ocular lens power calculations, injections, and non-predictive AIs.

RESULTS

Year of Publication

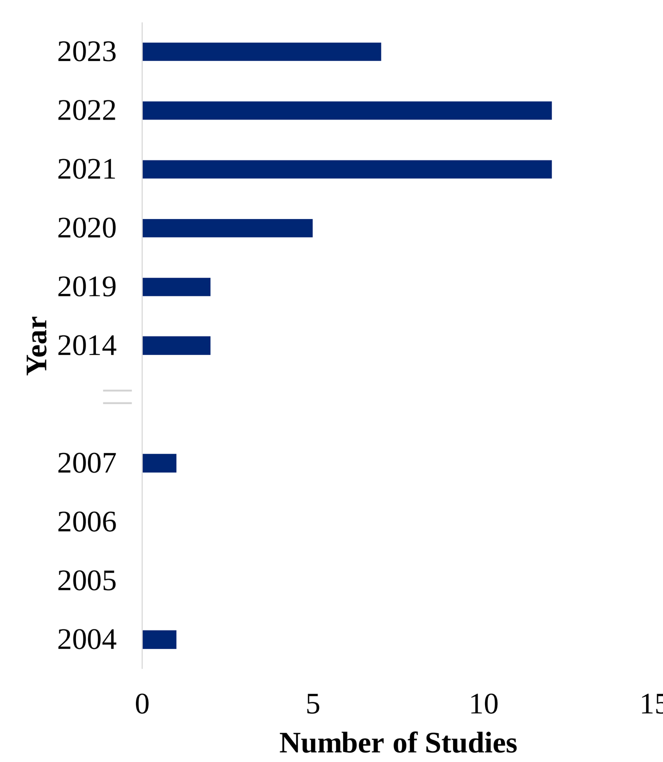

Figure 2. Number of full-text included publications organized by year of publication.

Sample Size

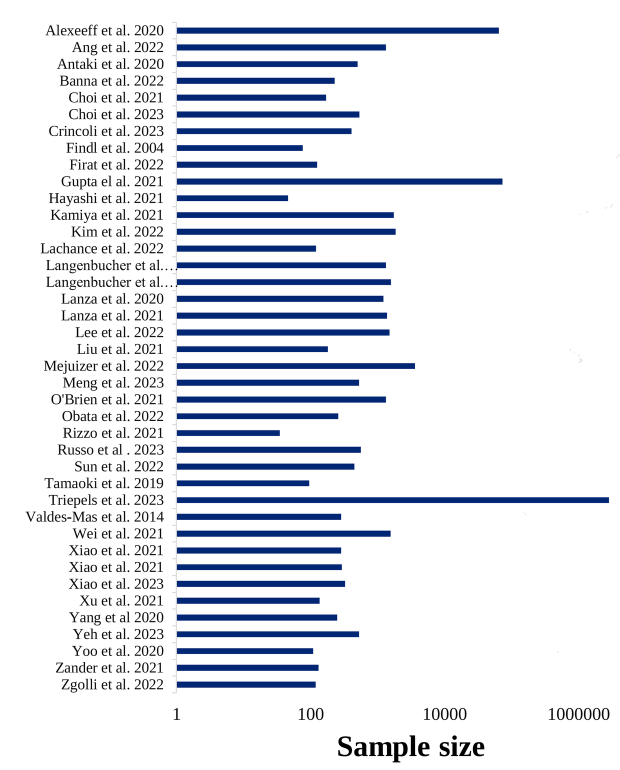

Figure 3. Sample size used in each of the included full-text studies, plotted on a logarithmic axis.

Country of Origin

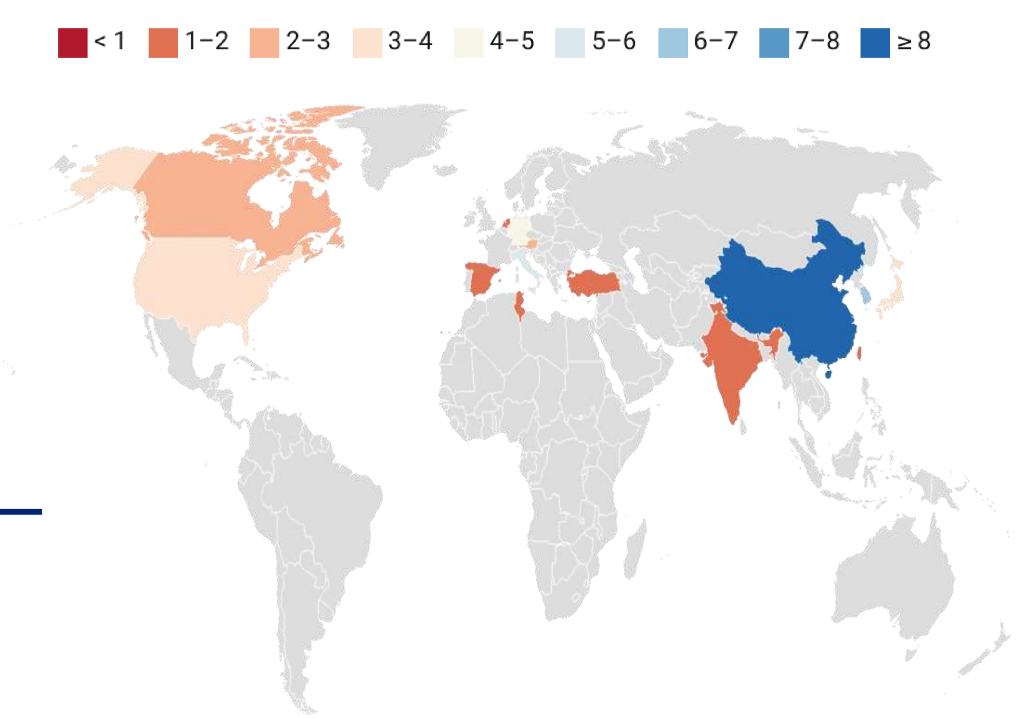

Figure 4. Number of studies performed by country. Countries in which no study was performed are indicated in grey.

Procedure Type

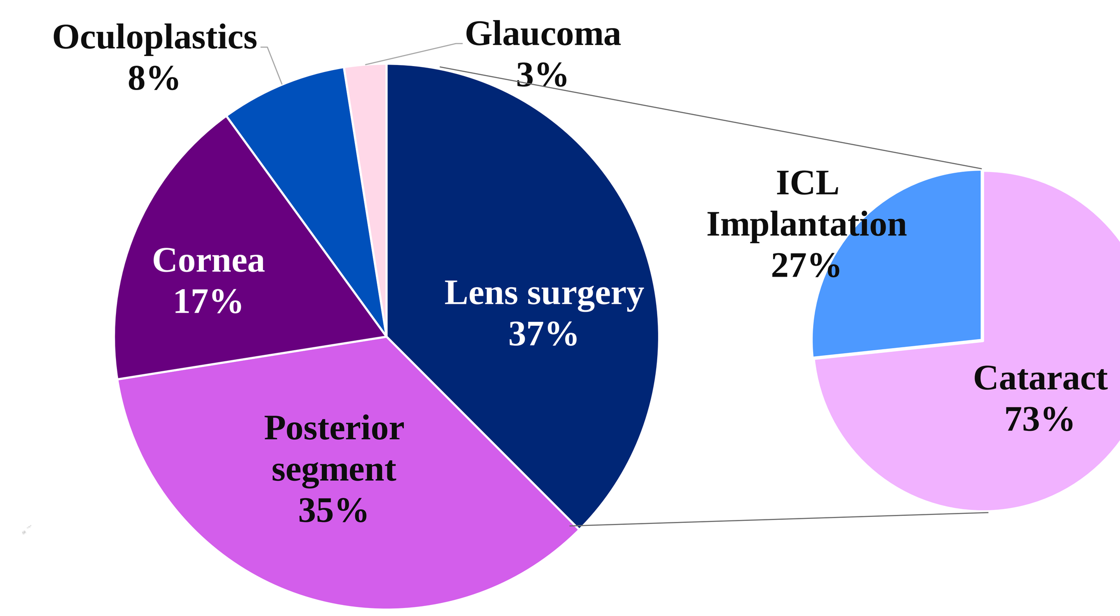

Figure 5. Percentage of included full-text studies examining each surgical category. Lens surgeries are further divided into specific surgical procedures. ICL=Implantable collamer lens.

Primary Outcome

Outcome Assessed	Number of Studies
Visual Acuity	11
Implanted lens position	6
Macular hole status	4
Post-operative appearance	3
Graft survival	3
Post-operative Depth of Focus	1
Chang Waring chord	1
Posterior capsule rupture	1
Big bubble formation	1
Edema resolution	1
Corneal curvature	1
Proliferative vitreoretinopathy	1
Anterior chamber angle	1
Dry eye disease	1
Foveal thickness	1
Other Surgical Complications	3

Table 1. Primary outcomes assessed in each of the included full-text studies and the number of studies associated with each outcome.

AI Model

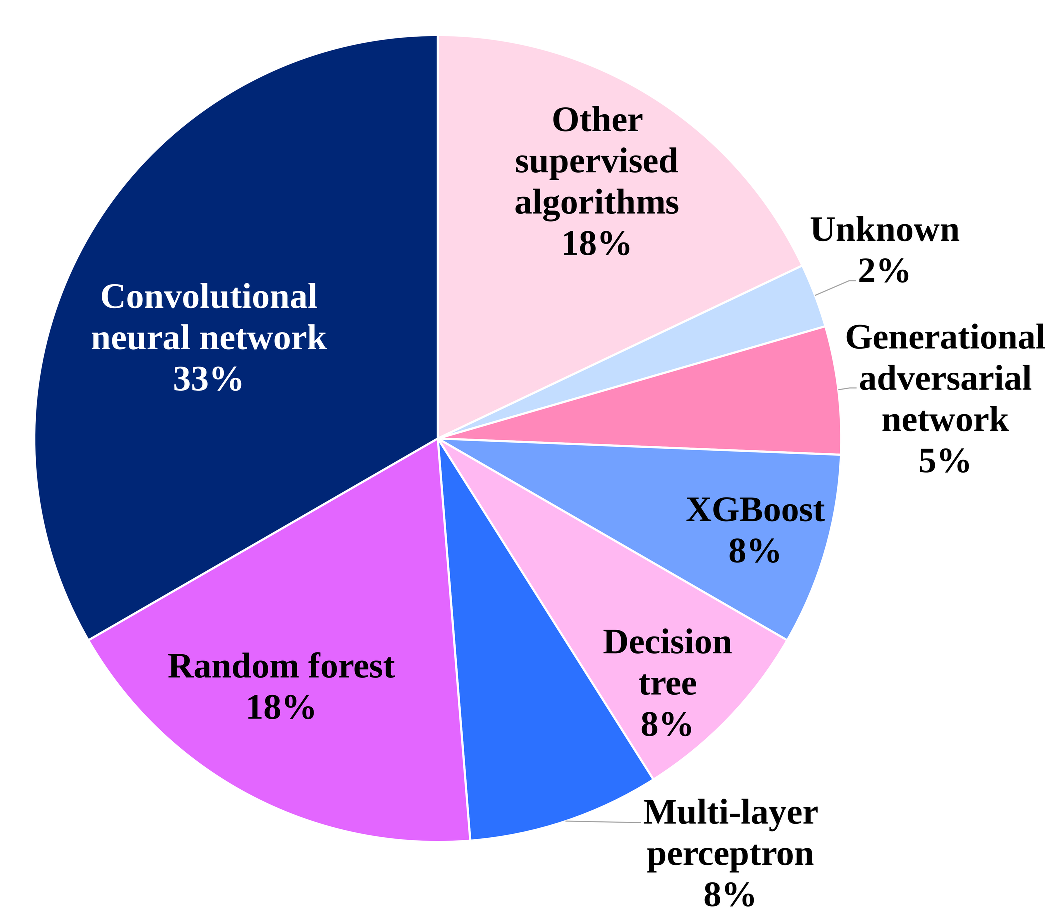

Figure 6. Number of included full-text studies implementing each AI model expressed as a percentage. Best-performing AI model is represented in cases where more than one AI was studied.

Concluded Effect

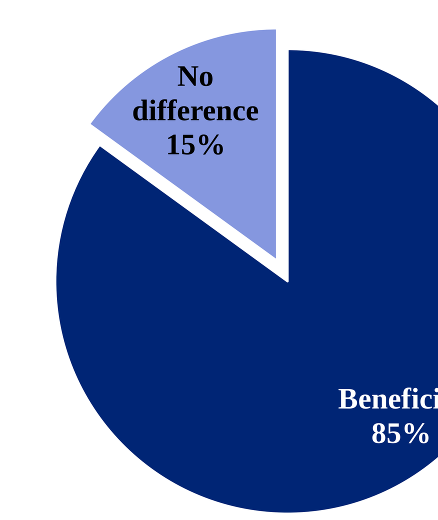

Figure 7. Proportion of included full-text studies that found significant improvement over controls or established significant predictive ability in the absence of a control.

The majority of included studies found that AI models were able to predict post-operative outcomes in ophthalmic surgical patients. These models largely outperformed traditional, non-deep learning methods of outcome prediction. Convolutional neural networks were the most widely used model, while visual acuity was the most commonly assessed outcome in these models.

CONCLUSIONS

- AI has been recently evolving in ophthalmology, with the vast majority of texts (90.2%) having been published since 2020.
- This field has most commonly focused on lens surgery, predominantly in cataracts.
- Many AIs tested in these studies showed improved predictive ability over traditional techniques, although low sample size was a limiting factor in deep learning algorithm performance[2-3].
- To the best of our knowledge, this is the first study to systematically summarize the published efforts utilizing AI to predict post-operative outcomes for ophthalmic surgeries.
- Future work in this area must be done to validate these models in multiple centers and populations. Additional work must also be done to establish the clinical benefit of AI-guided decision-making in ophthalmology.

REFERENCES

ACKNOWLEDGEMENTS

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