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"Our Intelligence is What Makes us Human, and AI is an Extension of that Quality"

Not only is the global prevalence of Diabetes Mellitus (DM) and Diabetic Retinopathy (DR) expected to increase, but concomitantly the global prevalence of vision-threatening DR (VTDR), which includes diabetic macular edema, severe non-proliferative (NPDR) and proliferative disease (PDR), is also projected to increase. The international number of patients with VTDR is estimated to increase by 57% from 28.5 million in 2020 to 44.8 million in 2045 [1]. Screening to detect early sight-threatening lesions of DR for timely monitoring and treatment is an important strategy to reduce the burden of vision loss due to DR.

An artificial intelligence (AI) algorithm has recently been shown to be an effective tool for screening DR. It can potentially lower the burden imposed on human personnel and improve patient access to care.

The history of artificial intelligence (AI) is deeply intertwined with the history of computer science and the advent of computers over 60 years ago. Diabetic Retinopathy detection with artificial intelligence utilizes a machine learning algorithm to analyze retinal, images, allowing for automated screening and diagnosis of diabetic retinopathy, a serious eye complication related to diabetes, often with high accuracy compared to traditional methods, potentially improving early detection and access to treatment, especially in underserved areas.

The global burden is immense with a worldwide prevalence of 8.5%. Recent advancements in artificial intelligence have demonstrated the potential to transform the landscape of ophthalmology with earlier detection and management of DR [1].

It is a process of teaching a machine to recognize specific patterns. The techniques can be classified into, machine learning (ML) techniques, Natural language processing methods, speech, vision, expert systems, robotics, etc. Machine learning techniques are more utilized in ophthalmology [2].

Traditionally, the detection of diabetic retinopathy involves manual examination of retinal images, which is time-consuming and subjected to human errors. In contrast, AI utilizes machine learning algorithms to analyze retinal images quickly and accurately. AI systems can identify subtle signs of DR that may missed by human examiners [3].

There are currently three FDA-cleared DR screening AI devices in the US; IDx- DR, EyeArt, and AEYE- DS. According to FDA guidelines, DR screening algorithms fall under class 11 devices [4]. The automated categorization of DR via retina pictures has been progressively studied using machine learning (ML) and deep learning (DL) with impressive outcomes.

Analyzing fundus photography is one of the most advanced directions in DR AI models, with many approved or in-use models for diagnosis or staging.

IDX-DR approved by the FDA in 2018, the device is paired with a nonmydriatic retinal camera, and the captured images are sent to a cloud-based server. The server then utilizes IDx-DR software and a "deep learning" (DL) algorithm to detect retinal findings consistent with DR based on autonomous comparison with a large dataset of representative fundus images. If DR is detected, a referral to an eye care professional is suggested.

It is to be noted that false negative results may provide a pseudo sense of security about retinopathy status. Hence, a comprehensive fundus examination after mydriasis remains the gold standard.

Retmarker is a feature-based machine learning model developed in 2011 that detects microaneurysms from color fundus photos to detect disease or no disease. However, it does not specify the stage and severity of the disease. The algorithm can be applied in the treatment of clinically significant macular edema. It lowers the grading burden by 48.8% in the DR screening program [4].

Retinalyze is another ML-based algorithm for detecting DR. The sensitivity and specificity were found to be 95% and 71% respectively [4].

ARDA (Automated retinal disease assessment), is a DL algorithm, that was developed using a dataset of patients' retinal photographs with DR from USA and INDIA. It has a sensitivity of 96.8% in comparison to human grader (74%).

AI Analysis on Smartphone Photographs is also useful. A pilot study conducted in India used the Remidio fundus on-phone application to capture retinal images after mydriasis, graded by the offline EyeArt algorithm, achieved 95.8% sensitivity [5].

AI Models for Prediction of Dr Progression

Sari et al. [6] used an ML prediction model to assess the development of DR within 5 years. Using clinical variables (e.g., albuminuria, GFR, DR status), the model had an AUC of 0.75, and using blood-derived molecular data (e.g., fatty acids, amino acids, sphingolipids), it had an AUC of 0.79.

AI models can potentially have a significant clinical impact in personalizing DR screening intervals. The Retina Risk algorithm generates a recommended screening interval based on the individual's predicted risk of developing sight-threatening DR.

AI Model for Diagnosis of DME

A major cause of visual impairment is diagnosed by OCT. Tang et al developed a multitask DL system using images from three OCT devices and demonstrated AUC values of 0.937-0.965 for DME detection and 0.951-0.975 for centers involving DME. DL models show high accuracy for quantifying the severity of macular edema useful for triage in teleophthalmology [5].

AI in the treatment of DR

AI has paved the way for precise treatment approaches. AI algorithm can assess the severity of DR and its progression and tailor the treatment plan for individual patients.

Artificial intelligence can help detect DR, identify risk factors, monitor progression, and provide treatment guidance and can also help in optimizing resources.

AI produces and acquires knowledge that can be reproduced and accessed from data more effectively than the majority of experienced experts.

AI Models for DME Treatment Response

For longitudinal predictions, focusing on treatment needs and analyzing both structural and functional outcomes, Cao et al [7] developed a model to predict the treatment response, the model utilized to autonomously extract OCT biomarkers followed by multiple classifiers for response. Moosavi et al [8] developed software for analyzing vascular features in fl. angiography to predict treatment outcomes.

Ethical Considerations

Issues related to data privacy and patient consent need to be carefully addressed when utilizing health care. Ensuring transparency in AI decision-making and addressing potential biases in algorithms is crucial for patient trust and responsible implementation.

Future

The future of AI in DR is likely to see advancements in early detection, personalized treatment planning, and improved accessibility to screening through automated analysis of retinal images [9].

AI can streamline the process of grading the severity of DR by automatical analysis. Regarding Telemedicine AI-powered tools are integrated into telemedicine platforms for screening in remote areas. However, the high cost of wide-field imaging and OCT angiography may be a limiting factor at present. A lot of work has been done on serum biomarkers for early detection and monitoring of disease. Hence the emergence of digital health technologies, may help address these obstacles and alleviate the disease burden [10].

Conclusion

The AI system had a higher sensitivity for detecting DR than either general ophthalmologists or retina specialists compared with clinical reference standards. It can serve as a low-cost point-of-care diabetic retinopathy detection tool and help address the diabetic eye screening burden.

AI shows significant potential not only in the diagnosis of DR but also in monitoring disease progression efficiently, thereby allowing for timely intervention and potentially preventing vision loss.

However, while AI can assist clinicians, it should not replace ophthalmologists and still requires careful consideration of the ethical and legal implications of implementation.

Novel developments in the sector of AI are opening up new promises for running DR detection and grading algorithms.

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