Artificial Intelligence and Diabetic Retinopathy; The Future is Here

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Ophthalmol Pak. - Official Journal of College of Ophthalmology & Allied Vision Sciences

Diabetes is becoming a national public health problem as Pakistan ranks 3rd after China and India with regards to its prevalance. The prevalence of diabetes has steadily increased over time, i.e. 11.77% in 2016, 16.98% in 2018 and 17.1% in 2019. Diabetic retinopathy is among the most debilitating complication leading to blindness.[1] Prevalence of Diabetic Retinopathy in diabetes is another debate. Some studies quote a range of prevalence i.e 5-35% at time of diabetes diagnosis. In Pakistan prevalence of diabetic retinopathy is 15.93% at the time of diagnosis of diabetes in Islamabad. This is quite high and showcases the impact of poor literacy rate, inadequate health education, low socioeconomic status and late presentation of the patient.[2] Duration of diabetes plays a major role in prevalence of diabetes. According to Wisconsin study in young diabetic patients less than 30 years, the prevalence of Diabetic Retinopathy was 8%, 25%, 60% and 80% at 3, 5, 10 and 15years respectively.[3]

In a systemic review pooled prevalence of diabetic retinopathy in diabetic population was found to be 28.78% in all diabetic and prevalence of vision threatening diabetic retinopathy was found to be 28.2% of all Diabetic retinopathy and 8.6% of all diabetic patients.[4] Vision threatening diabetic retinopathy includes proliferative diabetic retinopathy and diabetic macular edema. This high prevalence is due poor screening tools and high screening costs which illiterate and patients with poor socio-economic status can't afford. It is important to note that cost per patient of diabetic retinopathy in Pakistan was identified to be 108-135$ in 2007.[5] No further studies are available in this regard however if adjusted for inflation this equals to 190 $ in 2024. Population based KAP study conducted in suburbs of Karachi showed that only 39.2% diabetic were aware of their diabetes, 56.8% of these visited or routine exam and only 9.2 % asked for retinal exam.[6] In another KAP study conducted in Gaddap Town of Karachi, only 7.2% considered Diabetes as a cause of blindness.[7] This high screening cost, poor literacy rates, poor socio-economic status, unaffordable eyecare and lack of knowledge are the major barriers in screening and diagnosis of diabetic retinopathy. Financial constraints, Long waiting lines, busy hospitals, difficulties with travel and transportation, Lack of awareness about eye related complications were some of the challenges identified by Bechange S et al.[8]

To cater for problem of late presentation of diabetic retinopathy an effective and low-cost alternate of diabetic retinopathy screening must be established. The novel technology of computer science has made great leap forwards in automation. Artificial intelligence (AI) can provide a low-cost alternate to diabetic retinopathy screening and ultimately the diagnosis.

The Artificial intelligence employes machines

How to Cite this Article:
Yaqin MM, Asghar MA. Artificial Intelligence and Diabetic Retinopathy; The Future is Here.
Ophthalmol Pak. 2024;14(3):58-60.
DOI: https://doi.org/10.62276/OphthalmolPak.14.03.161

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Received: 30-05-2024 **Accepted:** 24-06-2024

learning with two main techniques, i.e. deep learning and neural network algorithms. The diagnostic results interpreted by these AI tools are based on the international clinical classification of diabetic retinopathy.

Machine learning employes that accurately labeled data set is available for computer referencing. This data set needs to be partitioned into three different types: training, validation and testing. Ground truth images are defined by labeling the data set by expert ophthalmologist. Machine learns the parameters on the ground truth images. The Algorithm is fed with fundus images that create output prediction. This output prediction is compared with ground truth images by ophthalmologist. The model is then tested by random images i.e the testing image. The algorithm does not have any knowledge of these testing images and does not learn from it. The results are used to test the algorithms performance in real time. [9]

It is important to note the difference between Deep Learning and Artificial neural network. The deep learning has been described above, in which the algorithm is taught by extensive input about specific entity and keeping the original algorithm fixed so it does not learn new things. However, this entails extensive data to train the AI and it is difficult to predict the extent to which data training is required in training the Algorithm to achieve a desired result. Artificial Neural network (ANN) is based on human mind. They way neurons learn and process the information. ANN contains nodes as similar to neurons. The nodes communicate with each other just like neurons. These communications are weighted on ability to produce the desired results. The nodes are arranged in a number of layers. At one end is input node and other end is the output node, in between these are multiple layers of hidden nodes that process the information. These layers can be intens, hundreds or even thousands. The beauty of ANN is in its ability to learn from the tests data sets in a feed forward method.[10]

Specificity and sensitivity are mandatory for any screening tool. If the sensitivity and specificity of AI tool reaches 85% than it is very close to human graders. FDA has approved three devices for Diabetic screening as class II devices, IDx-DR, EyeArt, AEYE-DS. In European Union there are multiple devices that have Class II-a registration, which include IDx-Dr, EyeArt, Retmarker, Google and Singapore Eye Lesion analyzer (SELENA. In China VoxelCloud Retina and AIDR Screening System is being used for diabetic retinopathy screening. [9]

Table-1: AI models for diabetic retinopathy screening along with their sensitivity and specificity:

Year	Model	Sensitivity	Specificity
2018	Idx - DR	87.2%	90.7%
2019	SELENA	92.3%	89.0%
2020	VoxelCloud Retina	83.3%	92.5%
2021	EyeArt	95.7%	54.0%
2021	EyeArt	95.5%	85.0%
2022	Google	94.7%	91.4%
2022	AIDRScreening system	86.7%	96.1%

All of the available Algorithms are developed based on non-mydriatic fundus cameras. Macula centered or disc centered 45 degree images are required by algorithms for a following reasons:[11]

1. Field of View: A 45 degree image provides a wide field of view, allowing the AI to analyze a large portion of the retina in a single image.

2. Focus on Key Areas: The macula is responsible for central vision and is often affected in diabetic retinopathy. The optic sisc, where the optic nerve connects to the retina, can also show signs of various eye diseases.

3. Standardization: Using standardized image types (like macula-centered and disc-centered) helps ensure consistency in the images being analyzed. This is important for training the AI models and for comparing resluts accross different studies.

4. Quality Control: These specific image types help ensure that the images are of good quality and that important parts of the retina are not missed.

In Future we may be able to develop such algorithms that may help in complete diagnosis of Diabetic retinopathy and other retinal problems. The currently available AI tools can help in Diabetic retinopathy screening in a cost effective manner, round the clock availability to the internist, and prompt referrals can help control the disease burden.

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CONFLICT OF INTEREST

Author has no conflict of interest.