Commentary: A mobile application for generating differential diagnosis in neuro-ophthalmology – New tool using artificial intelligence

Neuro-ophthalmology is a specialty that needs specialized training to recognize and diagnose complex neuro-ophthalmic conditions. Traditionally, neuro-ophthalmology has been a dreaded subspecialty for both ophthalmology and neurology residents. One of the greatest challenges to diagnosing neuro-ophthalmic conditions for the neurology residents is the inability to do a fundus exam confidently. Thus, diagnosing optic neuropathies remains a challenge to neurologists. Next comes the inability to integrate clinical signs with knowledge about neuro-ophthalmic conditions, making neuro-ophthalmology a challenging field to master. As rightly pointed out by authors of this manuscript, artificial intelligence can play a big role in bridging this gap.[1]

Modern medicine has widened learning opportunities for medical practice. Today one resorts to several online resources for learning such as eBooks, scientific manuscripts, and podcasts. As we are amid a global pandemic, we have seen how the whole globe has quickly adopted and transitioned to a virtual leaning style. Thus, in this day and era one could extensively use artificial intelligence to enhance learning skills in neuro-ophthalmology.

The term machine learning was coined 50 years ago by Arthur Samuel, who stated that machines could have the ability to learn without being programmed.[2] Deep learning is an approach that utilizes multiple neural networks to learn representation of data using multiple levels of abstraction.[3] Deep learning involves the process of training a multi-layer network of neurons, containing millions of parameters, to perform a given task. Training involves "showing" the network a large set of images as pixels (training data) and programming it to produce an output.

A machine-learning model can learn the patterns of health trajectories of vast numbers of patients and is being widely employed in modern medicine. For example, artificial intelligence (AI) is now widely applied to recognize many ophthalmic conditions such as papilledema and diabetic retinopathy with greater accuracy.[4,5] Deep learning (DL) has shown promising diagnostic performance in ophthalmology e.g., detection of diabetic retinopathy, glaucoma, and age-related macular degeneration from fundus photographs and optical coherence tomographs.[6]

Similarly, it has been observed that machine learning using data collected during a clinical visit could be used to generate differential diagnosis.[6] Deep learning has also been utilized in other medical specialties for diagnosis, for example in radiology for the detection of tuberculosis from chest X-rays and detection of intracranial hemorrhage from computed tomography of the
brain\textsuperscript{7,8} and in dermatology for the detection of malignant melanoma from skin photographs.\textsuperscript{9}

Deep learning has been utilized in many smartphone applications. Such mobile applications have been utilized in fields such as plastic surgery.\textsuperscript{10} An artificially intelligent model was trained to identify superficial surgical procedures in rhinoplasty when presented with patient photographs. This study demonstrated that predictions made by deep learning model were approximately as accurate as those of expert consensus. This study also suggested that such applications can be used as an educational tool for resident trainees.

A mobile application that could suggest possible differential diagnosis seems a novel concept built along the lines of artificial intelligence. The authors of the current manuscript have explored this concept by building a mobile application (Neurology dx) that could generate a differential diagnosis for neuro-ophthalmic conditions. The purpose seems to be solely for enhancing knowledge in neuro-ophthalmology. The project has been planned in a systematic manner. The first step included testing the validity of the mobile application. As cited in the manuscript the “gold standard differential diagnosis” was correctly identified by the mobile application with slightly greater accuracy than the neurology residents. Then they tested neurology residents across the country from 7 different tertiary care neurology programs, thus avoiding bias and enhancing validity. This works needs to be highly complimented.

As pointed out, there is definitely a void emanating from lack of such teaching tools in the field of Neurology/ Neuro-Ophthalmology. A handy mobile application such as Neurology Dx is a good attempt to bridge this void and help the clinician/resident in deriving a comprehensive list of differential diagnoses. While clinicians are ultimately responsible for decision-making in practice a mobile application can come handy in any situation to suggest differential diagnosis.

AI using DL is a promising novel state-of-the-art technology for the medical world. But it is crucial that we, ensure in such deep learning we use robust training datasets with reliable ground truths and we accurately test the validity of these models in clinical practice. This also applies to using a mobile application for generating a differential diagnosis. The validity should be periodically assessed to avoid clinicians from placing undue reliability on this tool.

Although one should not entirely depend on artificial intelligence in practicing medicine, a mobile application that can suggest potential differential diagnosis can clearly be a good learning tool for a trainee in any field of medicine.

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\textbf{References}

1. Vinny PW, Takkar A, Lal V, Padma MV, Sylaja PN, Narasimhan L, et al. Mobile application as a complementary tool for differential diagnosis in Neuro-ophthalmology: A multicenter cross-sectional study. Indian J Ophthalmol 2021;69:1491-7.
2. Samuel AL. Some studies in machine learning using the game of checkers. In: Computer Games. New York: Springer; 1988. p. 335-65.
3. LeCun Y, Bengio Y, Hinton G. Deep learning. Nature 2015;521:436-44.
4. Gulshan V, Peng L, Coram M, Stumpe MC, Wu D, Narayanaswamy A, et al. Development and validation of a deep learning algorithm for detection of diabetic retinopathy in retinal fundus photographs. JAMA 2016;316:2402-10.
5. Milea D, Najjar RP, Zhuo J, Ting D, Vasseneix C, Xu X, et al. BONSAI Group. Artificial intelligence to detect papilledema from ocular fundus photographs. N Engl J Med 2020;382:1687-95.
6. Rajkomar A, Dean J, Kohane I. Machine learning in medicine. N Engl J Med 2019;380:1347-58.
7. Lakhani P, Sundaram B. Deep learning at chest radiography: Automated classification of pulmonary tuberculosis by using convolutional neural networks. Radiology 2017;284:574-82.
8. Titano JJ, Badgeley M, Schefflein J, Pain M, Su A, Cai M, et al. Automated deep-neural-network surveillance of cranial images for acute neurologic events. Nat Med 2018;24:1337-41.
9. Esteva A, Kuprel B, Novoa RA, Ko J, Swetter SM, Blau HM, et al. Dermatologist-level classification of skin cancer with deep neural networks. Nature 2017;542:115-8.
10. Borsting E, DeSimone R, Ascha M, Ascha M. Applied deep learning in plastic surgery: Classifying rhinoplasty with a mobile app. J Craniofac Surg 2020;31:102-6.