

EDITORIAL

The future of neurology in the era of the artificial intelligence boom

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The practice of neurology over the centuries has had as its basic approach, a good history and examination that guide the relevant investigations to reach diagnoses. With the expansion of the armamentarium of investigations, the emphasis on clinical methods has lessened. The rapid and unprecedented development of artificial intelligence (AI) which is known as the “AI boom” in recent years, has the potential to make a serious impact on this time-tested approach to making a clinical diagnosis. This editorial attempts to explore the future of neurology in the AI boom.

Although AI applications came to the limelight recently, AI models like machine learning (ML) methods have been around since the 1950s. AI has been featured in medical sciences, especially radiology, neurophysiology, genetics, etc. for years. AI algorithms are made to learn the patterns inherent in large clinical data sets such as Computerised Tomography (CT) and Magnetic Resonance Imaging (MRI) scans or electrophysiological recordings and make predictions compared to determinations made by humans. This is referred to as supervised learning where ML algorithms are trained by previously labelled datasets into classifying data or predicting outcomes accurately. In contrast to supervised learning, unsupervised learning uses ML algorithms to analyse and cluster unlabelled data sets. They can discover hidden patterns in data without human input.

AI has several applications in current neurology practice. In the field of neuroimaging, AI can differentiate a haemorrhage from an infarction, quantify the Alberta Stroke Program Early CT Score in CT scans, and interpret the mismatch of infarction from hypoperfused areas in CT/MRI perfusion images in stroke patients. Machine learning (ML) algorithms have also been developed to learn the MRI images of patients with multiple sclerosis to define its subtypes. In epilepsy, AI applications are available to define focal cortical dysplasias. AI can also determine active epilepsy from that in remission by observing MRI characteristics (fractional anisotropy, mean diffusivity, radial diffusivity, and axial diffusivity in diffusion tensor imaging data). It also can lateralize temporal lobe epilepsies.

There are ML algorithms to differentiate Alzheimer disease (AD) from vascular dementia by observing neuroimaging datasets. Another AI algorithm that was trained using AD neuroimaging data is capable of making predictions on the radiological diagnosis of AD. The accuracy of that algorithm was closely related to the post-mortem histopathological diagnosis of AD in that cohort and exceeded the accuracy of the clinical diagnosis. In Parkinson disease (PD) there is an AI algorithm to study neuromelanin sensitive magnetic resonance imaging which detects abnormalities in the substantia nigra pars compacta. This algorithm has good accuracy in diagnosing PD as well as in differentiating PD from atypical Parkinson syndromes. Neuro-electrophysiology has also not escaped from AI. There are AI applications to detect epileptiform discharges from scalp and intracranial electroencephalograms (EEGs), detect the epileptogenic zone in presurgical evaluation, and predict seizure localization using the patients’ long-term scalp EEG data. The accuracies of these applications are eyebrow-raising. In the field of coma, AI applications are using scalp EEG data working on the prediction of six-month functional outcomes.



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The retinal examination is also an area encroached on by AI. There are ML algorithms to detect papilloedema and diabetic retinopathy, using retinal photographs. The accuracies of these applications are favourable compared to that of experienced clinicians. AI could also revolutionize pharmacology, especially in new drug development. Sheffield Institute of Translational Neuroscience, UK has recently used an AI platform to identify 100 existing compounds that are potentially useful in amyotrophic lateral sclerosis. Their scientists have worked on five potential compounds and one was found to be effective in retarding symptoms in mice. Neuralink, the multimillion-dollar investment project since 2016, has researched a brain-computer interface where human brains achieve a symbiosis with AI. The project would broaden the horizons of neurorehabilitation therapeutics in the future.

Although it is fascinating to see the scope of AI applications in the field of neurology, significant limitations also do exist. For instance, an AI application trained to detect papilloedema may fail miserably when there is optic atrophy. Also, the accuracy of the AI applications depends on the training they had with the data provided to them. The complexity of the AI tool is proportionate to the inexplicability of its data processing. This is being referred to as the black box problem in AI (human inability to explain the precise steps which lead to predictions of AI applications). The situation is further complicated by the condition known as AI hallucination, where the AI tool

generates outputs that are unrelated and unexpected and could lead to multifaceted impacts, including medicolegal issues. To assure the credibility and accountability of the AI tools, the U.S. Food and Drug Administration has reviewed and authorized several medical devices that utilize ML and published an approved AI/ML-enabled medical devices list.

Although AI technology is encroaching into the medical field like wildfire, a machine replacing a clinician would still be a part of science fiction. While the clinical methods would remain the pillars of future neurology practice, newer AI applications would certainly complement the traditional clinical methods. To be up in the game, the neurologist must understand the applicability of relevant AI applications and their limitations. Charles Darwin's famous quote "It is not the most intellectual of the species that survives; it is not the strongest that survives, but the species that survives is the one that is able to adapt and adjust to the changing environment in which it finds itself" would be equally applicable not only to neurologists but also to any professional in the AI era.

REFERENCE

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