Neurology and Epilepsy: Innovation, Burden and Future

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Abstract

Epilepsy is one of the oldest and most widespread neurological disorders described in the medical literature. However, it is still one of the most difficult to manage. With diagnostic and therapeutic advances and neurobiological insights, epilepsy continues to pose great clinical and social challenges. Over 50 million people worldwide have epilepsy but over 75% of patients in low and middle-income countries do not receive treatment [1,2]. For a neurologist who sees patients, epilepsy is at the intersection of brain and behavior and genes and public health. In this way, it involves more than seizures.

Keywords: Epilepsy; Seizures; Neurology; Artificial Intelligence

Advances in epilepsy within neurology

In the last twenty years, the field of neurology has experienced a revolution in the diagnosis and management of epilepsy. High-resolution MRI, functional neuroimaging, next-generation sequencing helped the clinician in identifying the epileptogenic lesions and syndromic etiologies. We now have a better understanding of genetic forms of epilepsy, allowing for diagnosis and treatment. Researching biomarker, particularly looking at EEG data with machine learning, has helped us understand better seizure networks and prognosis [3].

Newer seizure medications are more effective and better tolerated than older medications. However, around one-third of the patients are drug-resistant [4,5]. For such patient populations, surgical and device strategies have become necessities. Less invasive methods like laser interstitial thermal therapy (LITT) and stereotactic radiosurgery are broadening availability for surgeries once deemed high-risk [6,7]. Vagus nerve stimulation, responsive neurostimulation, deep brain stimulation are forms of neuromodulation that have shown benefit in reducing seizure burden in refractory cases [8].

The use of Artificial Intelligence and digital health too has been equally force. ML algorithms are deployed for identifying subtle seizure patterns, predicting seizure occurrence, and assisting in automated EEG analysis [9]. At the same time, wearables and smartphone applications are empowering patients to monitor seizures in real-time, and get medication reminders with a better integration with lifestyle. The union of neurology, data science and patient-centered tech announce a paradigm shift towards precision epilepsy care.

Persistent challenges

The burden of epilepsy in terms of humans and society still exits despite the advances in science. In resource-limited places, three out of four individuals are not treated due to weak health infrastructure, stigma, cost, and others [10]. In high-income countries, diagnostic delays, fragmented care pathways, and inequitable access to surgery or advanced therapies persist. It is a social problem as much as a medical one and this is the case with Epilepsy.

Stigma continues to negatively impact epilepsy management and affects education, employment, and psychosocial well-being. Globally, many people experience isolation and discrimination due to misinterpretations based on culture and religion [11]. The invisibility of their illness for a lot of patients outside the seizure marginalizes them. Thus, neurologists have two responsibilities: one is to treat seizures and the other is to work for destigmatization.

The sudden unexpected death in epilepsy, or SUDEP, is one of the most feared complications of epilepsy. It is estimated that SUDEP accounts for 9% to 17% of deaths in persons with epilepsy. Seizure control, supervision at night, and detection devices should be used. Inconsistent use can lead to them being ineffective. The diagnosis of depression and anxiety in neurology clinics can lead to worse outcomes [10]. We need integrated, multi-disciplinary models of epilepsy care because of these issues.

Future Directions and a Call to Action

The future of epilepsy care sits at the intersection between precision medicines, digital innovations, and global health policy. As we learn more about genes and brain scans, tailor-made medicine becomes real. New drugs for genetic defects, inflammation of the nervous system, and modification of synapses show promise. In addition, AI-linked devices may soon allow for continuous, personalized seizure warnings, which will change epilepsy management from reactive to proactive.

The global initiatives are changing the policy environment beyond lab and clinic According to the World Health Organization, integrated care, stigma reduction, and health system strengthening are essential priorities, as noted in Intersect Oral Global Action Plan on Epilepsy and Other Neurological Disorders (2022 - 2031) [11]. It is both a professional and ethical imperative for neurologists to join this global movement. There should be epilepsy care in the general discussion of non-communicable disease and mental health.

The neurologist's job in epilepsy is expanding: clinician, researcher, advocate, policymaker. In high-resource settings, it means using innovations responsibly. In low-resource settings, it means modifying the care model to the local environment. It is essential that neurologists collaborate with primary care providers, psychologists, social workers, and patient organizations in all contexts. The care of epilepsy will attain the equity and excellence it deserves only through such integrative approaches.

Conclusion

Neuroscience faces spectrum of epilepsy as a social problem in which variety of communities are involved. The advances in imaging, genetics, neuromodulation and artificial intelligence generate optimism. However, the treatment gap and stigma as well as the problem of comorbidities show we must plan to include the whole world. As neurology journals, professional societies and international organizations declare epilepsy a priority, neurologists are uniquely positioned to connect innovation and advocacy. The call to action is explicit: let us turn epilepsy into an example of holistic neurological care, human dignity and global solidarity, instead of a condition of repeated fits.

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