

A Review on Antiseizure Medications in Treating Generalized Epilepsy

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ABSTRACT: The hallmark of epilepsy is unpredictable seizures, however it is a neurological disorder that affects people of all ages. Classifying epilepsy is the most crucial clinical technique for evaluating a person who is having seizures. It's usually unclear what mechanisms are required or necessary for epilepsy to develop. With generalized seizures, all sides of the brain are engaged. A loss of consciousness and a postictal state occur after the seizure. Antiseizure medication (ASM) is the primary treatment for epilepsy and can keep up to two-thirds of patients from having seizures. About 30% of newly diagnosed epileptic patients will not achieve seizure freedom while receiving pharmacological treatment, which may lead to drug-resistant epilepsy (DRE), which is defined as failing to achieve seizure freedom after trials of two appropriate and tolerated ASM regimens, either as monotherapy or in combination. Anti-epilepsy medications may cause unfavorable side effects in certain individuals. Many people are concerned about the side effects of epilepsy medications since they might have a detrimental influence on a person's quality of life. Negative mental health symptoms might also occur, including depression, anxiety, irritability, mood swings, hyperactivity, and, in rare cases, psychosis.

KEYWORDS: Epilepsy, Antiseizure medication, Drug resistant epilepsy, SUDEP, Idiopathic generalised epilepsy, Ketogenic diet.

I. INTRODUCTION

Since the ancient Babylonians and up to the present, epilepsy has been documented as a chronic illness. Epilepsy is a widespread neurological illness that affects people of all ages, despite the fact that its hallmark is unpredictable

seizures. According to the Institute of Medicine (2012), epilepsy does indeed have a bimodal onset, with the majority of cases occurring in infancy and older age. The first step in any categorization system is to distinguish between focal and generalized seizures. This is significant because the proper classification will determine whether medicinal and surgical procedures are used (1).

The most important clinical tool for assessing a person who is exhibiting seizures is the classification of epilepsy. It affects every clinical consultation, but its influence extends well beyond the clinical setting to include basic and clinical epilepsy research as well as the creation of innovative treatments. Classification has several uses, including offering a framework for comprehending the patient's seizure type, additional seizure types that are more likely to occur in that person, possible seizure triggers, and frequently their prognosis. Comorbidities such as learning disabilities, intellectual disabilities, mental health conditions like autism spectrum disorder, and mortality risks like sudden unexpected death in epilepsy (SUDEP) are also influenced by classification. It is noteworthy that the choice of antiepileptic treatments is frequently influenced by classification (2).

Building on the framework created in 2017, the International League Against Epilepsy (ILAE) has revised the operational classification of epileptic episodes. Compared to the 2017 classification, which included 63 seizure types, the new classification has 21 seizure types and retains the four primary seizure classes: focal, generalized, unknown (whether focal or generalized), and unclassified (3).

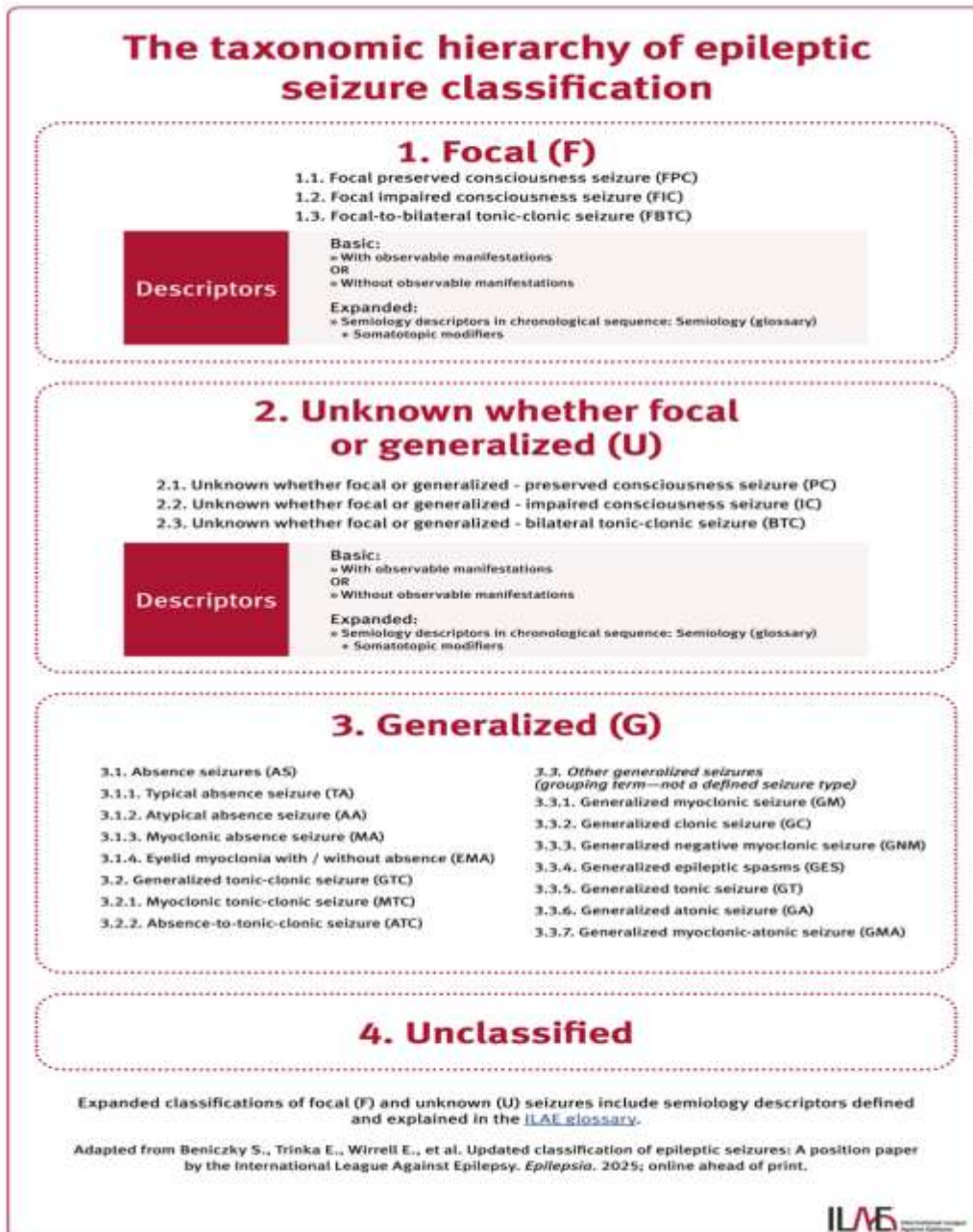


Fig:1 Classification of epilepsy

ETIOLOGY:

Based on its etiology, epilepsy is divided into three groups: acquired, idiopathic, and epilepsy of developmental or genetic origin. Idiopathic epilepsy starts in childhood and has no neurological symptoms. Childhood absence epilepsy and juvenile myoclonic epilepsy are two instances of idiopathic epilepsies. The cause of acquired epilepsy is recognizable structural brain

abrasions. Acquired epilepsy can be caused by prenatal and infantile factors, brain trauma, cerebral tumors, cerebral infections, hippocampus sclerosis, cerebrovascular disorders, and cerebral immunological disorders. Examples include meningioma, cavernous hemangioma, viral meningitis, open head surgery-induced epilepsy, and cerebral infarction. The cause of cryptogenic epilepsy is uncertain. Etiology can be hard to

pinpoint among acute and distant causes³. The term "cryptogenic" is prohibited in contemporary research due of its ambiguous connotations. Probably symptomatic is used in its place, with obvious consequences. According to the majority of research, ischemic stroke, central nervous system infections, brain damage, protracted symptomatic seizures, intracerebral hemorrhage, and neurodegenerative disorders are among the recognized causes of 40 out of 100 occurrences of epilepsy (4).

PATHOPHYSIOLOGY:

Epileptogenesis does not yet have a commonly agreed-upon definition. The process that results in the first spontaneous seizure and subsequent epileptiform occurrences following a brain injury is known as epileptogenesis.

MECHANISM OF EPILEPTOGENESIS

Numerous biological routes or processes, as well as structural and functional alterations, may be involved in epileptogenesis. The mechanisms that are necessary or required for the development of epilepsy are generally unknown. Nonetheless, a number of experimental investigations have shed light on the real and proposed mechanisms of epileptogenesis. They are

1. Neurotransmission signaling pathway
2. Molecular and genetic mechanisms: Ion channels and receptors
3. Neurogenesis and rewiring pathway: Structural, neurochemical and cellular change
4. Immunological and inflammatory pathway
5. Apoptotic pathway
6. Gene and protein regulation (5).

GENERALIZED EPILEPSY:

Both sides of the brain are involved in generalized seizures. Following the seizure, there is a postictal state and a loss of consciousness.

TYPES OF GE:

Absence seizure

'Petit mal' was its previous name. Moments of unconsciousness accompanied by blank stares and occasionally eyelid flutters that resemble "daydreaming" Absence seizure sufferers typically recover quickly and do not fall to the ground. In adults, the disorder is uncommon.

Atonic seizure

Temporary decrease of limb muscular tone that results in head drooping or an abrupt fall to the ground.

Tonic clonic seizure

Also referred to as a "grand mal" attack or convulsion. The individual will experience generalized jerking (clonic) movements and become rigid (tonic). The bladder may empty and breathing may cease. After experiencing widespread jerking motions that usually last a few minutes, the patient relaxes and becomes deeply unconscious before gradually waking up. People may not recall anything since they are frequently exhausted and disoriented. Tonic clonic seizures are categorized as secondary generalized tonic clonic seizures and can occur after simple partial seizures or complicated partial seizures. Generalized tonic-clonic seizures are defined as tonic-clonic seizures that happen suddenly and in the setting of generalized epilepsy (6).

Myoclonic Seizure:

Despite the fact that myoclonic seizures can happen at any age, epilepsy disorders that typically involve them typically start in childhood. The term "myoclonus" describes abrupt, short (less than 350 ms), shock-like involuntary movements that are physically derived from the cortex, subcortex, or spinal cord and are brought on by muscle contraction (or inhibition in the case of negative myoclonus). Myoclonic seizures can be localized or restricted to specific muscles or muscle groups, and their distribution and severity of symptoms might vary. They can be found in a variety of epilepsy syndromes, such as the group of progressive myoclonus epilepsies with notable semiologic and EEG differences and similarities, some epileptic encephalopathies (such as Dravet syndrome [DS]), and some idiopathic generalized epilepsies (IGEs; such as benign myoclonic epilepsy of infancy or juvenile myoclonic epilepsy [JME]) (7).

Status Epilepticus:

Depending on the reason, status epilepticus (SE), or continuous epileptic activity, can continue anywhere from minutes to hours. It may exhibit focal, unilateral, or bilateral epileptic seizures; nonconvulsive seizures, including absence or focal seizures, which may be typical or atypical; or convulsive clonic, tonic, or tonic-clonic seizures. Examples of SE include a single seizure or many seizures without awareness recovery. Usually symptomatic, but sometimes idiopathic (occipital epilepsy), it might be a sign of acute brain injury or complicated epilepsy at the beginning or during the course of the condition. EEG recording is required

for nonconvulsive SE, but clinical factors like history can hint at the diagnosis (8).

Idiopathic Generalized epilepsy:

Idiopathic generalized epilepsy (IGE) accounts for up to one-third of all epilepsy patients. Generalized tonic-clonic, absence, and/or myoclonic seizures are among the generalized-onset seizure forms that patients with IGE experience. Despite having "normal" magnetic resonance imaging (MRI), patients with IGE frequently have generalized spikes or spike-wave (GSW) discharges on electroencephalograms (EEG). At the group level, however, structural and functional neuroimaging can identify minor brain abnormalities, such as gray matter shrinkage and increased spontaneous local activity as evaluated by resting-state functional MRI (rs-fMRI) (9).

DIAGNOSIS:

The prognosis and course of treatment for IGEs are significantly impacted by the diagnosis. Development, neurological tests, and radiographic findings are generally normal in IGE patients. Furthermore, IGEs are frequently highlighted as being of pediatric concern primarily because the majority of cases occur in children and adolescents; yet, significant psychosocial symptoms, including mood disorders, attention deficits, and learning disabilities, can persist into adulthood. IGEs have been linked to outcomes like worse financial and work circumstances, less family interactions, and unintended births, according to long-term follow-up research. Therefore, IGEs should not be given less attention than symptomatic or partial epilepsies, even though they may appear to be simpler to treat (10).

Seizures must be distinguished from seizure mimics in order to be diagnosed accurately. The following diagnosis must be checked out in

individuals who have widespread tonic-clonic movements.

Heart-related or non-cardiac syncope; transient ischemic stroke; non-epileptic psychogenic seizure; paroxysmal movement disorders; sleep disturbances; and migraine (11).

ANTISEIZURE MEDICATION:

The main treatment for epilepsy is antiseizure medicine (ASM), which can prevent seizures in up to two-thirds of patients. Drug-resistant epilepsy (DRE), which is defined as failing to achieve seizure freedom after trials of two appropriate and tolerated ASM regimens, either as monotherapy or in combination, may be the result of the approximately 30% of newly diagnosed epileptic patients who will not achieve seizure freedom while receiving pharmacological treatment. Surgical procedures like reconstructive surgery might be explored for these patients. As supplemental therapy, other non-pharmacological methods such as deep brain stimulation (DBS), vagus nerve stimulation (VNS), and the ketogenic diet have also been effective (12).

The patient's type of epilepsy determines how ASMs are used clinically. In cases of generalized epilepsy (GE), only specific ASMs work. These consist of lacosamide, zonisamide, felbamate, topiramate, valproate, levetiracetam, and lamotrigine. Primary generalized tonic and tonic-clonic seizures, absence seizures, myoclonic seizures, and atonic seizures are among the seizure forms that fall within the wide category of GE. All of the ASMs listed above work well for generalized tonic/tonic-clonic seizures, however some, like lamotrigine, might not work as well for absence seizures or myoclonic seizures. Although it is frequently used off-label for absence, tonic, and atonic seizures, levetiracetam is only useful for generalized tonic-clonic seizures (13).

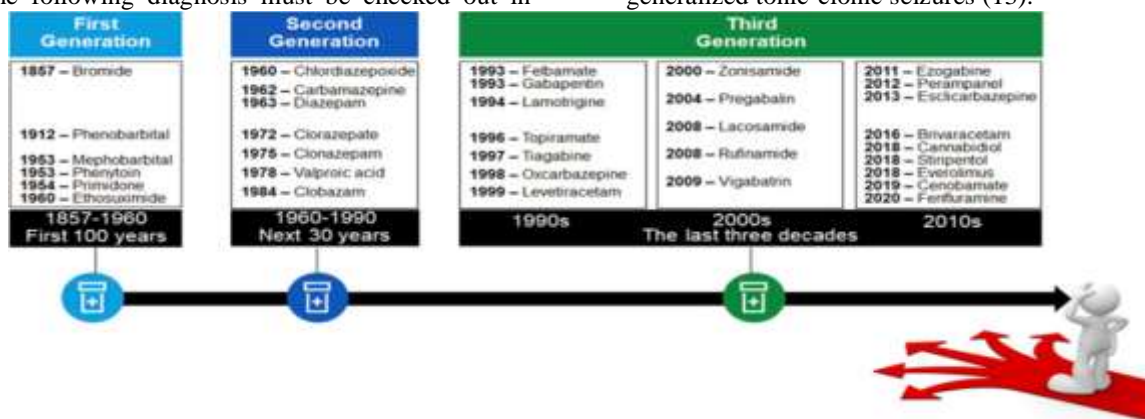


Fig:2 Generations of Antiseizure medications

MECHANISM OF ACTION:

It is crucial to comprehend the putative mechanisms of action (MOA) of an ASM before prescribing it. 7-9 ASMs can be divided into medications that function more generally via numerous targets (e.g., valproate, topiramate, zonisamide, felbamate, cenobamate, and cannabidiol) or quite specifically via a single target (e.g., several sodium channel modulators). 6, 9, and 10 The majority of ASMs fall into one of four general classes: (1) modulation of voltage-gated potassium channels (e.g., retigabine (ezogabine)), voltage-gated calcium channels (e.g., ethosuximide), or voltage-gated sodium channels (e.g., phenytoin, carbamazepine, lamotrigine, and lacosamide); (2) enhancement of γ -Aminobutyric acid (GABA)-mediated inhibition through effects on GABA-A receptors (e.g., benzodiazepines, barbiturates, striopentol), the GABA transporter-1 (e.g., tiagabine), or GABA transaminase (e.g., vigabatrin); (3) inhibition of synaptic excitation mediated by ionotropic glutamate receptors, such as N-methyl-D-aspartate (NMDA) [e.g., ketamine] and α -amino-3-hydroxy-5-methyl-4-isoxazole-propionate (AMPA) receptors (e.g., brivaracetam, levetiracetam); and (4) direct modulation of synaptic release through effects on synaptic vesicle glycoprotein 2A (SV2A) and the $\alpha 2\delta$ subunit of voltage-gated calcium channels (e.g., gabapentin, pregabalin) (14).

To treat generalized tonic-clonic, tonic, and clonic seizures, lamotrigine, levetiracetam, and topiramate work just as well as valproate. In the meantime, the best choices for treating absence seizures are ethosuximide and valproate, which support improved seizure control, which is the main objective of medication (15).

Patients initially diagnosed with generalized tonic-clonic seizures are advised to take valproate. Females of childbearing age who get valproate run the risk of developing neurodevelopmental problems and fetal abnormalities. Therefore, it is best to utilize valproate as little as possible. Lamotrigine, levetiracetam, zonisamide, and topiramate are regarded as first-line treatments in the event that valproate is not appropriate. Clobazam, lamotrigine, levetiracetam, valproate, topiramate, and perampanel may be considered as supplemental medications if the initial treatment proves ineffective or unpalatable. For absence seizures, ethosuximide or valproate is advised. If ethosuximide or valproate are not suitable, ineffective, or the patient is unable to tolerate them, lamotrigine may be an option. As a first-line

treatment for patients with absence seizures, ethosuximide and valproate were found to be more efficacious than lamotrigine in a large research comparing the three medications. The first line of treatment for myoclonic seizures is valproate. Lamotrigine or zonisamide may be used as a backup medication if the initial antiepileptic medication is ineffective in controlling myoclonic seizures. Tonic seizures can be effectively treated with phenytoin and lamotrigine. Although it is less successful at controlling tonic seizures, valproate is the preferred medication for atonic seizures, particularly in Lennox-Gastaut syndrome (16).

OTHER TECHNIQUES:

In resistant cases, neuromodulation methods like Vagus Nerve Stimulation (VNS) and Deep Brain Stimulation (DBS), which modify limbic and thalamic networks, offer extra seizure control. The latest closed-loop versions of these devices show promise for improved specificity and tolerability. Cannabidiol and ketogenic diets are two examples of nutritional and pharmacological adjuncts that have shown promise in treating some resistant illnesses. This area of research holds great promise for enhancing non-pharmacologic methods (17).

KETOGENIC DIET:

KD produces a variety of systemic alterations in circulatory metabolites, including lower glucose levels and increased ketones. Although it is unclear how these modifications relate to the effectiveness against seizures, the mechanisms underlying KD's anti-seizure effect have been discussed. These include increased release of inhibitory neurotransmitters in the brain, such as adenosine and gamma-aminobutyric acid (GABA), decreased oxidative stress, and improved mitochondrial function (18).

GENERAL SIDE EFFECTS:

Because epilepsy drug side effects can negatively impact a person's quality of life, many individuals are worried about them. Some people may experience undesirable side effects from anti-epilepsy drugs. Stephen et al. have identified fatigue, upset stomach, lightheadedness, or impaired vision as common adverse effects that typically occur during the first few weeks of taking seizure medications. These medications may also result in sexual dysfunction, nausea, exhaustion, and urine retention, according to Epilepsy Scotland. Patients with epilepsy will eventually stop taking epileptic medication and try conventional

medication if they are not informed about these side effects. In certain situations, anti-epilepsy drugs might alter how the brain functions. Normal activity is impacted by these anti-epilepsy drugs because they reduce the excitability of brain nerve cells. Cognitive problems can result from side effects of anti-epilepsy drugs and include issues with thinking, remembering, paying attention or concentrating, and finding the proper words (19).

ADVERSE EFFECTS:

Adverse psychiatric symptoms, such as sadness, anxiety, irritability, mood swings, hyperactivity, and, in rare instances, psychosis, can also happen. Psychiatric side effects are common with levetiracetam, topiramate, zonisamide, vigabatrin, and perampanel, despite the fact that the newer ASMs are believed to be better tolerated than the older medications. In contrast, some patients have mood-stabilizing effects from lamotrigine, carbamazepine, valproate, gabapentin, and pregabalin, whereas fewer of these medications produce behavioral or mental side effects. After months or even years of therapy, some of the subtle negative effects of ASMs may become noticeable. Examples include phenytoin-induced hirsutism and gingival hyperplasia, barbiturates-induced shoulder-hand syndrome and Dupuytren's contraction, valproate-, gabapentin-, pregabalin-, perampanel-, and vigabatrin-induced weight gain, and topiramate-, zonisamide-, and felbamate-induced weight loss (León Ruiz et al., 2019). Patients receiving long-term treatment with carbamazepine, phenytoin, or barbiturates may also experience metabolic changes due to enzyme induction, such as vitamin D deficiency, endocrine disorders, or aberrant blood lipids (20).

II. CONCLUSION

Antiseizure medication (ASM) is the primary treatment for epilepsy and can keep up to two-thirds of patients from having seizures. The clinical use of ASMs depends on the type of epilepsy of the patient. Only certain ASMs are effective in treating generalized epilepsy (GE). These include lamotrigine, felbamate, topiramate, zonisamide, lacosamide, valproate, and levetiracetam. Before prescribing an ASM, it is essential to understand its putative mechanisms of action (MOA). Anti-epilepsy medications may cause unfavorable side effects in certain individuals. Many people are concerned about the side effects of epilepsy medications since they

might have a detrimental influence on a person's quality of life.

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