NEUROPHYSIOLOGY AND INTRODUCTION TO EPILEPSY

Dr. Kimberly Ndahayo, DNP, FNP-C, RN, CNRN

Slide 1

Hello, my name is Dr. Kimberly Ndahayo, I am a doctor of nursing practice and family nurse practitioner with 15 years experience in pediatric and adult neurology. Today we will dive into the world of neurology and, more specifically, epilepsy and how we are nurses can ensure we recognize, care for and manage a patient with seizures.

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OBJECTIVES

- Define and describe the terms seizure and epilepsy
- Identify common causes and classifications of epilepsy throughout the lifespan
- Understand the diagnostic workup for patients with seizures
- Understand basic treatment strategies for seizures as well as refractory epilepsy
- Understand the diagnosis and importance of identifying status epilepticus
- Understand basic pathophysiologic mechanisms of seizures

Slide 2

Our objectives for this presentation are to define and describe the terms, seizures and epilepsy, and understand the differentiation between the two. We will identify common causes and classifications of epilepsy throughout the lifespan. We will discuss the diagnostic work up to anticipate for patients with first time seizure, as well as diagnosis of epilepsy. We will discuss the basic treatment strategies for seizures as well as for refractory epilepsy. We will look at status epilepticus and identify the significance in identifying this early as well as managing this medical emergency. And lastly, we will understand the basic physiologic mechanisms behind seizures in the brain.

BACKGROUND & SIGNIFICANCE OF EPILEPSY

Fourth most common neurological problem. Only behind migraine, stroke and Alzheimer's.

1 in 26 people in the United States will develop epilepsy at some point in their lifetime.

Prevalence is more common than autism spectrum disorder, multiple sclerosis and Parkinson's combined.

2.2 million American's have epilepsy, 65 million worldwide.

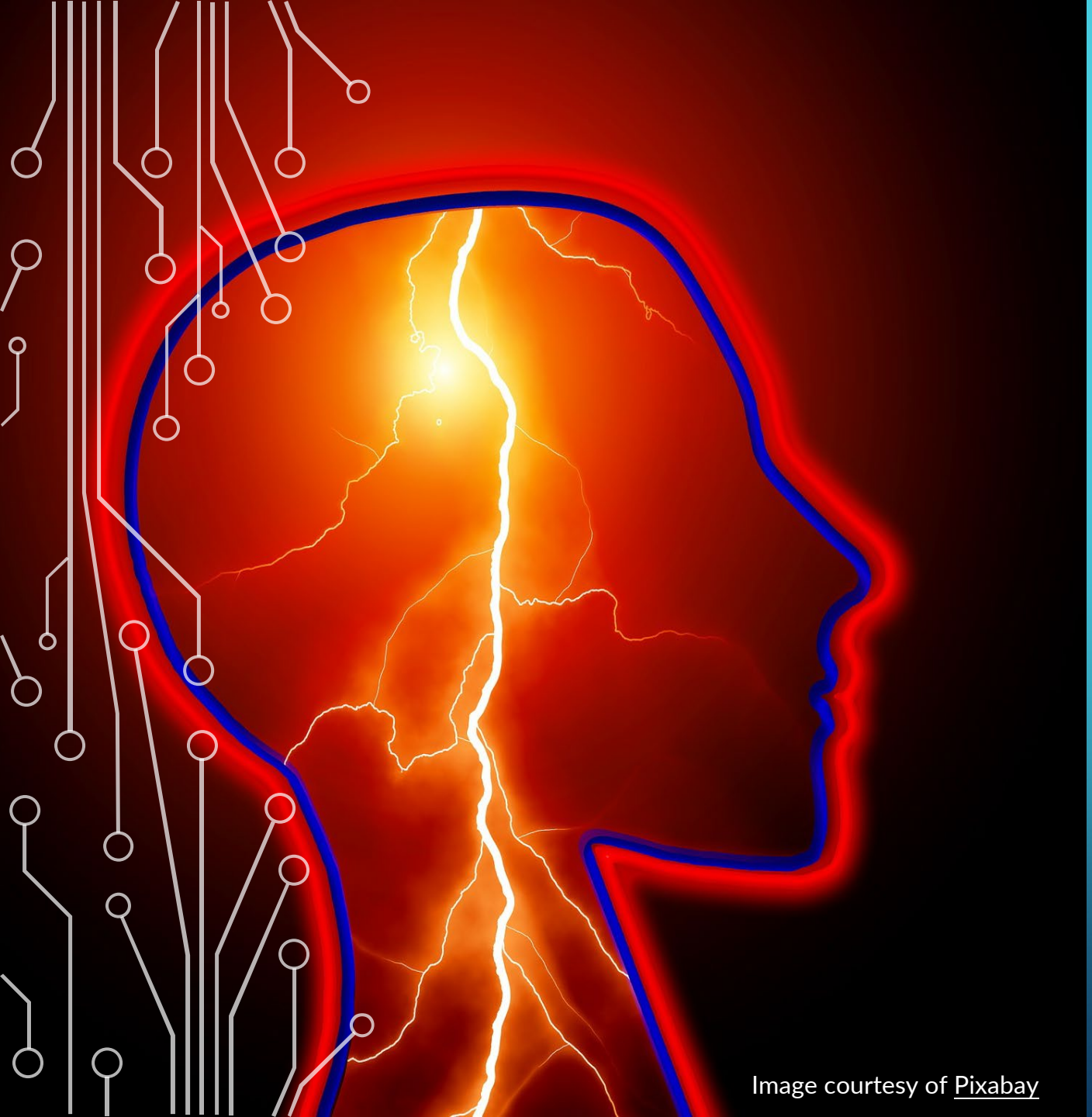
One in three adults know someone with seizures.

1 in 10 people in the United States with have at least 1 seizure in their lifetime.

Slide 3

Epilepsy is far more common than most would expect. It is actually reported as the fourth most common neurologic problem in the US, preceded only by migraines and stroke and Alzheimer's disease.

In fact, one in 10 people will have at least one seizure in their lifetime and one and 26 people in the United States will go on to develop epilepsy at some point in their lifetime. The prevalence is actually more common than autism spectrum disorder, multiple sclerosis and Parkinson's combined. In fact, 2.2 million Americans have a diagnosis of epilepsy and 65 million individuals have a diagnosis of epilepsy worldwide. It is estimated that one and three adults know someone with seizures, and it's very likely that many of you know someone who has had a seizure in their lifetime or has a diagnosis of epilepsy.
This significance is important to know, because as nurses, we will certainly come across individuals with a seizure, or a history of epilepsy at some point in our careers, if not frequently, regardless of the area of practice. Epilepsy and seizures can also be very scary both to the individual as well as bystanders, and through the years has carried significant stigma attached to it. Many individuals with epilepsy report feeling impact on the quality of life and ability to live independently. Because our job is nurses is not just to treat the patient medically, but also to treat their social and emotional health, understanding these facts and the high significance of epilepsy in the United States, can help us to better educate and care for the patient with epilepsy that cross our paths.
http://www.epilepsyfoundation.org/aboutepilepsy/index.cfm/statistics.cfm



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AN ELECTRICAL STORM INSIDE THE BRAIN

- What is a seizure?
  - Seizures are a result of a shift in the normal balance of excitation and inhibition within the central nervous system (CNS).
  - Any brain is capable of having a seizure under the right circumstances.
  - There are a variety of conditions that can place the brain at a higher risk for a seizure including structural changes to the brain, drugs, illness and/or increased stress and demand on the brain.
  - Seizures are episodic and can come and go.

Slide 4

So what is a seizure? The term seizure comes from the word to seize and literally means to take hold of something, in this case, taking hold of the brain and the individual's body. Seizures are a result of a shift in the normal balance of excitation and inhibition within the central nervous system. When this shift occurs a small electrical imbalance results. Any brain is capable of having seizures under the right circumstances. There are a variety of conditions that can place the brain at a higher risk for seizures, which include structural changes to the brain, drugs, illness, increased stress, and demand to the brain to name a few. We will look at these causes in depth as we go through this presentation. Seizures are frequently episodic, and they can come and go.

PATHOPHYSIOLOGY OF SEIZURES

- Seizure activity occurs when there is increased firing of excitatory neurons (such as Glutamate) or a decrease of inhibitory neurons (GABA or Glycine).
- Epilepsy is a syndrome characterized by recurring, unprovoked seizures

Slide 5

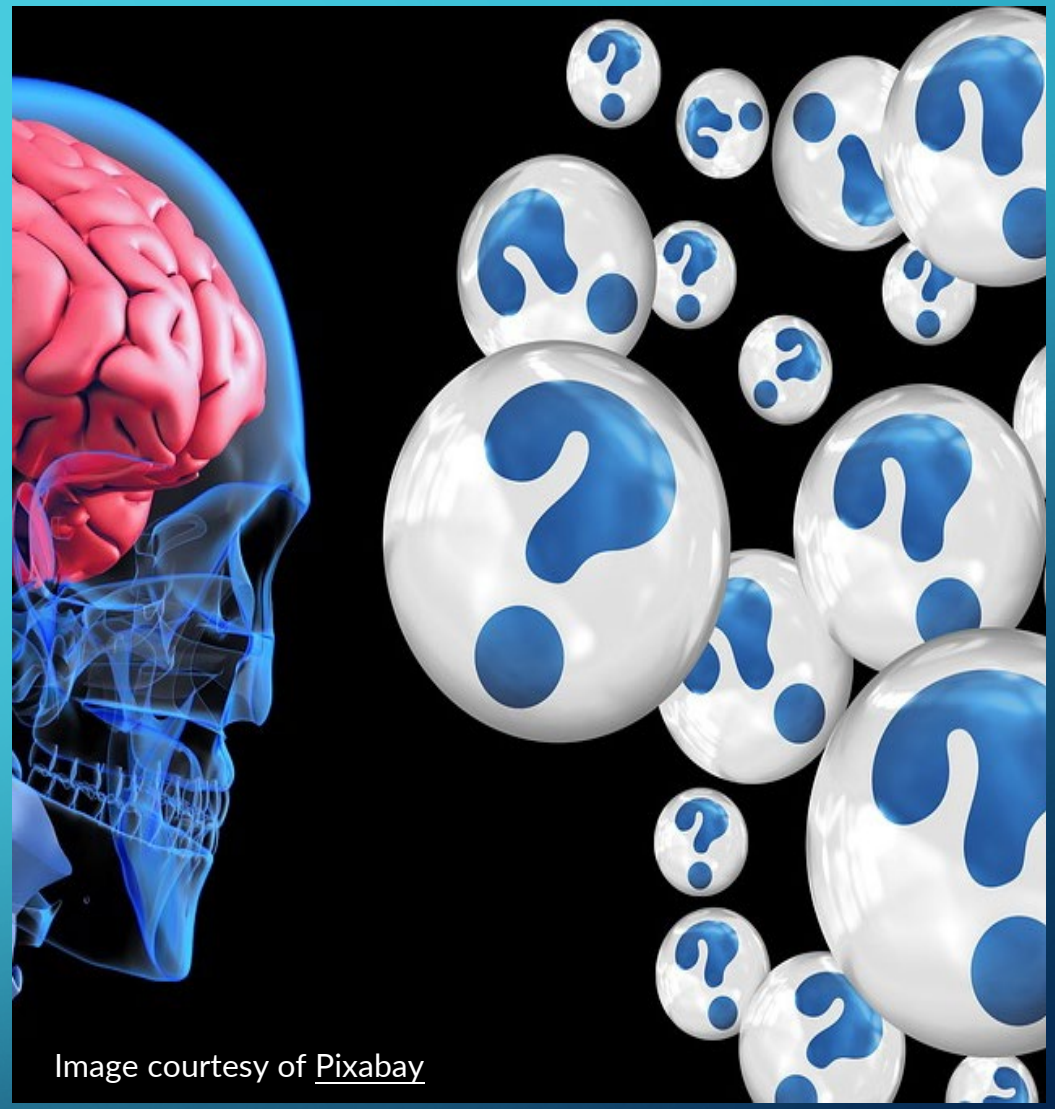
There are different neurons in the brain, some that are excitatory and some that are actually inhibitory.
A seizure occurs when there's an imbalance on either of these. So, for example, when there's an increase firing of excitatory, neurons, such as Glutamate, we see an increase in that electrical activity that results in a seizure. The inhibitory neurons, which are designed to create that balance can also sometimes decrease, and when we see a decrease in these neurons that are supposed to be inhibiting the excitatory neurons, we can see a lower threshold that causes increased electrical activity and results in a seizure. There's many causes for why there might be an increase firing of excitatory, neurons, or decrease in the inhibitory neurons, and these are some of the causes we will look at more in depth. Epilepsy is a syndrome and is characterized by recurrent unprovoked seizures.

SEIZURES VS. EPILEPSY

- What is a seizure?
  - A sudden, uncontrolled electrical disturbance in the brain which can cause a change in behavior, muscle tone, emotions and consciousness.
  - Common causes: hyponatremia, alcohol withdrawal, methamphetamine use, hypoxia, brain tumors, medications

So, when does a seizure become classified as epilepsy?

- Epilepsy is defined as 2 or more UNPROVOKED seizures.
- Examples of PROVOKED seizures include:
  - Acute infection such as Ingestion of alcohol or drugs
  - Meningitis
  - Hyperglycemia and hypoglycemia



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Slide 6

What is the difference between a seizure and epilepsy? Seizures and epilepsy are terms that often get intertwined and mixed together and rightfully so in that related, but there is significant differentiation between the two. At the core, the difference is that individuals with epilepsy have seizures, however, not all people who have a seizure have a diagnosis of epilepsy. A seizure is an uncontrolled sudden electrical disturbance in the brain which can cause change in behavior, muscle tone, emotions, and consciousness common causes or hyponatremia alcohol withdrawal, methamphetamine use hypoxia, brain tumors and even medications.
So, when does a seizure start being classified as epilepsy? Epilepsy is defined as two or more unprovoked seizures, or in more rare cases, a one time seizure with an underlying cause the place is the individual, an extraordinary risk for continued recurrent seizures that they are diagnosed with epilepsy.

You might say, 'wait a minute don't all seizures have something that provokes them?' This is true, however, when we talk about unprovoked, what we really mean is something that could be eliminated and the patient will go on to not have seizures. For example, a patient comes in and alcohol withdrawal and has a seizure. The seizure was caused by the alcohol intoxication. If this patient were to go on, and not abuse alcohol, they would have no more chance of having a recurrent seizure than anyone else. Other examples of provoke seizures include things, such as meningitis, hyper or hypo glycemia, hyponatremia and other causes that once corrected, no longer place the individual at risk of having ongoing seizures. The seizures in these cases are really just manifestations, or secondary effects of the true underlying problem.
However, when a patient comes in and has a history of a stroke, and now has areas of the brain that have residual damage and they have at least two seizures, they now would have a diagnosis of epilepsy. A patient with the changes in the brain, such as an asymmetry in the hippocampus, who have two seemingly unprovoked seizures, would have a diagnosis of epilepsy. A child born with a neurologic condition, such as Dravet syndrome, who has at least two seizures, would have a diagnosis of epilepsy.
This differentiation matters because it is the difference between one to start medication and when not to. Obviously any patient coming in with a seizure will be treated with medications. But do they need to continue medication's when they're discharged? If it is a provoked seizure then the answer very often is no, they do not need medication. But once they have a second unprovoked seizure, that is the time at which medication's are typically initiated. Now, obviously nothing fits into a perfect box and the decision to start medication's can be based on a variety of different factors.

CAUSES OF EPILEPSY

Majority (~70%) are symptomatic = underlying cause is known

- Acute= recent injury causing seizures (may go on to epilepsy)
- Remote= injury/malformation in the past with recurrent seizures (epilepsy)

Remaining (~30%) are cryptogenic = no identifiable cause

- Idiopathic = no identifiable cause but presumed to be genetic

Slide 7

So what causes seizures? In a moment we're going to break down causes that are most significant by various age groups throughout the lifespan. However, it's important to note that the majority, somewhere around 70% of epilepsy, are considered symptomatic mean that there's an underlying cause it is known these can include things like we discussed about a patient who had a stroke a patient with a symmetries in the brain and so on. From there we break these down into acute- meaning an underlying cause it is recent, and remote meaning an underlying cause, such as an injury or malformation from the past. This includes individuals who had a history of a traumatic brain injury years ago, who now develop epilepsy.

The remaining, somewhere around 30% of epilepsy, are considered cryptogenic and have no identifiable cause these are ones that we term idiopathic because there's no underlying cause although there's a high presumption that there's genetic causes.

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CAUSES OF EPILEPSY- NEWBORN

- Brain malformations
- Lack of oxygen during, or before delivery, or at birth
- Low levels of blood sugar, blood calcium, blood magnesium or other electrolyte disturbances
- Inborn errors of metabolism (chemical disorders)
- Genetic disorders
- Intracranial hemorrhage (bleeding in the brain)
- Maternal drug use

Slide 8

Causes of epilepsy in the newborn an infant population include brain malformations which form in utero, and the baby is born with. Lack of oxygen during birth, as well as other brain injuries in utero, or during the birth process, can result in damage to the brain leading to seizures. In addition, imbalances in the blood sugar, as well as electrolyte disturbances, magnesium and calcium are far more common in infancy, and can result in seizures. Inborn errors of metabolism is a broad category of diagnoses that result from genetic mutations and involve failures in the metabolic pathways, such as the inability to break down or store carbohydrates, proteins and fatty acids. These genetic conditions often are accompanied by seizures, in which case seizures typically begin very early in infancy.

Intracranial hemorrhage or bleeding in the brain is also a common cause of seizures in all age groups, but can occur in the newborn or infant age when the baby develops a brain bleed. Causes for intercranial hemorrhage are vast and can include things such as trauma to the head, underlying vascular disorder, an intrauterine hemorrhage. And lastly, maternal drug use, can often cause numerous complications to the child, including things, such as fetal alcohol syndrome, babies born with dependency and placing them at higher risk for seizures, due to withdrawal immediately after birth. For these infants, they are typically monitored in the neonatal intensive care unit during this period of detox and monitored very closely for seizures. Many can recover and go on to live very healthy lives, while other infants can develop significant lifelong complications from the maternal drug use including epilepsy.

http://www.epilepsyfoundation.org/aboutepilepsy/causes/index.cfm

CAUSES OF EPILEPSY- CHILDHOOD

- Congenital conditions
  - Down syndrome
  - Angelman's syndrome
  - Tuberous sclerosis
  - Neurofibromatosis
  - Lennox-Gastaut Syndrome
  - Dravet syndrome
- Genetic factors (Generalized seizure disorders)
  - Juvenile absence epilepsy
  - Juvenile myoclonic epilepsy
  - Generalized idiopathic epilepsy
- Head trauma
  - Traumatic brain injury
  - Acute illness (meningitis)

Slide 9

Shifting into childhood, some of these conditions listed here are present in the newborn and infant population, as well, while others develop later in childhood. Congenital condition such as down syndrome, Angelman syndrome, Tuberous sclerosis, neurofibromatosis, Lennox-Gastaut syndrome, and Dravet syndrome are all conditions that the child is born with. However, seizures can begin at any and are not necessarily present in infancy for some of these conditions.
Generalized epilepsy in Childhood typically involves juvenile absence epilepsy, juvenile myoclonic epilepsy and general idiopathic epilepsy. With these different forms of genetic epilepsy, we see a variation in age of onset. We will look at these three in a few minutes.
And lastly traumas can lead to seizures in the childhood years. Traumatic brain injuries are a significant cause of seizure development. We know that children have a much higher incidence of injuries, accidents and abuse that other age groups and these injuries can often result in seizures.

http://www.epilepsyfoundation.org/aboutepilepsy/causes/index.cfm

Progressive brain disease (rare, Parry-Romberg disease)

CAUSES OF EPILEPSY- ADULTS

- Structural
  - Stroke
  - Alzheimer's disease
  - Head trauma
- Infection
  - HIV
  - Encephalitis
  - Meningitis
- Autoimmune
  - Rasmussen’s Syndrome
  - Limbic encephalitis
  - GAD65 antibody associated encephalitis

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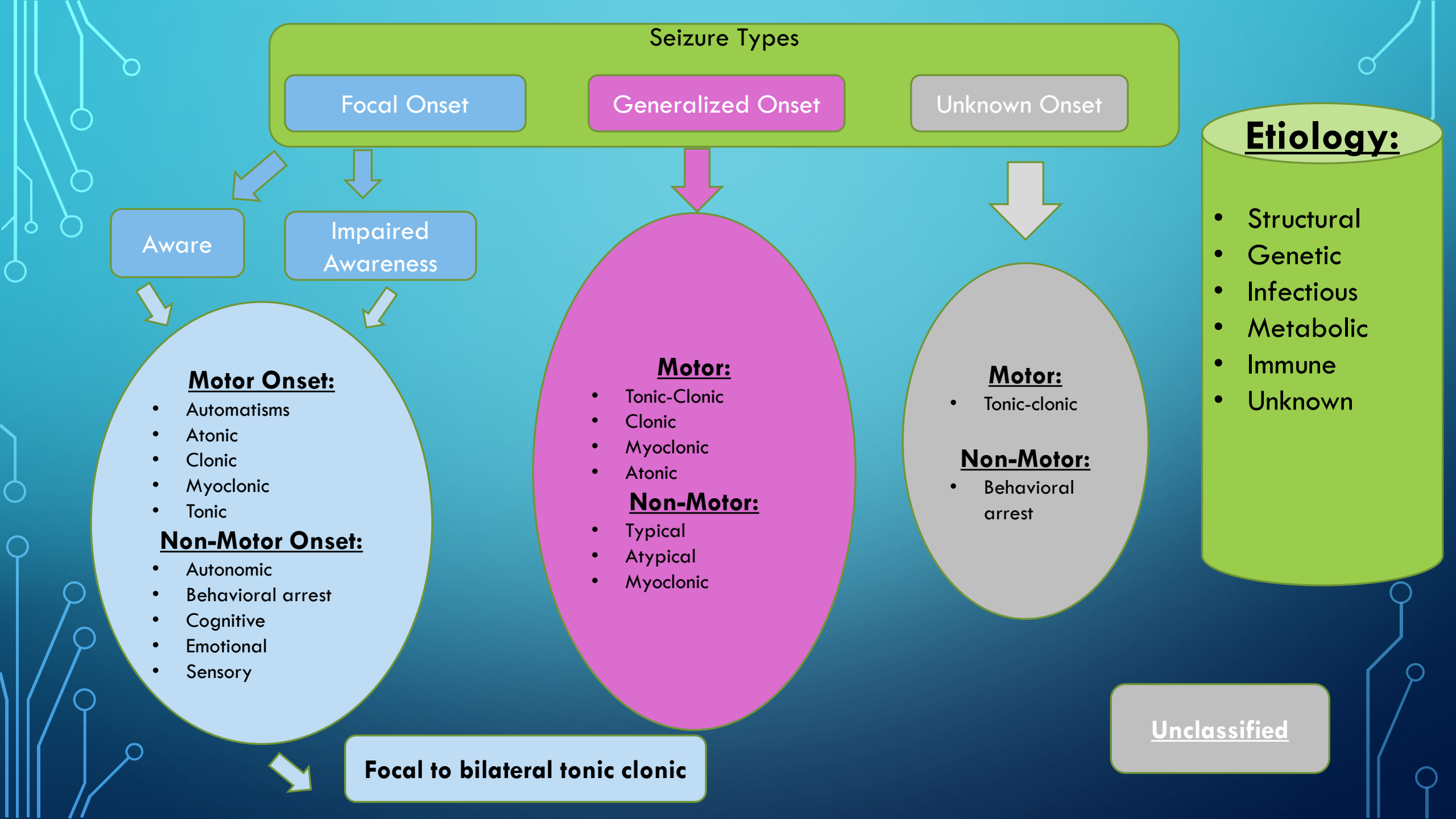
Slide 10

http://www.epilepsyfoundation.org/aboutepilepsy/causes/index.cfm

Causes of seizure in adulthood can vary by age. The highest incidence of onset of seizures are seen on both ends of the age spectrum- with spikes in childhood, followed by decreases through the early and mid adult years slowly rising again around the age of 60 and increasing steadily until the end of life. Structural changes in the brain, regardless of cause are leading etiology for many seizures in adulthood. History of stroke, head injuries, Alzheimer's disease are all examples of structural changes in the brain that are commonly seen with epilepsy.
Infection in the brain, such as encephalitis or meningitis, can cause seizures, both in the acute phase as well as result in permanent damage resulting and persistent epilepsy.
Other causes include auto immune, the most common of which is GAD 65 antibody, associated encephalitis.


Seizure Types
Focal Onset
Generalized Onset
Unknown Onset
Aware
Impaired Awareness
Motor Onset:
Automatisms
Atonic
Clonic
Myoclonic
Tonic
Non-Motor Onset:
Autonomic
Behavioral arrest
Cognitive
Emotional
Sensory
Motor:
Tonic-Clonic
Clonic
Myoclonic
Atonic
Non-Motor:
Typical
Atypical
Myoclonic
Motor:
Tonic-clonic
Non-Motor:
Behavioral arrest
Etiology:
Structural
Genetic
Infectious
Metabolic
Immune
Unknown
Focal to bilateral tonic clonic
Unclassified

Slide 11

We will come back to this slide in a few minutes, but I want to pause here for a moment.

Epilepsy is broken down into three broad categories: focal onset, generalized onset, and unknown onset. These categories and the terminologies used for classifying epilepsy is put forth by the international league against epilepsy or ILAE. Throughout the years has been many different terms used for seizures, and you may have herd terms such as grand mal, petit mal, complex partial. These are terms that are actually being done away with in epilepsy community and the new guidelines for and classification of epilepsy that was put forth by the ILAE was done so in 2017. You're still going to hear a lot of these old terms and it's important to know what each refers to.
But at the most general categories breaking down types of seizures are shown here. The first category we see is Focal Onset meaning the seizure onset begins in one part of the brain, Generalized meeting the seizure begins in multiple areas of the brain simultainiously, and Unknown which encompasses more rare forms of epilepsy. From those categories we further break down the seizure type by what is happening in the body.
Etiologies for seizures include structural, genetic, infectious, metabolic, immune and of course some are unknown.

From *Fisher et al. Instruction manual for the ILAE 2017 operational classification of seizure types. Epilepsia doi: 10.1111/epi.13671*

OUT WITH THE OLD, IN WITH THE NEW

Old Terms:	New Terms:
Unconscious	Impaired awareness
Partial	Focal
Simple Partial	Focal aware
Complex Partial	Focal impaired awareness
Dyscognitive	Focal impaired awareness
Psychic	Cognitive
Secondarily generalized tonic clonic	Focal to bilateral tonic-clonic
Arrest, freeze, pause, interruption	Behavioral arrest
Grand Mal	Generalized seizure
Petite Mal	Focal seizure

Slide 12

Here is a list of some of the older terminologies that has been used and the newer terms in place to replace these. The primary goal of changing terminologies when ILAE put forth the new guidelines in 2017 was to both streamline, many previous terms, as well as to provide clarity. While it may seem complicated, when you think about the diagnosis of focal, impaired awareness seizure you have your answer right in that verbiage as to what type of seizure they have. You know that their seizure is focal and originating in one area of the brain and you know that it causes some form of impaired awareness. When you hear the term focal aware seizure, you know that there is a seizure originating in a focal area of the brain however, the patient is still alert throughout the seizure. With some of the old terminologies, such as simple partial for grand mal, all these words in and of themselves, do not describe what is happening during the seizure nearly as well.
In addition, there's some stigma attached to some of the old terminology. For example, grand mal versus petit mal insinuates that one is significant while one is not as significant. While a convulsive seizure is more significant in some ways, both seizures are bad and both require treatment. Simple partial is another example where the diagnosis conveys a poor message of what is actually going on for the patient.

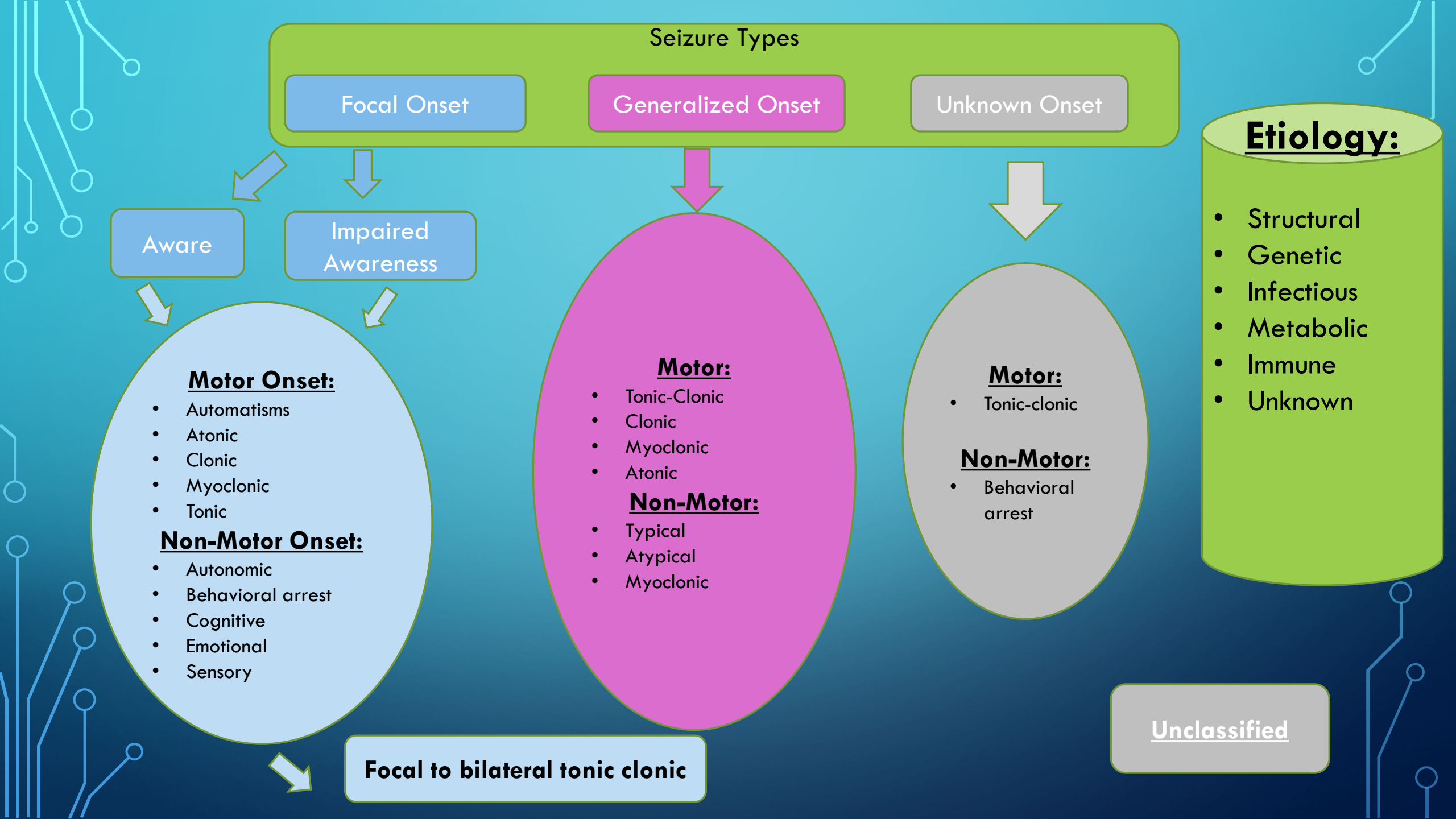
This is a list that is very important for you to use as you will continue to hear many patients as well as providers. Use both terms and you need to know what these terms are talking about as well as which ones are interchangeable. Unconscious is now referred to as impaired awareness. Partial is now referred to as focal. Simple partial then is referred to as focal aware and complex partial is referred to as focal with impaired awareness. Dyscognitive seizure is also a focal impaired awareness seizure. Psychic is now referred to as cognitive. Secondary generalized tonic clonic is when a seizure moves from being focal to spreading to the entire brain and is now referred to as focal to bilateral tonic clonic. Terms such as arrest, freeze, pause, interruption are all categorized under the more broad category of behavioral arrest. Grand mal represents the new term generalized seizure and petit mall represents focal seizure.

TERMINOLOGY

- Ictal: during a seizure
- Inter-ictal: in between seizures
- Post-ictal: the time period after a seizure
- Tonic: muscle contraction
- Clonic: limp jerking
- Seizure semiology: manifestation of internal sensation and external characteristics that occur during a seizure. Key in helping identify seizure type and localization of onset.
- Automatism: a rhythmic or semi-coordinated movement without conscious intent.

Slide 13

Other terms that are important to understand when dealing with seizures are ictal, which is the period during the actual seizure. Interictal which refers to the time in between seizures or a seizure free period. And post ictal refers to the time immediately following the seizure. Tonic refers to muscle contraction, and Clonic refers to limp movement. Therefore, a tonic clonic seizure involves muscle contraction and relaxation. Seizure semiology is a term you were here used frequently in the world of epilepsy. Seizure semiology refers to the manifestation of internal sensations and external characteristics that occur during a seizure. Seizure semiology can be quite helpful and identifying and localizing where seizures may be originating from and we will look at this more in a moment. And automatisms refer to a rhythmic or semi coordinated movement without conscious intent. This can include things such as hand, tapping, nose swiping, lip smacking, and so on. Atonic- drop sz, loss of muscle control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Non-Motor:
Behavioral arrest
Etiology:
Structural
Genetic
Infectious
Metabolic
Immune
Unknown
Focal to bilateral tonic clonic
Unclassified

Slide 14

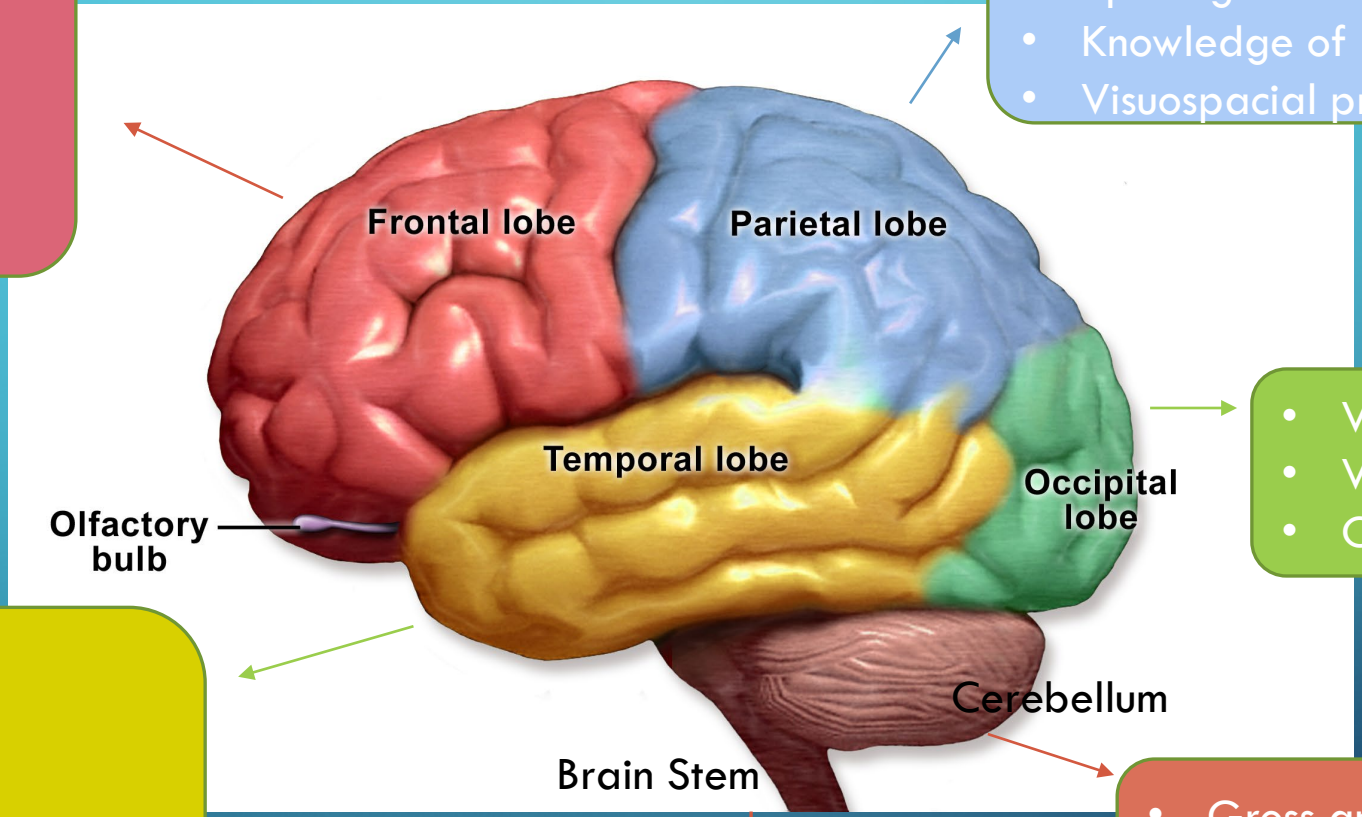
So let's take a closer look at focal epilepsy. Focal epilepsy defined by a seizure originating from one location and can be further broken down into focal aware or fungal with impaired awareness. As this name suggest this simply means that there is a loss of awareness or no loss awareness. For both of these categories, we then further breakdown the seizure type by semiology, which again is a manifestation of symptoms seen during the seizure. There is motor onset and non-motor. Think of motor onset as things involving the muscles. These will include automatism, such as lipsmacking, atonic, which is a drop seizure where there's form loss of muscle control, myoclonic which is jerking of the muscles and tonic, which is stiffening or contraction of muscles.
Then there are non-motor onset which involves symptoms such as autonomic dysfunction, behavioral arrest, cognitive impairment, emotional, and sensory. Because the brain controls everything we do there is really no symptom that is off-limits to when it comes to a seizure. Often non-motor onset seizures tend to be the hardest to diagnose specifically if there's no loss of awareness. Examples of these are Seizures where the individual smells a funny smell, or has a bad taste in their mouth, or perhaps a feeling of déjà vu. Because these do not involve convulsions, they're often missed for quite some time. And then, of course, focal onset seizures have a possibility to progress into a bilateral tonic clonic seizure once that electrical activity spreads through the brain and specifically wants it crosses hemispheres.

From *Fisher et al. Instruction manual for the ILAE 2017 operational classification of seizure types. Epilepsia doi: 10.1111/epi.13671*

SEIZURE SEMIOLOGY 101

- Thinking
- Planning
- Problem solving
- Emotional regulation
- Decision making

- Perception
- Object classification
- Spelling
- Knowledge of numbers
- Visuospacial processing



- Vision
- Visual Processing
- Color identification

- Memory
- Understanding
- Language
- Facial recognition
- Hearing
- Vision
- Speech
- HIPPOCAMPUS- Memory

- Regulates body temperature, heart rate, swallowing, breathing

- Gross and fine motor skills
- Hand-eye coordination
- Balance

Slide 15

Going back to seizure semiology, we said that seizure semiology refers to the physical manifestations that occur during a seizure. In the world of epilepsy semiology is an incredibly useful tool in guiding our thought process and diagnosis of an individual seizures. Our brain is broken up into several lobes, including the frontal lobe, the temporal lobe, the parietal lobe, the occipital lobe and then of course you have the cerebellum and the brain stem. Each of these lobes are responsible for different functions in the brain. Listed here are just some of the functions controlled by each lobe. For example, the frontal lobe controls, our thinking, planning, problem-solving, emotional regulation, and decision-making. The parietal lobe is responsible for perception and object classification, as well as spelling, knowledge of numbers. The occipital lobe also controls our vision as well as visual, processing and color identification. The temporal lobe controls our memory, understanding, language, facial recognition, just to name a few. Most notably from the temporal lobe is where our speech comes from, and this matters when there is speech arrest during a seizure we know it is coming from the temporal lobe.

So let's take what we know of each of these lobes and think about it in terms of seizures. A patient comes in with a seizure that always starts with an inability to express words or expressive aphasia, and a feeling of déjà vu. Knowing that the temporal lobe is responsible for these functions, would guide the practitioner suspect that this individual has focal onset, seizures, originating from the temporal lobe. And now let's say a patient comes in with a seizure where they experience flushing, or heat flash, feeling of heart, palpitation, feeling of throat tightness, and then progresses after about 15 seconds to loss of awareness or subsequent. While the patient is having a compulsion, and we know that at that point is generalized, the onset of the seizure involves characteristics that are controlled in the brainstem or more specifically the insular region. This would prompt us to suspect a focal onset, seizure originating in the insular region of the brain with progression to secondary bilateral tonic, clonic seizure. It seem confusing, but it's really as simple as understanding what areas of the brain are responsible for what areas of the body and then gathering a very detailed history specifically looking at the onset or the first thing. Now why do we care where the seizure starts? Onset of seizures can really change or management and treatment of an individuals epilepsy. The only way to definitively confirm the onset location of a focal seizure is through EEG, however, using a reasonable nursing critical thinking there's much we can deduce from the symptoms that they're describing to us.

FOCAL SEIZURES

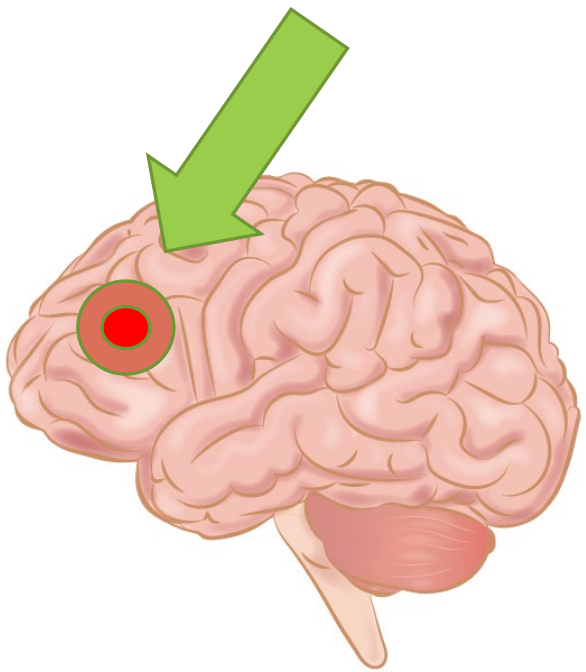


Image modified from Wikimedia

These can be further broken down into:

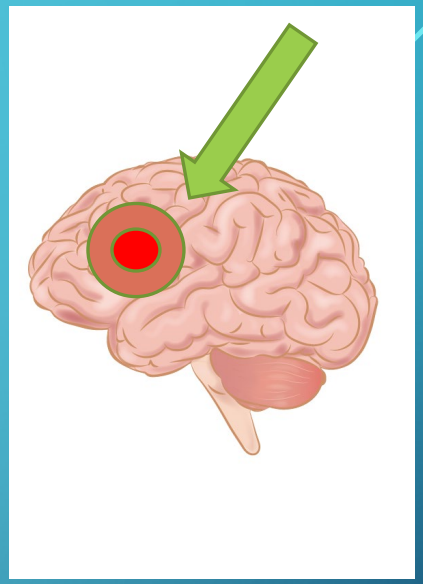
- **Focal aware seizures** = no loss of awareness (old simple partial seizure)
  - Typically 30-60 seconds
  - No loss of consciousness
  - Sudden jerking, sensory phenomena, transient weakness or loss of sensation
- **Focal unaware seizures** = loss of awareness (0ld complex partial seizure)
  - Typically last 1 to 2 minutes
  - May have aura (epigastric rising, unusual smell, déjà vu, etc)
  - Automatisms (such as lip smacking, picking at clothes, fumbling), unaware of environment, may wander, amnestic for seizure events, mild to moderate confusion during, sleepy after

Slide 16

As we discussed focal seizures, further broken down into focal aware, seizures and focal unaware seizures. Focal aware seizures just means that there's no loss of awareness. This is what used to be referred to as a simple partial seizure. The seizures are typically short lasting no more than 30 to 60 seconds and above no loss of consciousness. They often involve symptoms reported by the patient as confusion, feeling of a bad taste in her mouth, or an altered smell, a feeling of déjà vu, as well as anything autonomic related. Focal unaware of seizures, involve loss of awareness. Now this doesnt mean that it can't start as a focal aware seizure but it progresses to altered awareness. These used to refer to his complex partial seizures. These are often slightly longer perhaps 1 to 2 minutes although these can also be incredibly brief. These very well may involve an aura during which time there's no loss of awareness such as that feeling of déjà vu however, then progressed to the patient having alternate awareness and loss of memory of the seizure. Because the seizures are more broad involving more of the brain there tends to be more of a postictal phase after the seizures, which can include the individual being confused or tired for several minutes up to a half an hour following a seizure.
https://commons.wikimedia.org/wiki/File:Human_Brain.png

https://www.epilepsydiagnosis.org/seizure/hemispheric-localization-overview.html

FOCAL SEIZURES

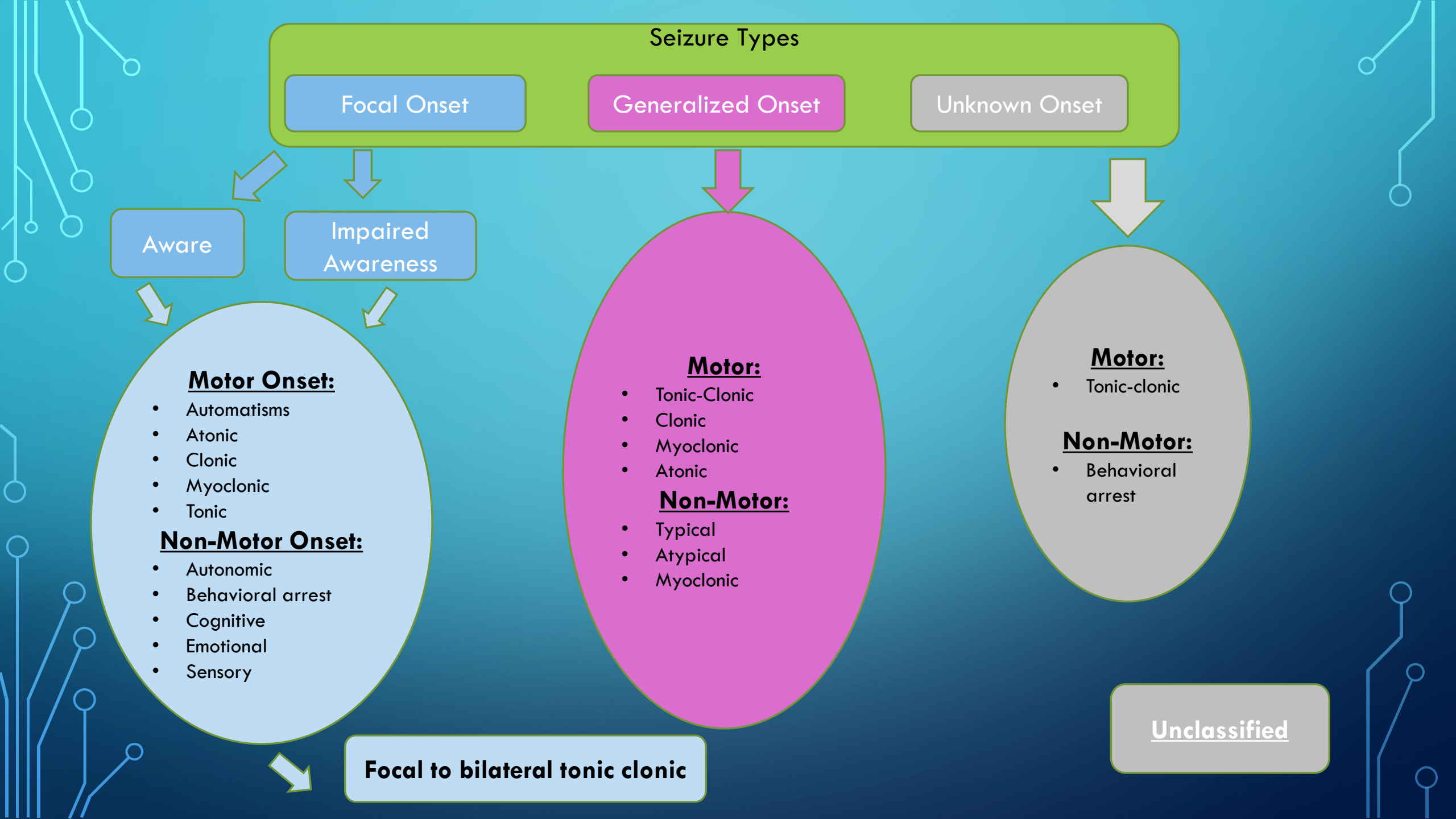


- Focal Aware
  - Non-motor: Focal sensory or autonomic symptoms (auras)
  - Motor: muscle jerking
- Focal Seizure with Impaired awareness
  - Non-motor: Autonomic, behavioral arrest, sensory impairment.
  - Motor:
    - Automatisms: lip smacking, manual picking, patting, coordinated movement (walking)
    - Atonic- 'drop seizures'
    - Myoclonic, tonic or clonic

    → Progression to bilateral tonic clonic seizure (convulsive seizure)
- Most common cause:
  - 75% idiopathic
  - Other causes: brain injury (stroke, trauma, mass lesion, infection)

Slide 17

Focal aware seizures are then further broken down into non-motor or motor seizures. Focal seizures with impaired awareness can also be broken down into a non-motor or motor seizures, which can then be further broken down into seizures involving automatisms such as lip, smacking, atonic, such as a drop seizure, myoclonic, such as muscle jerking, and then progress to full body involvement, resulting in bilateral tonic clonic movement or a convulsion. The most common causes of focal seizures are actually not known and are considered idiopathic. However, many focal seizures can have underlying ideology including things that we previously discussed such as brain injury from a stroke, or traumatic brain injury, a lesion or an area of infection.


Seizure Types
Focal Onset
Generalized Onset
Unknown Onset
Aware
Impaired Awareness
Motor Onset:
Automatisms
Atonic
Clonic
Myoclonic
Tonic
Non-Motor Onset:
Autonomic
Behavioral arrest
Cognitive
Emotional
Sensory
Motor:
Tonic-Clonic
Clonic
Myoclonic
Atonic
Non-Motor:
Typical
Atypical
Myoclonic
Motor:
Tonic-clonic
Non-Motor:
Behavioral arrest
Focal to bilateral tonic clonic
Unclassified

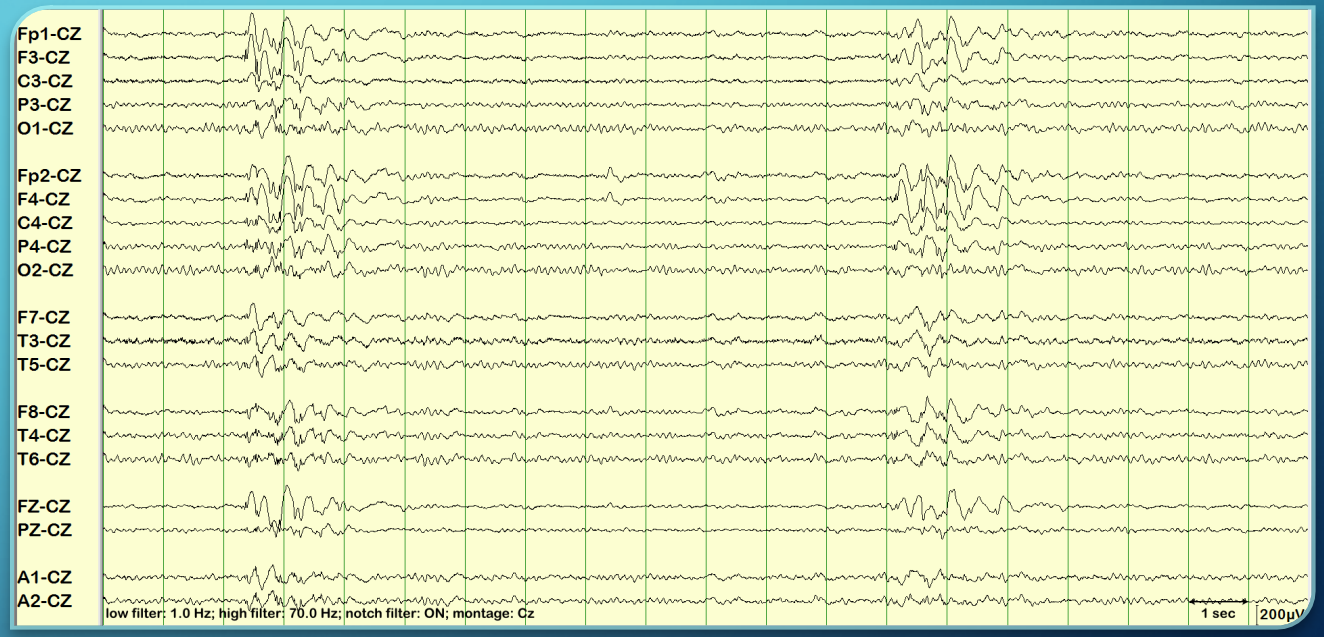
Slide 18

Now, let's come back to our table with the classifications of seizures given to us by the ILAE. But let's shift our focus to seizures with generalized onset. Again, you'll see here that these can be further broken down into a motor or non-motor seizures, involving tonic clonic, just clonic, myotonic, atonic, as well as nonmotor seizures which can be broken down into typical, atypical, and Myoclonic.

From *Fisher et al. Instruction manual for the ILAE 2017 operational classification of seizure types. Epilepsia doi: 10.1111/epi.13671*

GENERALIZED SEIZURES

- Widespread abnormal electrical activity affecting both hemispheres simultaneously.
- On EEG, pattern is generalized and may show spike and wave or polyspike and wave epileptiform discharges.
- The Patient will typically lose awareness with these seizures.
- These can be convulsive or non-convulsive
  - Present as generalized tonic clonic; tonic; myoclonic; absence; and atonic.



Slide 19

During a generalized seizure- widespread abnormal electrical activity in the brain is affecting both hemispheres of the brain simultaneously. Because of this, there's always some form of altered awareness although if the seizures incredibly brief such as a myoclonic jerks the alteration may go unnoticed

An ictal pattern is often noted to be generalized and can have something called a spike and wave or poly spike and wave epileptiform discharges.
Patients will typically lose awareness with generalized seizures. A classic example of this is absence seizures in which the patient zones out or becomes unresponsive for a moment often without any motor movement at all.

https://eegatlas-online.com/index.php/en/alphabetical-index/ige-guest

GENERALIZED SEIZURES (CONTINUED)

Convulsive:

- Sudden loss of awareness, with onset of contraction of limb muscles (tonic) followed by symmetric jerking of the limbs as a result of alternating contraction and relaxation of the muscles (Clonic). Typically lasts 1-2 minutes and is followed by post-ictal phase.

Non-Convulsive:

- Absence

Myoclonic

- Sudden, very brief, sporadic involuntary contraction of the muscles, without loss of awareness

Atonic:

- Drop attack due to sudden loss of postural muscle tone

Slide 20

For the breaking down of our generalized seizures, we can classify these as convulsive, non-convulsive, myoclonic atonic. Convulsive seizures involves sudden loss of awareness with onset of contraction of the muscles, which is the tonic phase, followed by symmetric jerking of the limbs as a result of alternating contraction and relaxation of the muscles. This is referred to as a tonic, clonic seizure. While these are very intense, they typically are brief, lasting no more than 1 to 2 minutes. Because he's involve both hemispheres of the brain, and they typically have a significant post ictal phase. The patient will be confused, tired, and can even have something referred to as postictal agitation where the confusion leads to wandering or a not the boss of general seizures.
Absence seizures are those seizures where by simply zone out for a few seconds without awareness of the seizure.
Myoclonic seizures involve both hemispheres of the brain and result in a sudden, very brief, involuntary contraction of the muscle, without any loss of awareness

Atonic seizures is a sudden complete loss of muscle tone which is typically referred to a a drop seizure or a drop attack
due to the complete loss of muscle tone.

TYPES OF GENERALIZED EPILEPSY

Childhood absence epilepsy

- Genetic
- Typical age of onset 7
- 10% can have convulsions
- More common in girls
- Provoked by hyperventilation
- 70% remission by adulthood
- Treatment: Sodium channel agents (Ethosuximide, Depakote, lamotrigine)

Juvenile Idiopathic epilepsy

- Genetic
- Typical age of onset 10-17 years
- Same incidence in male/female
- Convulsions are more common
- Tends to cluster in the morning
- Provoked by hyperventilation
- EEG findings: 3-5 Hz generalized poly spike wave
- Treatment: Broad spectrum medications

Juvenile myoclonic epilepsy

- Genetic, complex inheritance
- Neurologically normal
- Early morning myoclonus
- May also have convulsions and absence type seizures
- Provoked by sleep deprivation, alcohol, photosensitive
- Tx: Depakote, lamictal, keppra
- Phenytoin and carbamazepine may worsen seizures

Slide 21

Generalized epilepsy is most often related to a genetic syndrome, although the underlying cause of these syndromes is not fully understood.
The three main categories of generalized epilepsy include childhood absence epilepsy, juvenile idiopathic epilepsy, and juvenile myoclonic epilepsy.

In juvenile absence epilepsy, the vast majority of these involve only absence seizures however, 10% of these patients can also have convulsions. They are more common in girls and typically have an onset around early elementary years. The seizures can often be provoked by hyperventilation. Therefore, when doing an EEG test with children, they will typically have the child hyperventilate intentionally to invoke a seizure. A large amount of these seizures or epilepsy actually resolved into adulthood.
With juvenile idiopathic epilepsy, this typically began slightly later, but still in later elementary years summer between the ages of 10 to 17 typically. The incidence of juvenile idiopathic epilepsy is about the same between girls and boys. Convulsions are more commonly seen with juvenile idiopathic epilepsy, then with the absence of epilepsy. And interestingly seizures with this generalized epilepsy type, tend to cluster and occur earlier in the morning. The seizures by hyperventilate and often involve a very characteristic finding an EEG that is referred to as a 3 to 5 Hz generalized poly spike wave pattern.
Now it is not our responsibility to read EEGs, but this is such a classic finding on an EEG but it's worth noting, because if you see this they are referring to some type of generalized epilepsy.

And lastly juvenile myoclonic epilepsy, which tends to be the most complex of the three. Typically these patients are neurodevelopmental normal although certainly some of them can have developmental delays. Classic features include early morning myoclonus, which is that jerking seizure we spoke about, however, clustering most commonly in the morning. These patients typically also has absence seizures as well as generalized convulsive seizures. The real differentiation between this seizure type versus the other two is that myoclonic jerk. Commonly provoked by sleep, deprivation, and tend to be photosensitive, such as being triggered by a strobe light. This form of generalized epilepsy typically begins in mid to late adolescence years, and most often does not resolve on its own throughout the lifetime. Meaning of these patients will typically be on medication treatment for the duration of their life.

STATUS EPILEPTICUS

What is Status Epilepticus?

- Prolonged seizure or cluster of seizures without return to baseline
- Most seizures end after a few minutes. If seizures are prolonged (greater than 5 minutes) or occur in a series (patient does not return to baseline before the next seizure) there is an increased risk of status epilepticus.
  - This 5 minutes does not include the postictal recovery

A medical emergency

- Adverse consequences can include hypoxia, hypotension, acidosis and hyperthermia
- Mortality ranges from 7-40%

Treatment

- Safety and ABCs
  - Maintain airway, can use oxygen if available
  - Side-lying position
  - Support head
  - Move to floor if able
- NEVER restrain or place object in mouth
- Medications:
  - Benzodiazepines are first line treatment

Slide 22

A very important condition to be recognized by the nurse is something called status epilepticus. Status epilepticus is a prolonged seizure or a cluster without returning to be between. As we discussed must seizures are actually relatively brief, lasting no more than one to two minutes. If a seizure becomes prolonged, typically referred to as more than five minutes or longer, or the patient is having shorter seizures, but they are clustering without return to baseline in between this also is classified as status. Now the five minutes that we speak about here does not include that post ictal phase. We are really only talking about the active seizure itself.

Why is status epilepticus such a big deal? Status of left a case is considered a medical emergency because once a seizure goes past the five minutes or involves clustering without return to baseline the chances of the seizure, resolving on its own diminish significantly and continue to diminish the longer the seizure goes on. As the seizure becomes prolonged, there also can be permanent brain damage occurring in the brain. Mortality rates can range anywhere from 7 to 40% and once a patient experiences status epilepticus the chances of them experience this again down the road.
Therefore quick and aggressive treatment is critical. As a nurse, you will not be deciding which medication's to give typically important to note that the first line medication to use are typically benzodiazepines. The most common rescue medication's are midazolam or diazepam. Both of these come in an at home, nasal spray solution and many patients with convulsive seizures will have this rescue medication on hand to allow family members to administer this quickly wants to seizure appears to be coming prolonged.
In a hospital or clinic, setting you are responsible to administer one of these benzodiazepines if it appears. Maintaining safety, and your basic ABC's should be top priority. Ensuring that the airway is maintained is critical, and may require you to get supplemental oxygen via a mask and suction secretions coming out of the mouth. If you are suctioning, secretions, be sure, not to place the suction in the mouth as this can cause more damage to the patient. The ideal position for a patient having a seizure, regardless of duration is a sideline position is this decreases the risk of aspiration. You'll want to make sure they had a supported so if they have fallen to the ground, you're going to want to place something soft under their head to avoid further injury. If they are in a chair or in an area where they could further fall or in safe, moving them to the floor would be best although if it is happening in the hospital setting keeping them in the hospital, that would be the most appropriate.
One of the greatest misconceptions during a seizure is that you should restrain the patient's limb or place something in their mouth. And years past there was a thought to put a bite block in the patient's mouth avoid injury to their tongue. We now know this actually placed a patient an increased risk for injuries, and this is no longer considered appropriate practice.

Patient is safe during a seizure particularly ensuring that arms are not stuck within bed rails and so on will help ensure that the patient has minimal secondary injury. If you are in a setting as a nurse outside of the hospital, you will want to ensure that 911 has been called. In the hospital, the medical team, such as the advanced practice provider or medical doctor will be guiding treatment in terms of subsequent medication's. While it's not your responsibility to know what

all of these medication's are. You should know what to anticipate additional doses of benzodiazepines and even progress to loads of seizure medication such as an IV load of Depakote or Keppra and in some cases when a prolonged seizure really cannot be stopped, a medically induced coma is used, at which point they would be being transferred to the intensive care unit for monitoring.

Reference: Kwan P., et al, Definition of drug resistant epilepsy. Consensus proposal by the ad hoc Task Force of the ILAE Commission on Therapeutic Strategies. Epilepsia. DOI: 10.1111/j. 1528-1167.2009.02397.x

Mohanraj R and Brodie MJ. Eur J. Neurol, 2006; 13:277-282 used with permission (Cyberonics)

IDENTIFYING SEIZURE TRIGGERS

Common Seizure Triggers:

Sleep deprivation	Missed medications	Alcohol	Stress	Menses	Infection	Flashing lights (rare, apx 3% of patients with epilepsy, typically seen in generalized epilepsy)	Low (less often, high) blood glucose	Electrolyte imbalance (Low sodium, low calcium, low magnesium)

Slide 23

Identification of seizure triggers can be incredibly helpful as this can help in some cases prevent seizure. However, it's important to note that not every seizure has an identifiable trigger and you will see that some patients can really drive themselves a little crazy trying so hard to find a trigger when sometimes there just isn't one.
However, the most universal triggers for seizures, include sleep deprivation and missed medication. Educating on sleep hygiene is a critical aspect of nursing care for these patients, as well as identifying sleep disorder, such as obstructive sleep apnea, which can significantly worsened an individuals epilepsy. Other triggers include alcohol, stress, menstrual cycle for some women, infection, flashing lights, altered blood sugar, as well as altered electrolytes. Now let's circle back to a few of those. For some individuals alcohol at any doses can be a significant trigger for their seizures. However, many patients can reasonably consume moderate amounts of alcohol and education the patient about risks is important.

Stress is a part of life and if you're listening to this while in nursing school, you know stress better than anyone else. However, teaching patients how to cope with stress and prioritize time for themselves, and frequent breaks, as well as mindfulness and relaxation can go a very long way in helping them better control their seizures.

Menstrual cycle can also be a trigger for some women, in which case we refer to this as catamenial epilepsy. For these women it is important to recognize this because sometimes we can actually change treatment and sometimes people give an additional medication referred to as a bridge during the week of their menstrual cycle to help prevent seizures.
Hormones also play a critical role in epilepsy as estrogen can act as a pro convulsant for women who have epilepsy, while progesterone actually, synthesize is and act as an anticonvulsant for these women. because of this progesterone-based birth controls are the preferred method for patients and estrogen should be avoided and epilepsy as well as many other neurologic conditions, including migraines.

The last one I want to highlight here is flashing lights. There's a very common misconception that all patients with epilepsy are triggered by flashing lights. In reality, seizures triggered by flashing lights are actually a very small percentage of all epilepsy, estimated somewhere around only 3%. This is still a critical trigger to identify because in these patients it will almost always set off a seizure. Anytime they visualizes lights in these lights conclude stimulation such as video games. Recognizing this is a trigger for these patients is incredibly important.

SEIZURES THAT MIMIC EPILEPSY

Nonepileptic seizures (NES)	• Seizure activity in the absence of electoral (EEG) changes in the brain. • Underlying psychiatric cause
Convulsive syncope	• More tonic vs clonic movements, usually brief (<30sec), little to no postical phase, characteristic warning.
Migraines	• Auras related to migraines can often mimic focal aware seizures. • Hemiplegic migraines can often be misdiagnosed as seizures.
Benign nocturnal myoclonus	• Myoclonus= quick, involuntary muscle jerk • Most often these are idiopathic
Tics	• Often idiopathic, but can be related to underlying psychiatric disorders or Tourette syndrome

Slide 24

So, when is a seizure not epileptic? There are causes of seizures that are not based on the electrical activity in the brain or what we have been discussing here today.
These include things such as non-epileptic, seizures, compulsive, syncope, migraines, benign nocturnal myoclonus and tics. Nonepileptic seizures account for the highest number of seizures that do not originate from an electrical activity in the brain. Diagnosing this is incredibly important as it is estimated that somewhere around 30 to 40% of all seizures in adulthood actually are non-epileptic. Why is this important to identify? Because the medication some treatments use for epilepsy will not work if the seizure is not a result of abnormal electrical activity therefore the medication's we are giving often cause more harm than good and are not serving the patient to treat their seizures.

Convulsive syncope tends to be more often tonic rather than clonic is typically very brief less than 30 seconds has a very characteristic warning, such as dizziness, narrowing of Vision, or other things, you would expect to hear from syncope. Also, there's rarely a postictal phase following a a compulsive syncope, because there was no abnormal electrical activity in the brain. Proper identification and treatment is still of the upmost importance as there are often causes such as cardiovascular etiology that need to be identified and treated. Migraines could also be a presentation all by itself, and should be an area that you become well-versed with as a nurse. Migraines tend to be thought of only as really bad headaches, however, migraines to result from abnormalities in the brain, and could be far more complex, including things, such as hemiplegic migraines with a wide variety of symptoms and even loss of muscle tone. Again the only way to truly identify these as a migraine versus an epileptic seizure. If they involve similar characteristics to a seizure would be diagnosing on an EEG.
Benign nocturnal myoclonus is what we spoke of earlier that feeling of like jerking typically when you're feeding in or out of sleep. However, as we mentioned earlier, these are not always the cause of electrical activity in the brain, and have many other causes behind them.

And lastly tics, which often idiopathic, but could be related to underlying psychiatric disorder or even tourette syndrome.

NON-EPILEPTIC SEIZURES

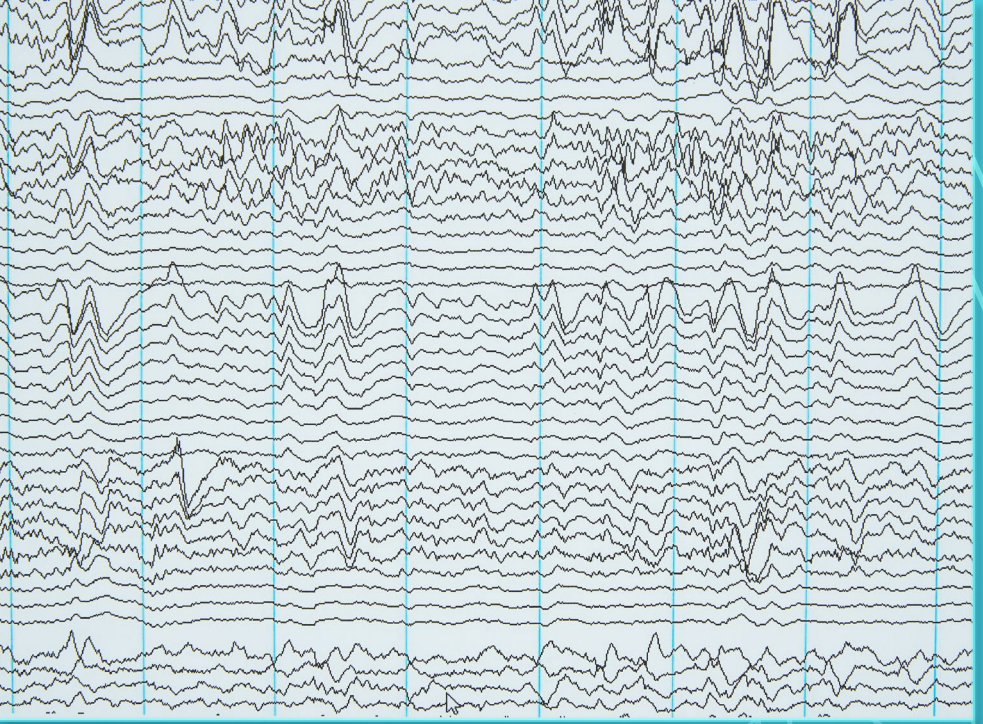
- Formerly called “Pseudoseizures” or “psychogenic seizures”
- Nearly 40% of patients referred to the EMU for intractable seizures are diagnosed with NES.
- More common in females
- High correlation with psychiatric disease (80%), however not always
- Key Feature: non-rhythmic movements, waxing and waning, prolonged duration

Slide 25

Let's take a moment to dig a little deeper into nonepileptic seizures. While non epileptic seizures could be a presentation all in an on, its own, it's important to understand this event as a nurse, as you will likely come across this at some point in your nursing career. These events are seizures, but do not have changes in electrical activity that we see with epilepsy. NES is a subtype of functional neurological disorder (FND). Most of the time (but not necessarily always) it is trauma related and the person's body trying to express distress when their words cannot do so. Non epileptic seizures occur involuntarily and are incredibly painful and debilitating for many individuals. NES may be the body's way to accomplish something (processing trauma, getting help/support, not working due to stress or trauma from work, body reset) but doing so in a very ineffective and dangerous way.

In the past, there has been a significant stigma with non-epileptic seizures, and you may have heard these called things such as pseudo seizures, or psychiatric seizures.
These are not fake seizures or faking on behalf of the patient causing the symptoms. These are still fully uncontrollable events and are just as scary and can result in injury just as epileptic seizures can. Many of these patients have been discredited or made to feel stupid, drug seeking, or simply unheard by the time they land on the proper diagnosis. Many of these patients are also not offered much sympathy or care, especially in the emergency room, setting as many emergency room providers have a great misconception of what is happening in non epileptic seizure and often do believe these to be fictitious or malingering.

It is estimated that nearly 40% of patients who come into an epilepsy monitoring unit for intractable seizures, receive a diagnosis of nonepileptic seizures. These are also more common in female, and have a very high correlation of psychiatric disease, as well as PTSD or trauma. EEG is required to definitively diagnose. There are some key characteristics that make the stand apart from a epileptic seizure. Non epileptic seizures tend to have more non-rhythmic movements. They also tend to have a waxing and waning. Meaning they get more intense than and less intense, and then more intense again, and less intense again and follow this pattern. This is not seen an epileptic seizures. Epileptic seizures tend to build, and then stop. In addition, non epileptic seizures can often be quite prolong sometimes up to hours, which is not seen an epileptic seizures.



EPILEPSY WORK UP

Evaluate underlying cause should guide treatment

Routine labs : electrolytes, calcium, magnesium, glucose, BUN, LFT, drug/alcohol

Electroencephalogram (EEG)

- Measures electrical discharges across the brain
- When a patient has a seizure, these discharges become larger in amplitude and disrupt normal brain function.

Neuroimaging

- Indicated for first time seizure and/or abnormal neuro exam.
- Typically CT done in ER setting, MRI follow up to detect structural abnormalities

Slide 26

So we've talked a lot about EEG being needed to definitively diagnose epilepsy, as well as to rule out some of those other conditions that are not epilepsy, but can appear the same as an epileptic seizure. Initial work up for an individual coming in with a seizure should always be to evaluate for an underlying causes. As we discussed, not every seizure is epilepsy, and if there is an underlying cause, such as alcohol intoxication, hypoglycemia, an electrolyte, abnormality, and infection that these need to be treated. Even in an individual with a diagnosis of epilepsy, they should still be a valuated for underlying causes for that seizure.

Other workup would include things such as routine labs like electrolytes, calcium, magnesium, glucose, BUN, liver function, panel, drug and alcohol panel. Depending on other symptoms, they are presenting with further testing may be necessary.

An EEG is an electroencephalogram, and involves placing many electrodes on the scalp of the head to reach the electrical activity of the brain. This test is most often done in an outpatient or non-acute setting to try to better understand the persons epilepsy. However, if you were working in emergency room, you may see patients hooked up to an EEG particularly when there is a concern for status or altered mental status to better help assess the providers to know what is going on.

Neuro imaging can be another helpful tool. We discuss certain underlying causes such as structural abnormalities in the brain, stroke, tumor. Many of these underlying causes would be diagnosed through neuro imaging. A CT will typically be ordered in an emergency setting since this is We consider an hour imaging indicated for any first time seizure and or sudden change or increase in seizures down the road even in an individual with epilepsy with an abnormal Neuro exam. Typically in an emergency room setting you will see a CT done as this is more feasible and would rule out some of the causes that would require immediate intervention. However, down the road, an MRI really is best to the text structure abnormalities and is necessary for the patient to proceed with any form of surgical work up for their epilepsy.

TREATMENT OF EPILEPSY

Primary treatment is medication

Balance with co-morbidities and concomitant medication use

In general, avoid hepatic inducers (Phenobarbital, Carbamazepine, Phenytoin)

Screen for related health issues: depression, sleep issues, sexual dysfunction

Discuss life plans: driving, work, relationships (plans for pregnancy?

Patients who become refractory (failed 2 or more APPROPRIATE seizure medications) may be worked up for surgical interventions.

Slide 27

How do we treat epilepsy? The primary treatment for epilepsy is medication. We also want to help the patient's balance other comorbidities that might be increasing her likelihood of having seizures. There's a drug class for seizures, which are hepatic inducers. These are medication such as phenobarbital and phenytoin, which used to be a staple in treatment for epilepsy, but have such significant side effects and take quite a toll on the patient of these are typically avoided unless necessary.

It is also important that we are screening for other related health issues, including depression, sleep issues and sexual dysfunction, all of which are seen at a significantly higher rate in individuals with epilepsy. You will want to discuss plans with the patient, including their ability to drive, work, as well as pregnancy. Will discuss this morning minute in terms of patient education.

Patients can also become refractory and you will want to recognize when a patient becomes refractory. We will circle back to this in a moment.

EPILEPSY MEDICATION

BROAD SPECTRUM	NARROW SPECTRUM
Acetazolamide (Diamox)	Carbamazepine (Tegretol)^#@E
Benzodiazepines%	Cenobamate (Xcopri)T
Brivaracetam (Briviact)	Eslicarbazepine (Aptiom)
Cannabidiol (Epidiolex)	Gabapentin (Neurontin)#@!
Clobazam (Onfi)%	Lacosamide (Vimpat)
Felbamate (Felbatol)&	Oxcarbazepine (Trileptal)^@
Lamotrigine (Lamictal)1@!#	Phenobarbital^E
Levetiracetam (Keppra)+	Phenytoin (Dilantin)^E
Perampanel (Fycompa)T	Pregabalin (Lyrica)#%!
Rufinamide (Banzel)	Primidone (Mysoline)^E
Topiramate (Topamax)*&!@	Tiagabine (Gabitril)
Valproic acid (Depakote)*^@!	Vigabatrin (Sabril)
Zonisamide (Zonegran)&!T	
	Absence only:
	Ethosuximide (Zarontin)

1 May worsen myoclonus
* Do not use in pregnancy
^ Affect bone health; check vit. D &/or DEXA
& Potential weight loss
# Potential neuropathic pain relief
@ Mood stabilizer
! Migraine/HA relief
% Anxiolytic
T Long half life, can be dosed once daily
E Enzyme inducers
+ Best for dementia

xxx = sodium channel agents
xxx = carbonic anhydrase inhibitors
xxx = glutamate/AMPA
xxx = GABA
xxx = calcium
xxx = multiple mechanisms
xxx = unknown

Slide 28

Here you'll see a list of commonly used medication's for epilepsy. They fall into two main categories listed as broad-spectrum or narrow spectrum. Broad-spectrum anticonvulsant medication's work best on generalized epilepsy and help to treat the brain as a whole. When a patient has generalized epilepsy, or if they have any new onset epilepsy that has not been confirmed as focal versus generalized the staple treatment will always be a broad-spectrum anticonvulsive medication to ensure that we are treating them to the best of our possibility. The most common medication's that you may see on this list are Keppra which is almost always a first medication used in patients with new onset seizures, and can be given as an IV load in the hospital. Other first time medication's are typically Depakote and Lamotrigine. You'll see a chart here that identifies which medication falls into which category. We won't cover these in depth today but I would encouraged to look into these more. Just as understanding, the function of the lobes of the brain to help us clue in to the type of seizure the patient is having, understanding the mechanism of action behind the medication's will help us to better understand when and why these medication's might be appropriate for certain epileptic patients.

Narrow spectrum agents are typically only used for focal epilepsy and most commonly fall under the medication, class of sodium channel agents as well as gabba inducers. The most common narrow spectrum agents you might see used initially for focal epilepsy include Vimpat, Tegretol, Trileptal. Xcopri is the newest medication to the market for epilepsy, but it's becoming more and more frequently used.

REFRACTORY EPILEPSY

- Refractory epilepsy is failure to obtain seizure freedom with 2 or more APPROPRIATE anti-epileptic medication.

- Success of seizure freedom decreases with each "failed" anti-seizure medication tried.

- It is important to consider diagnostic and/or surgical work up for these patients.

Rates of 1-year seizure freedom with successive anti-epilepsy drug regimens

Regimen	Number of people attempting regimen	Of those who attempted, number achieving seizure freedom	Seizure freedom rate	Number eligible to try next regimen*
First	1,795	820	45.7%	975
Second	742	208	28.0%	534
Third	330	78	23.6%	252
Fourth	140	21	15.0%	119
Fifth	71	10	14.1%	61
Sixth	43	6	14.0%	37
Seventh	15	1	6.7%	14
Eighth	9	0	0%	9
Ninth	5	0	0%	5
Tenth	2	0	0%	2
Eleventh	1	0	0%	1

* This group includes all patients not achieving 1-year seizure freedom, including those who stopped taking medication due to adverse effects, pregnancy, or other concerns. Not all eligible patients go on to try subsequent regimens.

Data from Chen Z, Brodie MJ, Liew D, Kwan P. Treatment outcomes in patients with newly diagnosed epilepsy treated with established and new antiepileptic drugs: a 30-year longitudinal cohort study. *JAMA Neurol.* 2018;75(3):279-286. doi:10.1001/jamaneurol.2017.3949

Slide 29

So let's circle back to that refractory epilepsy. We said that refractory epilepsy is when a patient has failed two or more appropriate antiepileptic medications. What do we mean by appropriate? We mean that were using the right medication for the type of seizure they have. If they have generalized epilepsy, but they were on a narrow spectrum agent then this was not an appropriate treatment and therefore we don't consider this a true failure of the medication. But once a patient has been on two different medications at optimal doses. We consider them refractory. Now this does not mean that they've had no benefit, but it does mean that we've not been able to fully control their seizures on these medication's. There's much to be in the world of epilepsy about how quickly to move a patient into a surgical work up and how long to try other medications based off a study from about 13 years ago it was believed that the chances of success after failing to appropriate medications on a subsequent medication was less than 5%. Because of this, there's been a significant movement to ensure that once a patient is refractory, they are being worked up appropriately and determined for any potential surgical options. However, more recent studies do suggest that there's actually higher success rates than 5% and because everybody responds differently to different medications. There certainly is wisdom in try multiple medications to help control the patient's epilepsy.

The real key take away here is making sure that we're being aggressive in the management of patient seizures, and identify when they seem to not be responding well to medications to prompt us to move on with proper referrals and testing.
Mohanraj R and Brodie MJ. Eur J. Neurol, 2006; 13:277-282 used with permission (Cyberonics)

https://www.ilae.org/journals/epigraph/epigraph-vol-22-issue-4-summer-2020/setting-the-record-straight-on-the-chances-of-seizure-freedom-after-two-medications-fail

NON-PHARMACOLOGICAL MANAGEMENT OF REFRACTORY EPILEPSY

- Deep Brain Stimulation (DBS)
  - Intermittent stimulation of the bilateral anterior thalamic nuclei (ATN), most often used in generalized epilepsy.
- Responsive neurostimulation (RNS)
  - Implanted device with electrode placed on the spot of seizure onset. This device reads the actual EEG and is able to give targeted electrical stimulation when a seizure onset is detected.
- Vagal Nerve Stimulation (VNS)
  - Involves an implanted device that sends electrical stimulation to the vagus nerve
- Ablation or removal of brain tissue
- Callosotomy

Slide 30

What are surgical options for epilepsy, while certainly you don't need to know all of these as a nurse, these are becoming more common and it is very likely you will care for a patient who has had one of these surgical interventions.

Deep brain stimulation place is electrodes deep into the brain stem in the bilateral anterior thalamic nuclei or ATN, and stimulates his area of the brain. This is most often used in a generalized epilepsy rather than focal.
An RNS, or Responsive Neurostimulation
is a newer device
that also provides electrical stimulation but this is used for patients where we have conclusively found where the seizure is coming from and the electrode is being place don that spot.
This device not only provide stimulation, but it actually can read the EEG way to the brain and can be programmed, and taught to understand abnormalities in the EEG, and when to stimulate the brain to prevent a seizure. It has one of the highest success rate of any device used for epilepsy. However, it's also one of the more invasive of these devices, and therefore requires a significant woke up to ensure it is being used appropriately.

The vagal nerve stimulator is probably the oldest of these and the most well known. In this device, we have an electrode that is placed on the vagus nerve, left side of the neck, and it provides electrical stimulation to this nerve. By providing stimulation to the snow that reverses the polarity and actually shifts and increases the neuro chemical balance in the brain. The Vns is used that only for epilepsy but also for a factory depression.

And the last surgeries listed here are ablation or removal of brain tissue. This is done when there's a specific area of the brain that has identified to be the cause of a seizure and also identified to have no negative impacts it removed or abladed. This is one of the most successful treatments when used on the correct patient however, is also one of the most invasive.

And, lastly, a callosodomy and this waxes and wanes in popularity. It is a procedure which involves separating the two hemispheres of the brain, to prevent the ability of the seizure to jump from one hemisphere to the other. This is most often used only in generalized epilepsy that is very severe, and in patients who are having signific atonic or drop seizures.

Image courtesy of Pixabay

SPECIAL CONSIDERATIONS

- Medications to avoid for Patients with epilepsy:
  - IV drug use/cocaine
  - Tramadol, buproprion/Wellbutrin
- Marijuana
- Important screening
  - Vitamin D
  - Dexa Scan
- Women with epilepsy
  - Oral birth control
  - Best medications: Lamotrigine (Lamictal) and Levetiracetam (Keppra)
  - AVOID: Topiramate (Topamax) & Valproic acid (Depakote)
  - Folic Acid

Slide 31

Before I wrap up, I just want to discuss a few special things to be aware of for a patient population.
There are certain medication's that should be avoided with patients with epilepsy. Certainly this is not an extensive list, but a few key medications to be aware of include Tramadol and Wellbutrin. These are two medications you come across very frequently as a nurse, and you should be aware that these are both medication's that can lower seizure threshold in patients. In addition, antihistamine medication's and certain cold medication's can also lower seizure threshold, although these are certainly used for patients with epilepsy just with caution.

Marijuana has been a hot topic in much of medicine, and most definitely in the world of epilepsy. There really is no studies or definitive knowledge to tell us whether marijuana might have beneficial effects for epilepsy, although many patients with epilepsy have done their own investigation into this and feel strongly that marijuana could be helpful. What we do know about marijuana is that it has the two components of the THC and CBD. CBD actually has been studied in epilepsy and been shown to be helpful in Managing epilepsies. There now is a an FDA approved CBD oil called Epidiolex , which has only been studied and some of the symptoms of epilepsy, including Lennox-Gastaut, Tuberous sclerosis and dravet syndrome. However, in these conditions it has shown a significant improvement in patient seizures, as well as quality of life. We're things get stickier is with the THC. THC is the component that has not been studied well and seizures and we do know that higher levels of THC actually invoking to do seizures. Whether or not a combination of low-dose THC with CBD is beneficial at managing seizures is not known, and patients are educated to avoid medical marijuana when they have a diagnosis of epilepsy.

There are also certain screenings that are really important for patients with epilepsy. Vitamin D is linked closely with bone health as it helps absorb calcium in the bones. Many of the medication is used to treat epilepsy can cause bone loss over time, and therefore many studies have been done showing that improving vitamin D levels in patients with epilepsy and anticonvulsant medication's can improve their long-term bone health. Because these medication's impact on health screening such as DEXA scans are also important in this patient population.

Another important consideration is women with epilepsy. Oral birth control is often not absorbed properly in individuals epilepsy secondary to their antiepileptic medication's. Therefore, women with epilepsy should be counselled on alternative methods of birth control, including IUD or implants are preferred. Also estrogen-based birth control should be avoided as these can worsen seizures.

Women with epilepsy can become pregnant and have very healthy, pregnancies and healthy children. It is important, however, to ensure that these women are counseled an educated about any potential risks. The best medications to use for epilepsy during pregnancy are lamotrigine and Keppra, as these have been studied for the longest, and have the lowest risk to the baby. There are many other seizure medication's that have not been directly studied in

pregnancy, and can be used but with caution. Medication that should absolutely be avoided in pregnancy include topiramate and valproic acid, as these have been shown to have the highest incidence and resulting in a baby with neural tube defects, developmental, delays, and autism. Folic acid is a supplement that we're well aware of, the CDC has recommended that women take a folic acid supplementation during pregnancy, and specifically in the first six weeks of pregnancy to reduce risks of neural tube defects in babies, and this is for all women not just women with epilepsy. Because the medication to be used to treat epilepsy, even the safer ones, increase the woman's risk for having a baby with neural tube defects or autism and developmental delays folic acid is even more critical for these patients them for the general public. Because the first six weeks at the most crucial time in a woman's pregnancy, in terms of reducing these complications, it is best for women to be on a preventative a prophylactic Folic acid supplementation if they are in their childbearing years or have a possibility to become pregnant. This will ensure that they have the proper amount of Folic acid to turn the first few weeks of pregnancy when most women are not aware that they are pregnant. During pregnancy women's metabolism increases significantly, and this includes how they metabolize their medication's. Throughout the woman's pregnancy, the medication levels will need to be checked frequently, typically, at least once a month, and their medication doses will be adjusted, sometimes to a typically high doses based off of their serum levels to ensure that they remain in the therapeutic range of their medication. This is crucial to ensure that we are managing their seizures during a pregnancy.

TAKEAWAYS FOR INPATIENT MANAGEMENT

- Recognizing seizure activity is key
- Keep patient safe- remain with patient
- Protect airways
- Provide O2
- Try to identify underlying cause
- Maintain seizure precautions- have O2 and suction available, bed rails up, pad bedrails, keep bed in lowest position.
- Be prepared to give medications

Slide 32

The nurses ability to recognize seizure activity is crucial to ensuring that the patient is both safe and well cared for. As we've discussed today, seizures do not always present as cookie-cutter as what we see on TV shows. Sometimes seizures include more subtle findings like altered mental status, and slight automatisms or muscle jerks. Because of this, it's critical that we as nurses are able to evaluate patients and recognize when there are signs of potential seizures. When a patient is having a seizure remain with the patient and keep them safe. Focus on protecting their airway and providing oxygen if needed. Ensure that they are turned to their side to reduce possibility of aspiration. Help to identify underlying causes to ensure that we can treat those as quickly as possible. Basic seizure precautions in all patients with known seizures or epilepsy, which includes having oxygen and suction ready and available, having their bed rails up and padded bed rails, as well as keeping the bed in the lowest position. This provides the most safe environment for a patient. Should they have a seizure while in the hospital. Be aware of what medications they are on and if there's any medication's that are contraindicated with their diagnosis of epilepsy

know which medication should be given in case of an emergency or prolonged seizure, and be prepared to administer these per protocols, that will be in place at your institution.

PATIENT EDUCATION

- Medications- side effects, adherence
- Safety- nothing in mouth, lay flat, turn to side
- Rescue medications
- When to seek help- >5 minutes, not returning to baseline
- Tracking seizures
- Video
- Plug into support
- Special considerations- BC meds less effective, caution with alcohol, med list, driving

Slide 33

Nursing education for patients is at the heart of what we do as nurses. It goes beyond treating just the immediate and ensuring that patients have the ability to manage their own diagnosis and care. Because of this, the education provided to patients with epilepsy should never be underestimated or taken lightly.

Patient should be educated about their medications, specifically, how crucial it is to not miss medications. We all know that this is easier said than done and helping educate patient about strategies to improve medication, adherence, such as a pill, container, or an alarm reminder will go a long way and providing them practical ways to better adhere to their medications.
Teaching patients as well as their family friends and loved ones about safety is also important. Patients and families need to be educated about some of the safety things we discussed today, including not placing something in an individual's mouth, rolling the individual onto their left side, ensuring that the individual has a safe environment and somethings safe under their head as well as when to call for help for these patients will have a rescue medication such as a nose, spray, or a pill that is a benzodiazepine. They should be educated to recognize the signs of when these medication should be used as well as what to monitor for such as respiratory depression if these medications are administered in the home setting they need to know when to seek help, discussing risks. Such a status epilepticus with patients and families is very important in ensuring that they recognize when to call for help for a prolonged seizure. We should teach patients how to track their seizures as this is a very critical piece in their epilepsy providers ability to manage them long-term. The frequency and duration of their seizures is important to track and there are apps on the phone and many different tools available to patients to help track these.
We always say that a video is worth 1000 words, this is very true with seizures. If a patient is having a seizure that has not been witnessed by the epilepsy provider, or they do not have a definitive diagnosis, having loved ones, take a video of their seizure when it is safe to do so, and bringing that with them to their outpatient appointments can go along way and helping the providers be able to visualize what the seizures look like at home and guide their treatment. It may seem unconventional to ask a loved one to video a person having a seizure, however, this is a very useful tool. Ensure, however, that they know that safety comes first before taking this video.
As with any diagnosis, plugging patients into support goes along way and helping with their overall quality of life and management of their disease. Organization, such as the epilepsy foundation of America have local chapters in each state that provide amazing resources to patients with seizures. Ensure that were educating patients about some of the special considerations we discussed. Women should know that oral birth control becomes much less effective and other forms of birth control. Be recommended if the plan is to avoid pregnancy. Patient should be educated to be cautious with alcohol and avoid if this is a known trigger. Driving is a difficult consideration because regulations in terms of driving with a diagnosis of epilepsy vary from state to state, ranging anywhere from states such as Colorado, which have no laws on the book in terms of driving with epilepsy to state, such as New York that require 18 months, seizure freedom before the ability to drive. It's important to educate patients to know what their local laws are regarding driving with a diagnosis of epilepsy. A study done at Mayo clinic provided recommendations that patient should be at least 3 to 6 months seizure. Free without medication changes during that time before they resume driving. These are good guidelines regardless, if they are in states that do not require abstinence from driving.

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Slide 34

Thank you so much for your time and attention. Here are some references that were used today, which are great sources to find more information. Epilepsy is a scary and dangerous condition and often can be very impactful on a patient quality of life. We as nurses have the unique ability to understand this disorder, and provide the best medical treatment, as well as recognize the psychosocial impact, epilepsy, bring and walk alongside our patients throughout their journey with epilepsy.

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