NOTES
EPILEPSY & SEIZURES

GENERALLY, WHAT ARE THEY?

PATHOLOGY & CAUSES

- *Seizure:* brain neurons → abnormal, excessive, synchronized electrical activity period
  - Clusters of brain neurons temporarily impaired (seconds-minutes) → paroxysmal electrical discharges → disordered awareness, behavior, movement
  - → too much excitatory, too little inhibitory activity

CAUSES

- Many unknown causes; some known causes (e.g. brain infection):
  - ↑ *excitation:* long-lasting/fast activation of NMDA receptor via glutamate
  - ↓ *inhibition:* genetic mutations → dysfunctional GABA receptors
- Causation → classification

Provoked seizures

- Triggers → abnormal brain activity; subside once trigger removed
- Medication
  - Aminophylline, bupivacaine, bupropion, butyrophenones
- Recreational drugs
  - Amphetamines, cocaine, methylphenidate, psilocybin, psilocin
- Alcohol consumption/ withdrawal
- Flashing lights
  - Photosensitive epilepsy
- Fever
  - Febrile seizures

Epileptic seizures

- Recurring, unpredictable seizures; brain dysfunction → abnormal brain activity; seizures triggered
- Idiopathic seizures/epilepsy disorder
  - Most common
- Disorders
  - Brain injury, brain abscess, brain tumors, eclampsia, encephalitis, Angelman syndrome
- Cerebrovascular disease
  - Intracranial bleeding; perinatal hypoxia, ischemia; ischemic stroke
- Systemic disorders
  - Uremic encephalopathy, hepatic encephalopathy, electrolyte imbalances, hypoglycemia, thiamine deficiency, vitamin B_{12} deficiency

Nonepileptic seizures

- → fainting spell, psychological conditions, stress, not epileptic brain activity

SIGNS & SYMPTOMS

- Subtle signs
  - Spacing out, unusual sensations, brief muscle jerks
- Life-threatening
  - Generalized muscle contractions > five minutes

DIAGNOSIS

DIAGNOSTIC IMAGING

MRI/CT scan

- Detects structural brain abnormalities (brain tumors or vascular disorders)

LAB RESULTS

- Electrolytes; blood glucose; complete blood cell count; liver, renal function; serum calcium; urinalysis

- Assess possible underlying infection, genetic condition, metabolic disorder, other causes

OTHER DIAGNOSTICS

Electroencephalogram (EEG)

- Detects abnormal, epileptiform brain electrical activity

Clinical history

- Assess type of seizure; differentiate between primary, secondary seizures

Neurological exams

- Assess behavior, motor abilities, mental functions → underlying seizure cause, type

TREATMENT

MEDICATIONS

Epilepsy

- Antiepileptic medication
  - Depends on type of seizures, age, lifestyle, and comorbidities

OTHER INTERVENTIONS

Provoked seizures

- Address trigger

MNEMONIC: SICK DRIFT3R

Differential diagnosis for seizures

Substrates: sugar, oxygen
Isoniazid
Cations: Na, Ca, Mg
Kids: pregnancy/eclampsia
Drugs
Rum: alcohol withdrawal
Illnesses: chronic
Fever
Trauma
3 "antis": antihistamine, antidepressant, anticonvulsants
Rat poison

ABSENCE SEIZURE

osms.it/absence-seizure

PATHOLOGY & CAUSES

- Formerly called petit mal seizures
- Generalized seizure; brief loss of awareness/responsiveness; sudden onset, termination; usually no postictal state
- Most common in children; can occur 50–100 times/day; often misdiagnosed as inattentiveness, daydreaming

CAUSES

- Cause → abnormal neuronal activity unknown

COMPLICATIONS

- May progress into generalized tonic-clonic seizures
- Learning difficulties
- Behavior problems

Figure 75.1 An EEG taken from an individual having an absence seizure.

SIGNS & SYMPTOMS

- Sudden loss of awareness, responsiveness → from few seconds-half a minute
- Blank stare
- Preceding activity ceases
- Ends abruptly or followed by automatisms
- (e.g. lip smacking, chewing motions, eyelid flutters)
- Possible sign of coexisting seizure types
- No recollection of seizure

DIAGNOSIS

DIAGNOSTIC IMAGING

MRI/CT scan

- To rule out brain abnormalities

OTHER DIAGNOSTICS

EEG

- Shows generalized spike-and-slow wave discharges
- Easily induced by hyperventilation (most reliable test)

TREATMENT

- Usually resolves as child ages

MEDICATIONS

Anticonvulsant medication

- Valproic acid (drug of choice in case of other coexisting types of seizures), ethosuximide (only for absence seizures)

EPILEPTIC SEIZURE

osms.it/epileptic-seizure

PATHOLOGY & CAUSES

- Recurrent, unprovoked seizures → epilepsy symptoms

TYPES

Focal (partial) seizures

- Affect one brain hemisphere
  - *Subcategories:* Focal aware seizure; focal impaired awareness seizure

Generalized seizures

- Affect both brain hemispheres
  - *Subcategories:* tonic seizures, atonic seizures, clonic seizures, tonic-clonic seizures, myoclonic seizures, absence seizures

CAUSES

- Seizures genetic/idiopathic
- Cerebrovascular disease
  - Intracranial bleeding; perinatal hypoxia,

ischemia; cerebrovascular insult
- Neurological disorder/illness
  - Brain tumors, metastases; brain injury; brain abscess; encephalitis; eclampsia; Angelman syndrome; multiple sclerosis; systemic lupus erythematosus
- Systemic disorders
  - Uremic encephalopathy; hepatic encephalopathy; electrolyte imbalances (hypercalcemia, hyponatremia); hypoglycemia, hyperglycemia; thiamine, pyridoxine, vitamin B_{12} deficiency

COMPLICATIONS

- Injury → falling, drowning, car crash during attack
- Pregnancy complications → seizures during pregnancy; → antiepileptic medication → teratogenic effects
- Status epilepticus
  - Continuous seizure activity > five minutes → permanent brain damage, death
- Sudden unexpected death in epilepsy (SUDEP) → frequent tonic-clonic seizures, inadequate antiepileptic treatment

SIGNS & SYMPTOMS

Focal seizures

- Focal aware seizure
  - No awareness impairment; motor, sensory, autonomic, psychological sensations
- Focal impaired awareness seizure
  - May include automatisms (e.g. lip smacking, chewing, swallowing, unpurposeful walking, etc.)

Generalized seizures

- Tonic seizures
  - Sudden, continuous muscle contractions; causes falling, often backwards
- Atonic seizures
  - Sudden muscle relaxation; causes falling, often forwards
- Clonic seizures
  - Rhythmic muscle contractions (convulsions)
- Tonic-clonic seizures
  - Tonic phase → muscles suddenly stiffen; clonic phase → muscles rapidly contract, relax
- Myoclonic seizures
  - Short, one/multiple muscle twitches over short time
- Absence seizures
  - Loss of awareness/responsiveness; staring spell

Generalized seizures often → postictal state

- Confusion, drowsiness, sleepiness, total amnesia for hours

Todd's paralysis or paresis

- May follow; affects arms/legs, usually limited to one side
  - Lasts about 15 hours; temporary, but severe suppression of brain activity in seizure-affected area

DIAGNOSIS

DIAGNOSTIC IMAGING

MRI/CT scan

- Detect structural brain abnormalities (brain tumors, vascular disorders)

LAB RESULTS

- Electrolytes, blood glucose and calcium levels
  - Assess possible underlying infection, genetic condition, metabolic disorder, other causes

OTHER DIAGNOSTICS

- ≥ two unprovoked seizures required for epilepsy diagnosis

EEG

- Detect abnormal, epileptiform electrical brain activity

Neurological exam

- Assess behavior, motor abilities, mental functions → underlying cause, type of seizure

TREATMENT

MEDICATIONS

Anticonvulsant medications

- Depends on type of seizures, age, lifestyle, comorbidities
  - *Focal epilepsy:* lamotrigine, oxcarbazepine, carbamazepine
  - *Generalized epilepsy:* valproate, lamotrigine, ethosuximide (only for absence seizures)
  - *If unsure:* broad spectrum anticonvulsants (effective for all types): valproate, lamotrigine, topiramate

SURGERY

- Surgical resection in certain cases (e.g. brain tumors or vascular disorders)

FEBRILE SEIZURE

osms.it/febrile-seizure

PATHOLOGY & CAUSES

- Triggered by fever
- Exact mechanism unknown; proposed explanations
  - ↑ body temperature during fever → ↑ excitability of neurons
  - Hyperventilation during fever → ↓ CO_2 levels → respiratory alkalosis → ↑ neuronal excitability
  - ↑ cytokine levels during fever → enhancement of NMDA receptors → ↑ neuronal excitability

TYPES

Simple febrile seizure (most common)

- Affects whole body (tonic-clonic seizures)
- Lasts < 15 minutes
- Does not repeat within 24 hours

Complex febrile seizure

- If 1/3 criteria met
  - Affects specific body part corresponding to specific brain part
  - Lasts > 15 minutes
  - Repeats within 24 hours

RISK FACTORS

- Genetic susceptibility
- Age 6 months–5 years
- Infections
  - Usually common infections, e.g. otitis media

SIGNS & SYMPTOMS

- High body temperature: >38° C/100.4° F
- Simple febrile seizure
  - Presents as tonic-clonic seizures
  - Tonic phase (muscles stiffen, go rigid) → clonic phase (muscles rapidly contract, relax) → convulsions
  - Followed by postictal state, residual arm/leg weakness

DIAGNOSIS

LAB RESULTS

- Laboratory studies
- Lumbar puncture to distinguish from other underlying causes of fevers, seizures (e.g. encephalitis, meningitis)

TREATMENT

- Simple febrile seizures usually resolve by themselves

MEDICATIONS

- Anticonvulsant
  - Complex febrile seizures
- Antipyretic medications (ibuprofen, acetaminophen)
  - Fever management

FOCAL SEIZURE

osms.it/focal-seizure

PATHOLOGY & CAUSES

- Seizure that initially stems from localized brain region; limited to one hemisphere

TYPES

Focal aware seizure

- Affects small brain area
- Individual awake, alert; remembers seizure

Focal impaired awareness seizure

- Unilaterally affects larger area of one cerebral hemisphere
- Individual loses awareness, responsiveness; does not remember seizure
- May develop into a secondary generalized seizure (focal onset bilateral tonic-clonic seizure)

SIGNS & SYMPTOMS

Focal aware seizures

- Symptoms may be subtle, last ≥ two minutes, vary by affected lobe
  - Preserved consciousness
- Motor symptoms
  - Twitching, muscle jerking
- Sensory symptoms
  - Unusual auditory, gustatory, tactile, olfactory sensations
- Autonomic symptoms
  - Sweating, piloerection, dilation of pupils, incontinence, unusual feelings of nausea
- Psychological symptoms
  - Sudden unusual feeling of sadness, happiness, fear, anger; feelings of derealization (environment is not real) or depersonalization (dissociation from the environment or self); feeling of déjà vu
- Speech difficult/impossible

Focal impaired awareness seizure

- Impaired consciousness
- Often preceded by aura (symptoms of focal aware seizure)
- May involve automatisms (e.g. lip smacking, chewing, swallowing, unpurposeful walking, etc.)
- Amnesia (no recollection of seizure)

DIAGNOSIS

DIAGNOSTIC IMAGING

MRI/CT scan

- Identify structural brain abnormalities (brain tumors, vascular disorders)

LAB RESULTS

- Blood tests
  - Detect possible underlying infection, genetic condition, metabolic disorder, other causes

OTHER DIAGNOSTICS

EEG

- Detect epileptiform, abnormal electrical brain activity

Neurological exam

TREATMENT

MEDICATIONS

- Anticonvulsant medications
  - E.g. lamotrigine, oxcarbazepine, carbamazepine

SURGERY

- Treat underlying cause
  - E.g. brain tumors, vascular disorders → surgical resection

MYOCLONIC SEIZURE

osms.it/myoclonic-seizure

PATHOLOGY & CAUSES

- Type of generalized seizure; presents with myoclonus
  - Sudden, brief, involuntary muscle jerks lasting 1–2 seconds
- Epileptic; non-epileptic, e.g. physiologic while falling asleep, waking up; myoclonic jerks → nervous system disorders, metabolic abnormalities, etc.
- *Associated with epileptic syndromes:*
  - Juvenile myoclonic epilepsy
  - Progressive myoclonus epilepsy
  - Myoclonic epilepsy with ragged-red fibers (MERRF)
  - Lafora disease
  - Unverricht–Lundborg disease
  - Neuronal ceroid lipofuscinosis

COMPLICATIONS

- May become generalized tonic-clonic seizures

SIGNS & SYMPTOMS

- Brief body jerks; most commonly facial muscles, limbs
- Preserved consciousness, recollection of seizure

DIAGNOSIS

OTHER DIAGNOSTICS

EEG

- Detect abnormal, epileptiform electrical brain activity

TREATMENT

MEDICATIONS

- Anticonvulsant medication
  - Clonazepam, valproate, levetiracetam; carbamazepine, oxcarbazepine, pregabalin, others contraindicated

STATUS EPILEPTICUS

osms.it/status-epilepticus

PATHOLOGY & CAUSES

- Medical emergency involving one acute prolonged seizure ≥ five minutes or multiple seizures occurring close together without recovery between

TYPES

- Convulsive status epilepticus (CSE)
- Nonconvulsive status epilepticus (NCSE)

CAUSES

- Epilepsy
  - Usually triggered by medication change/inadequate treatment
- Alcohol consumption/fasting while on anticonvulsant
- Acute cerebral injury
- Brain disorders
  - Brain tumors, brain injury, brain abscess, encephalitis
- Systemic process/illness
  - Uremic encephalopathy, hepatic encephalopathy
- Cerebrovascular disease
  - Intracranial bleeding, cerebrovascular insult
- Eclampsia

COMPLICATIONS

- Delayed treatment → irreversible neurological damage
- Prolonged muscle activity → hyperpyrexia, acidosis

SIGNS & SYMPTOMS

- CSE
  - Prolonged/repeated tonic-clonic seizures
  - Tonic phase (muscles stiffen and go rigid), followed by clonic phase (muscles rapidly contract, relax) → convulsions
- NCSE
  - Prolonged/repeated absence or focal impaired awareness seizure
  - Long-lasting stupor, staring; unresponsiveness

DIAGNOSIS

- Continuous seizure lasting > five minutes or recurrent seizures without regaining consciousness in between them for > five minutes

DIAGNOSTIC IMAGING

MRI/CT scan

- Detect structural brain abnormalities

LAB RESULTS

- Identify underlying cause

OTHER DIAGNOSTICS

EEG

- Detect abnormal, epileptiform electrical brain activity

TREATMENT

MEDICATIONS

- Immediate application of benzodiazepines followed by antiseizure drug phenytoin
- If uneffective
  - Valproic acid, phenobarbital, propofol, or ketamine

OTHER INTERVENTIONS

- Oxygen, intravenous fluids

TONIC-CLONIC SEIZURE

osms.it/tonic-clonic-seizure

PATHOLOGY & CAUSES

- Formerly called grand mal seizure
- Characterized by tonic (rigid) stage and clonic (convulsion) stage
- Most common seizure type
- May occur as one or multiple episodes as part of epilepsy disorder
- Can initiate in both brain hemispheres (generalized tonic-clonic seizure) or initiate in one and spread to both (focal to bilateral tonic-clonic seizure)
- Episode > five minutes → status epilepticus

SIGNS & SYMPTOMS

- May be preceded by unusual sensations, e.g. visual, auditory, olfactory hallucinations; dizziness (called an aura)
- Characterized by two phases
  - *Tonic phase:* rigid, stiffening muscles; contracting chest muscles → cry/groan; biting of tongue, cheeks
  - *Clonic phase:* muscles rapidly, rhythmically contract, relax; elbows, hips, knees bend, relax; urinary/fecal incontinence
- Tonic-clonic seizure → postictal state
  - Confusion, drowsiness, sleepiness, total amnesia for hours after seizure
- May be followed by Todd paralysis/paresis for minutes–hours following seizure

DIAGNOSIS

DIAGNOSTIC IMAGING

MRI/CT scan

- Detect structural brain abnormalities (brain tumors, vascular disorders)

LAB RESULTS

- Electrolytes; blood glucose, calcium levels
  - Identify possible underlying infection, genetic condition, metabolic disorder, other causes

OTHER DIAGNOSTICS

EEG

- Detect abnormal epileptiform electrical brain activity

TREATMENT

MEDICATIONS

- Antiepileptic medication
  - Valproate, lamotrigine, topiramate, phenytoin

SURGERY

- Surgical resection for brain tumors, vascular disorders