How To Interpret an EEG and its Report

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What is an EEG?

- An EEG is a scalp recording of brain wave activity.
- The brain wave activity recorded is a summation of the inhibitory and excitatory post synaptic potentials that occur across a neuron membrane.
That’s all good but how the heck do I read an EEG!?  

• First know what you are looking at on the screen.
  
  • 1. Montages
    • Electrodes
    • Channels
Different Montages allow you to see different things.

A Montage

aka referential montage

B Montage

aka Bipolar Montage
Bipolar Montage
2. Sensitivity
Sensitivity

• The gist… whatever voltage you decide to read at will see waveforms at that voltage or higher

• The lower the voltage the more you will see

• Read at the voltage that allows you to see the waveforms the best

• Usually at 7.5 microvolts
3. Filters
LF (Low Frequency) Filter

• The gist... whatever number you set it up at, the EEG will not amplify any frequencies below that number.

• Ex. LF filter set at 1.0Hz will not show on EEG any waves with a frequency below 1.0Hz.

• Usually LF filter is set at 1.0Hz
HF (High Frequency) Filter

- Just the opposite of LF filter. EEG will not display any frequencies above this designated number.

- Usually set at 35Hz
Notch (60Hz) Filter

• Special filter that sharply cuts off any activity at 60Hz and above.

• Current through plugs often is at 60Hz, allows you to get rid of outside artifact by other machinery in room.
Enough of the technical, can we please learn how to read the EEG!

• Break it down into steps:

1. **Background Activity** - gives you an overall sense of what is going on with the patient.
2. **Symmetry** – is there any focal changes seen.
3. **Stage of alertness**
4. **Abnormality** – slowing, sharp waves, triphasics, seizure, PLEDs, etc…. 
Background

– Gives you a sense of how the patient is doing
– Best evaluated in posterior channel, usually occipital
– Patient has to have eyes closed
– 4 different frequencies: delta, theta, alpha, and beta
Background Frequencies

- **Delta (marked slowing)**
  - 1-3Hz
- **Theta (mildly slow)**
  - 4-7Hz
- **Alpha (normal background)**
  - 8-13Hz
- **Beta (barbituates/benzos)**
  - >13Hz
Delta Frequency
Theta Frequency
Normal EEG

• Normal background activity (alpha frequency)
• No abnormalities (nothing stands out in the background)
• No changes in the EEG provoked by photic, hyperventilation
• No asymmetry
Asymmetries
Asymmetric Slowing

- Seen with focal lesions, surgery, etc.
- Easy to see with A montage
- Can be unmasked with hyperventilation or photic stimulation
Right Hemisphere Slowing

[Graph showing electroencephalogram (EEG) data with labels for various channels like Fp1-F7, F7-T3, T3-T5, T5-O1, Fp2-F8, F8-T4, T4-T6, T6-O2, T3-Cz, Cz-T4, Fp1-F3, F3-C3, C3-P3, P3-O1, Fp2-F4, F4-C4, C4-P4, P4-O2, OS, OD, and ECG.]

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PLEDs

- Stands for “Periodic Lateralized Epileptiform Discharges”
- Occurs throughout the entire EEG at a frequency of 1-2Hz
- Only in one hemisphere
- Seen usually in acute lesions (stroke, bleed, etc), postictal, Herpes Encephalites, CJD, etc
- Controversy over what they mean, nonconvulsive status or not?
PLEDs
A Little Aside on PLEDs

• The Boards/RITE exam loves PLEDs

• Usually on these tests, the answer is either CJD or Herpes Encephalites

• How to distinguish for exam, CJD usually associated with myoclonus, more subacute

• Herpes Encephalites usually associated with fever and more acute
Partial (focal) Status Epilepticus

• Status involving one hemisphere
• Patient may still be able to converse, appear awake during this type of seizure
• Don’t necessarily need to treat this type of seizure with anesthetics.
• Need to aggressively treat before becomes secondarily generalized Status.
Partial Status Epilepticus
Abnormalities

1. Epileptiform Activity
Epileptiform Activity

• Means the EEG reader saw some abnormalities that may be related to seizures but still needs clinical correlation

• Usually means EEG reader saw either sharp waves, spikes, or slow waves

• DOES NOT MEAN THE PATIENT IS ACTUALLY SEIZING DURING THE EEG!
Spike
Spike

- The duration of the abnormal wave is 70 microvolts or less.
- Stands out from the background.
- On Bipolar Montage, needs to have phase reversal to be real.
- Per Guru Dr. Shah, “If it looks like you would sit on it and it would hurt, it’s probably a spike”.

Sharp Wave

- Duration is 70-200 microvolts
- Again needs phase reversal on Bipolar EEG to be real
- Needs to stand out from background
- Also both sides of slope should be sloped, if straight on one side usually artifact
Slow Wave

- >200 microvolts
- Stands out from background.
2. Actual Seizures
Seizure Activity

• Not just epileptiform, actual seizures occurring during record
• EEG reader can tell if partial or generalized, status epilepticus, or consistent with primary generalized syndrome
• Seizure should be like a wave, should have a buildup and let down
• When EEG reader tells you this, you need to treat patient!
Partial Seizure (Temporal lobe onset)
Temporal lobe seizure cont...
Temporal lobe seizure cont...
Temporal lobe seizure w/secondary Generalization
Generalized Seizure
Generalized Seizure Ending...
Seizure Over, Postictal Slowing
3. Triphasic Waves
Triphasic Waves

• Usually indicates metabolic or toxic encephalopathy – usually liver failure or renal disease

• Patient always has some degree of encephalopathy-mild to moderate

• Can be seen with Cefepime encephalopathy, see this on EEG and patient on Cefepime, change antibiotic first

• Can be seen with Li intoxication
• Usually anterior dominant, diffuse, and bilaterally synchronous
• Has 3 phases to the waveform, negative, positive, negative
• Will have a lag anterior to posterior in wave 2 peak
• On RITE exam or Boards if shows EEG on A montage usually this is the answer
• Per Guru Dr. Shah, “Looks like a backward check mark.”
• Can be seen in seizures if rhythmic
Triphasic Waves
4. Primary Generalized Epilepsy
Primary Generalized Epilepsy

• Hereditary
• Generalized bursts of activity
• Often made worse with photic stimulation
• Tegretol and Dilantin can often make worse
• Need to distinguish from secondary generalized bisynchrony
• Again patient not actually seizing, but pattern seen in this type of epilepsy
Primary Generalized Epilepsy
Secondary Generalized Bisynchrony

• Generalized burst following a localized focal abnormal epileptiform waveform

• Not Primary Generalized Epilepsy
Secondary Generalized Bisynchony
5. Burst Suppression
Burst Suppression

• When spontaneous, very poor prognosis (ex. After hypoxic event, bad prognosis)

• Seen after a severe hypoxic event, postictal, anesthesia, and induced coma with meds

• When trying to stop status, you want good burst suppression for at least 24 hours before withdrawing meds
Burst Suppression
6. Brain Dead aka Electroencephalographic Silence
Electrocerebral Silence

- Special EEG protocol for diagnosis
- Essentially patient is brain dead
- Not performed very often anymore because very difficult to run EEG for required period of time without seeing some type of artifact that may be mistaken for brain activity
Electrocerebral Silence
7. Breech Rhythm
Breech Rhythm

• Seen over a skull defect, namely surgery
• Has the same frequency as rest of EEG, just higher amplitude
Breech Rhythm
8. Hypsarrhythmia
Hypsarrhythmia

• Seen in infantile spasms (West Syndrome)

• “chaotic” background, no true organized background

• Will have decremental appearance when child is actually having spasm
Hypsarrhythmia

Source: Semin Neurol © 2003 Thieme Medical Publishers
Hyparrhythmia with spasm
9. SSPE
(subacute sclerosing panencephalitis)
SSPE

• Encephalites that tends to affect young boys after had prior measles illness
• Mortality high and those that survive have intellectual sequelae
• First signs are often decreased school performance, beh. changes, followed by myoclonic seizures, and continued decline
• Different pattern than burst suppression, because in between bursts, background is not suppressed.
SSPE

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Source: Semin Neurol © 2003 Thieme Medical Publishers
Common artifacts that get Interns into trouble
Eye Blink Artifact

• Only seen in prefrontal channels
• If look at eye channel, waveform occurs at same time, just in opposite direction
Eye Blink Artifact
Muscle Artifact

- Too sharp to be real
- Patient usually agitated, moving
- If remove HF filter, gets even worse
Muscle Artifact

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EKG artifact

- Corresponds with the QRS complex on the EKG
- Usually looks like regular spikes transmitted throughout the EEG
Stages of Sleep

- Often times mistaken by interns as abnormal
- Best seen on bipolar montage in Cz channels
- K complexes, Vertex waves, Spindles
Spindles
K Complexes
Finally what do the words in the EEG report mean?

• **Epileptiform** – waveforms are seen that have the potential to cause seizures but clinical correlation still needed

• **Photic Stimulation** – provoking procedure done to induce primary gen. Epilepsy or assymmetries, **Driving response** means patient reacting normally to the stimulation, **No driving response** means, no EEG change with photic stimulation
EEG report continued…

• **Hyperventilation** – procedure performed to provoke primary gen. Epilepsy and provoke assymmetries, symmetric physiological slowing is normal

• **Stage 1 sleep** – Presence of Vertex waves and theta slowing during EEG

• **Stage 2 sleep** – presence of K complexes and sleep spindles with delta slowing during EEG

• **Drowsiness provokes epileptiform activity!** Why sleep deprived EEG is recommended to truly rule out seizure disorder.
Still more EEG report…

- **Diffuse slowing** – background is theta or delta frequency, seen with encephalopathic state, medication effect, postictal, dementia, bilateral structural defect.

- **Focal Slowing** – seen over lesions like tumors, stroke, hippocampal sclerosis, usually indicates structural lesion in area.

- If patient actually seizing the report will say seizure or status epilepticus.
EEG is Great!