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Why does a patient come to the epilepsy monitoring unit (EMU)?

The purpose of this handout is to provide medical students with a brief, general summary of the possible patient flow and treatments you will see with EMU patients.

What are the indications of an EEG?[1]	What are the indications of the EMU?[2]
• To determine whether a spell is truly epileptic or instead related to some other physiologic or psychogenic cause • To investigate whether an epileptic seizure was caused by an acute insult, provoked by other triggers, or related to a predisposition for recurrent, unprovoked seizures • To localize the origin of seizure activity • To determine treatment plan	• Differential diagnosis of paroxysmal spells • Characterization of seizure types • Presurgical epilepsy evaluations • Seizure quantification • Monitoring medication adjustment in a safe setting

What are some of the different types of EEGs I might hear about while on the EMU?

Routine[1]	Ambulatory[1]	Continuous[3]
• Take 20-30 minutes • Can be done with or without video • Often done with standard "activation procedures" i.e. photic stimulation, hyperventilation, and/or sleep deprivation	• Recorded in the outpatient setting or at home • Usually for about 1-3 days • Can be with or without video	• Prolonged video-EEG monitoring • Helps detect seizures, ischemia, and swelling in real time • Often done in ICU

During your time working on the EMU, you might also hear the terms "Phase I" or "Phase II" be used:

Phase I[4]

To determine if a patient is eligible for surgical management of their epilepsy, they will undergo a series of non-invasive techniques, including continuous video-EEG monitoring in the EMU, MRI, and neuropsychological assessment. If these results provide adequate localization of the epileptogenic zones and potential postoperative deficits, the patient is referred to surgery[4] (figure 1). If the patient is determined to have a diagnosis such as psychogenic nonepileptic seizures (PNES), then they will not be a candidate for surgery, and will be provided with a different form of treatment (figure 2). If there are ambiguous results concerning localization of the epileptogenic zone, further noninvasive testing may be applied, including:

- **Magnetoencephalography (MEG)[5]**

    - A direct measure of brain function via magnetic field generated by the electrical activity of neurons
    - Provides better spatial resolution of source localization (2-3mm) than EEG (7-10mm)
    - Usually combined with MRI to get a good structural perspective
    - Provides very accurate resolution of the timing of neuronal activity
- **fMRI**[6]
    - Maps the physiological or metabolic consequences of altered electrical activity in the brain
    - Used for localization of eloquent cortex (areas essential for carrying out basic neurological functions)[7] and to predict language as well as memory outcomes
- **FDG-PET**[4]
    - Topography of hypometabolism on PET shows strong correlation with extent of electroclinical network defined by clinical seizure semiology and EEG
- **Ictal SPECT (Single-photon emission computed tomography)**[4]
    - Provides information on changes of regional cerebral blood flow (rCBF) – which is considered a surrogate marker of increased neuronal activity – in the seizure onset zone
    - More blood flowing through an area creates brighter activity
- **Wada test**[8]
    - Helps determine which side of the brain language and memory abilities are located, and whether there will be changes to these areas if a patient were to have surgery
    - Performed by an epileptologist and neuroradiologist/interventional neurologist/neurosurgeon
    - During the procedure, half of the brain is put to sleep via an anesthetic medication through a catheter to the right or left carotid artery. The patient will temporarily lose ability to use the opposite side of the body, and their ability to speak and use their memory will be tested. After a few minutes, the epileptologist will ask the patient what they remember. The other side will then be tested

Figure 1

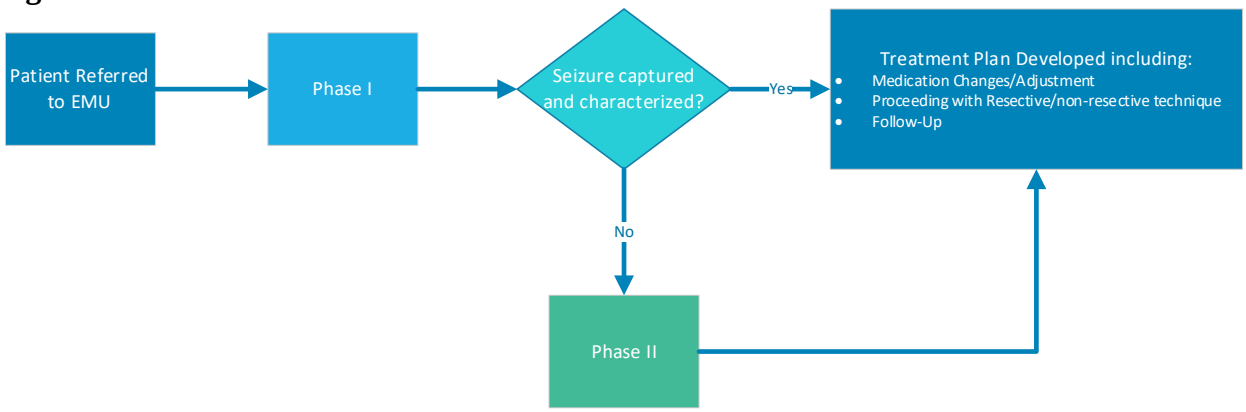

Figure 2

Phase II[9]

If the epileptogenic zone cannot be localized with non-invasive techniques, there are conflicting results, or if the epileptogenic zone is close to eloquent cortex, then the patient may undergo a phase II evaluation. In phase II, intracranial EEG is applied. Electrodes are directly implanted on and in the brain to localize where seizures are coming from. Similar to phase I, the patient will be recorded under continuous video-EEG. Anti-seizure medications may be weaned to better capture seizures. Once there is sufficient information, electrodes are removed. There are many methods for intracranial EEG, two more commonly used methods include:

- **Stereo EEG**
  - Uses 3D analysis of many contacts placed into the brain with stereotactic guidance with the aim of delineating the seizure foci and network of seizure propagation
  - Does not require craniotomy
- **Subdural grid/depth electrodes**
  - Placement of subdural grids and strips over suspicious areas of the brain
  - Great coverage of cortical surface and allow spatial contiguity in detecting ictal onset and immediate spread
  - Can be combined with one or more depth electrodes to see deep foci
  - Requires craniotomy

Surgical Techniques for Epilepsy Management[10]

Surgery for epilepsy is generally safe, with most complications being minor and transient. It is an option that can potentially convert drug-resistant epilepsy to drug responsive epilepsy, and can decrease burden of antiepileptic medication side effects. In regards to outcomes after surgery, approximately 60-65% of patients are seizure free after temporal lobe resection compared with

40% of patients with extratemporal resection. A brief summary of the surgical techniques for epilepsy management is provided below:

- **Resection**
  - The gold standard against which all other procedures are judged
- **Nonresective techniques**
  - **Laser interstitial thermal therapy**
    - If seizure is deemed resectable without significant decrease in neuropsychological function or damage to another eloquent area such as speech or motor, yet is difficult to get to with open surgery
    - Consider for a deep lesion, mesial temporal sclerosis, cavernous malformation
    - Retains the minimally invasive nature of the treatment while achieving comparable results to open resection
  - **Neuromodulation**
    - **Responsive neurostimulation (RNS)**
      - Implant electrode and stimulate that part, detect when seizures coming from that part and stimulate when seizures begin
    - **Vagus nerve stimulator (VNS)**
      - Considered when seizure onset zone is generalized or >2 foci
      - Can be for those who are not candidates for resection or laser
      - 60% of patients experience a significant response (>50% seizure reduction)

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