EEG IN ACUTE NEUROLOGY

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INTRODUCTION

An acute clinical neurology service requires acute EEG availability. Patients present to the Emergency Ward in altered states of consciousness, sometimes without obvious cause, secondary to subclinical seizure activity only diagnosable by EEG. As many as one-third of patients in a neurologic intensive care unit have been identified as having nonconvulsive seizures without clinical accompaniments.

WHEN TO CONSIDER AN EEG

1. If a patient is in an altered state of consciousness:

   A. Without a reasonable explanation from known iatrogenic (e.g., recent anticonvulsant drug loads), clinical, radiologic and metabolic parameters. (Note that a recent drug load may have converted overt seizures to subclinical.)

   B. Observe the patient and question the nursing staff for signs suggestive of seizures such as blinking, ocular jerks, limb twitches, tongue and lip movements, tachycardia, altered respiratory patterns. If there are clear clinical signs of seizure activity, perhaps with a correlation confirmed by a prior EEG, then these clinical signs can be followed for a evaluation of therapeutic efficacy and EEG monitoring is not entirely necessary.

2. If the patient had an observed seizure and is not regaining full consciousness quickly enough.

   A and B above.

3. Episodes of altered consciousness of uncertain etiology:

   A. Obtain a detailed, second by second clinical history of onset. If not clearly cardiac in origin, an EEG might show interictal epileptiform abnormalities which suggest a seizure disorder (or the EKG monitor channel might show a cardiac arrhythmia or QT prolongation).

   B. This application does not necessarily require an acute EEG. Also, consider a 24-48 hour ambulatory EEG to catch a spell; the patient should be having about one per day to make this worthwhile.

4. Iatrogenic coma monitoring (for status epilepticus and increased ICP):

   Complicated topic. See Appendix on burst-suppression monitoring.

5. Brain death:

   A. When performed and interpreted properly (requires a certified/trained technologist), no false positivies or negatives.
B. All waveforms present > 2 microvolts must be explained with respect to origin.

C. The wording of the EEG interpretation is “Electrocerebral inactivity” (silence) which may have several etiologies. Brain death is a clinical diagnosis.

D. A flat EEG in the presence of hypothermia, as long as temp >92F, is consistent with brain death.

E. A flat EEG in the presence of CNS depressant medications (usually anticonvulsants), as long as blood levels are not above the middle therapeutic range, is consistent with brain death.

6. Peculiar events:

A. Clinical events which are not easily identifiable as seizures. Consider a video-EEG so that the electro-clinical correlation can be determined. If no video, a nurse or family member can help by making a note on the EEG machine when an event occurs. Video may help to judge the contribution of artifacts to EEG picture and allow detailed study of the clinical event.

HOW TO OBTAIN THE EEG

1. Get the technologist to do it.

A. Coordinate the arrival of the EEG tech with other tests such as CAT scan and MRI.

B. Help the technologist to define the test parameters according to the information desired:

I. Will this likely be a long-term recording? This affects the choice of electrode application method, tape or collodion.

II. Is it for burst-suppression monitoring? Only 2 channels (4 electrodes) on each side of the head will suffice.

III. Has the patient had a prior EEG which showed the epileptiform activity which is to be monitored? This will allow definition of a restricted number of electrodes and recording channels which will simplify the patient setup and the subsequent interpretation of the EEG, "double-distance" electrode set.

C. Paper vs digital vs digital with seizure detection software.

I. If burst-suppression monitoring or evaluating relatively prolonged clinical states, paper might suffice. If discrete events are the clinical question, the paper machine will not be running when the event happens.

II. If discrete events, a standard digital machine storing to disc will save all the data but someone (MD, nurse, family member or friend) must note exact time of event on EEG machine so that review of EEG can be correlated with clinical event.
III. If discrete events but no one to note time, or no clear clinical appearance, or amount of seizure activity to be determined, consider EEG with automated seizure detection algorithms.

IV. Consider video-EEG to allow detailed study of clinical events and correlation with artifacts.

D. Who is going to be responsible for the EEG recording and make sure that the desired answers are obtained, and/or who is going to make use of the data and how? Organize someone (MD, nurse, family, friend) to make notes on EEG machine or take times or diary of significant events. The more clinical information that there is correlated with the EEG, the better the answer that can be provided. If monitoring seizure activity or burst-suppression patterns, who will review the EEG, how often, and how will they react to changes in the EEG?

2. Do it yourself.

A. An acute clinical neurology service requires acute EEG availability. Many hospitals find it too much trouble, too expensive or cannot find personnel to have an on-call EEG technologist. So, if you want to do a good clinical job, there are times when there might be no alternative to doing it yourself. You might have to learn how to perform it and interpret it competently. Possible legal ramifications both ways.

B. Hairline montage. This is OK but misses the seizure activity in about 10% of patients because the seizure activity is parasagittal/midline, usually parietal, and there are no nearby electrodes. Thus, if the hairline montage does not show seizure activity, you have to decide whether to add more electrodes or accept the 10% false negative rate.

C. The EEG Lab is completely willing and able to give you instruction on electrode application and running the EEG machines, and has in the past. We also can provide easy access to a fully equipped, resident-ready, EEG machine during the times that the EEG Lab is closed. The tech on-call can give assistance over the telephone and the Epilepsy Fellow and staff person can assist with EEG interpretation by telephone and fax of pages of the EEG.

**WHAT TO LOOK FOR**

1. Is it artifact or real brain activity?

A. Is it time-locked to patient activities such as blinking, chewing, head or limb movements, myoclonic jerks, EKG (pulse artifact mimics PLEDs), respirator, other bedside machines? Observe in tandem, one watching EEG machine, the other watching the patient/machine and calling out events. Use head movement monitors (piezo-electric).

B. Is it muscle artifact? Very dense spikes of very short duration. Be sure that high filter is at 70 Hz otherwise muscle activity is rendered into more sinusoidal beta activity. Artifact from myoclonic activity almost always makes it impossible to know if there is a visible scalp EEG accompaniment (there must be at some level of the CNS, but the area of involved cortex might be too small - less than 1 sq. inch - to produce enough of an electric field to be visible through skull and scalp). Consider a muscle relaxant to clarify these issues.

2. Is it electrographic seizure activity?
A. Repetitiveness. The more evenly spaced are the discharges, the more likely it is to be a seizure. Repetitive slow waves may be a seizure discharge.

B. Rhythmicity. The more rhythmic are the discharges, the more likely it is to be a seizure. Rhythmic slow waves may be a seizure discharge.

C. Organization. A seizure has structure, with a beginning, often leading into a gradual increase in amplitude and frequency, followed by a period of gradual decrease in amplitude and frequency. The event should last at least 10 secs to be considered an electrographic seizure.

D. These are difficult determinations and EEGers differ among themselves. It may help to print out the event or a few minutes of the EEG and spread it out so that you can see the whole thing at once, even by walking along it, to be best able to appreciate the main EEG features of an event. Adding electrodes might also help (double-distance to full-head).

3. Patterns of controversial and uncertain significance:

A. PLEDs (periodic lateralized epileptiform discharges). These have a natural history in which they will usually disappear after a few days and they are very difficult to abolish with medications, usually requiring infusions. The majority of patients with PLEDs will have a clinical seizure during their hospital course so that they should be on routine levels of an anticonvulsant. Some regard PLEDs as a form of status and treat as such; presently we do not except in special circumstances.

B. Post-anoxic EEGs. These may have PLEDs, BiPLEDs or a burst-suppression EEG. The presence of any of these more than 12 hours after the incident (absent CNS-suppressant medications) indicates a very poor prognosis. There is no evidence to indicate that suppression of these improves prognosis; use high therapeutic level of a single anticonvulsant as a reasonable compromise.

THINGS TO THINK ABOUT BEFORE REQUESTING AN EEG AT NIGHT

1. Consult with the Epilepsy/EEG Fellow. Any disagreements can be discussed with ward and epilepsy staff.

2. Can it wait another hour or few until the EEG laboratory opens for business as usual at 8 am?

A. If the patient is recovering from a seizure but too slowly, will the delay affect outcome?

B. Are there clinical signs of seizure activity which can be followed?

C. It might take the technologist 2-3 hours to start the EEG in any case.

D. Try to schedule other tests, e.g., CAT scan, MRI, so that the technologist doesn’t arrive to find the patient at those other tests for 2 hours.

3. Will the results of an emergent EEG change your immediate plans? For example, if a patient is anesthetized without any plan to discontinue the anaesthetic until morning, an EEG could be deferred until after 8 AM. Remember that there is no good data correlating the depth of anaesthesia with outcome, so an urgent desire for an EEG to titrate the anaesthetic is difficult to justify.
4. If the patient already has electrodes attached and is being monitored and needs to go for a CT or MRI (when the electrodes will need to be removed) in the middle of the night, can the CT or MRI be delayed until 4 or 5 am so that the electrode replacement can be accomplished after 8 am? The pentobarb level required to affect prognosis is completely unknown so that, if the patient has been on pentobarb for some time, the approximate necessary regimen will be well known and following this for several hours without EEG is perfectly reasonable. Even if the patient is newly on pentobarb, the role of EEG is uncertain.

EEG Laboratory
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