Electroencephalography (EEG)

EEG refers to the recording of brain's spontaneous electrical activity over a short period of time, as recorded from multiple electrodes placed on scalp.

- It reflects summation of synchronous activity of thousands or millions of neurons that have similar spatial orientation.
- Pyramidal neurons of cortex produce most EEG signal because they are well-aligned & fire together.
- Activity from deep sources is more difficult to detect than that near the skull.

Clinical use (Indication):

i. The main diagnostic application is epilepsy:
   - To distinguish epileptic seizures from other types of spells, such as psychogenic, syncope, sub-cortical movement disorders & migraine variants.
   - To characterize seizures for the purposes of treatment.
   - To localize region of brain from which a seizure originates for possible seizure surgery.
   - To determine whether to wean anti-epileptic medications.

ii. A secondary clinical use is:
   - In the diagnosis of coma, encephalopathies, & brain death.
   - Monitor certain procedures e.g; the depth of anesthesia.
   - Used in intensive care units for brain function monitoring.

INSTRUCTIONS FOR PATIENT:
1) Wash your hair and scrub the scalp thoroughly. Do not apply hair oil, gels or sprays.
2) Continue your normal medications and bring a list of medications with you.
3) Continue normal diet. Attempt to eat a meal within two hours of your scheduled test.
4) Do not drink caffeinated beverages on the day of your test. No alcoholic beverages within 48 hours prior to testing.
5) The night before the test stay up until 1:00 a.m., and sleep until 5:00 a.m. (4 hours sleep). After waking at 5:00 a.m., stay awake until your test time. PLEASE NO NAPS
6) After the test it will be advisable to wash your hair again when you return home to insure all of the paste is removed before it has a chance to dry on the scalp. (You might want to bring a scarf or hat to wear when leaving the testing center).

Method

- Computerized methods now exist.
- A routine clinical EEG recording typically lasts 20–30 minutes (plus preparation time) & usually involves recording from scalp electrodes.
- In conventional scalp EEG, recording is obtained by placing electrodes on scalp with a conductive gel or paste.
- Electrodes are typically placed on scalp using a standardized method called 10-20 system, which is named by their location: F, frontal; C, central; P, parietal; T, temporal; Fp, frontopolar; O, occipital.
- They are numbered with odd numbers over the left hemisphere, even numbers over the right, and z referring to the midline.
- Electrode contact must be firm in order to ensure low impedance.
- Connect patient to one common ground to avoid artifact & improve signals.
During recording, a series of activation procedures are used. These procedures may induce abnormal EEG. These procedures include hyperventilation, photic stimulation, eye closure, mental activity, sleep & sleep deprivation.

Hyperventilation is a method of “activating” EEG.

- It should not be performed in very elderly patient or in pt suspected of having any intracranial mass lesions or a recent transient ischemic event/stroke.
- In adult, it is normal to hyperventilate the patient for 3 - 5 min. This act causes the subject to exhale excessive amounts of CO2 & become hypocapnic → mild cerebral vessel vasoconstriction → mild cerebral hypoxia.
- Hypoxia & hypocapnia potentially can produce changes that signal a disorder.

In case of inpatient epilepsy, monitoring is done by Video EEG.

- Normal EEG varies by age. Neonatal EEG is quite different from adult EEG.
- EEG in childhood generally has slower frequency oscillations than adult EEG.
Principle of registration

- EEG curve is registered/recalculated as the difference of electric potentials between two electrodes (varying in the course of time)
- derivation = recording from a pair of electrodes (two electrodes are connected to a single amplifier, to one EEG channel)
  - bipolar
  - monopolar

EEG Reading

- Morphology
- Amplitude
- Frequency

**EEG reading: morphology (wave shape)**

**EEG reading: amplitude**

- voltage in microvolts
- a peak-to-peak measurement
- compared with the calibration signal
- commonly 20 -100 μV (in normal EEG)
- amplitude changes may be pathological

**EEG reading: frequency**

- the rhythmic EEG activity is classified as:
  - delta - less than 4 Hz
  - theta – 4 to 8 Hz
  - alpha – 8 to 13 Hz
  - beta – more than 13 Hz
Normal rhythms

- **Alpha rhythm**
  - sinusoidal waves (8-13 Hz)
  - maximal over the posterior head region (occipitally)
  - occurs during wakefulness and relaxation
  - best seen with the patient’s eyes closed
  - Blocked or attenuated with eye opening.

- **Beta rhythm**
  - is not prominent
  - has low amplitude
  - is best seen frontally
  - not affected by eye opening

- **Theta rhythm**
  - a small amount, of low amplitude, frontally
  - accompanies drowsiness

- **Delta rhythm**
  - is normal during deep sleep
  - is normal in childhood
  - is abnormal in the other cases

Artifacts

- **Biological artifacts** Electrical signals detected along scalp by EEG, originate from non-cerebral origin.
  - Eye-induced artifacts (eye blinks & eye movements).
  - ECG (cardiac) artifacts
  - EMG (muscle activation)-induced artifacts
  - Glossokinetic artifacts (tongue movement).

- **Environmental artifacts**; originate from outside the body.
Clinical Physiology                           Electromyography / Electroencephalography (EMG/EEG)

EEG device

Pt connected to EEG electrodes
Interictal patterns in epilepsy – local focus:

Interictal patterns in epilepsy – generalized: