Electroencephalogram (EEG) in a Neuropsychiatry clinic, questions you are too embarrassed to ask!

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Disclosures

- No conflicts of interest
Outline

- History and basic elements of EEG signal
- EEG in epilepsy
- EEG in neurology
- EEG in psychiatry

History of EEG

- 1791 Galvani nerve tissue has intrinsic electrical activity
- 1875 Caton records brain potentials from cortex
- 1883 Marxow discovers evoked potentials
- 1929 Berger records electrical activity from the skull
Strength and Advantages of EEG

- Is a measure of brain electrical function; supplement neuroimaging studies
- Provides direct rather than indirect evidence of epileptic abnormality
- May be the only test that shows abnormalities in epileptic patients
- Provides some spatial or localization information
- Low cost
- Low morbidity
- Readily repeatable
- Portable / ambulatory

The International 10/20 System

- **Nasion**: point between the forehead and the skull
- **Inion**: bump at the back of the skull
- **Location**: Frontal, Temporal, Parietal, Occipital, Central
  - z for the central line
- **Numbers**: Even numbers (2, 4, 6) right hemisphere, odd (1, 3, 5) left
EEG in the States of Vigilance

Frequency Ranges

**Beta:** 14 – 30 Hz  
**Alpha:** 8 – 13 Hz  
**Theta:** 5 – 7 Hz  
**Delta:** 1 – 4 Hz

- Interictal EEG is **NOT** a diagnostic test for epilepsy!
- Prevalence of interictal epileptiform discharges in non-epileptic subjects:
  - 0.5% healthy adults
  - 2% - 4% healthy children
  - 10% - 30% cerebral pathologies (i.e. tumor, congenital brain injury, cranial surgery)
- Temporal lobe status (Gastaut 1956)
- Generalized vs. Focal non-convulsive status
- Continuous form vs. Cyclic form (partial responsiveness)
- Temporal type vs. Extra-temporal type (impairment of consciousness, speech disturbances)
Psychiatric manifestations of nonconvulsive status epilepticus
Riggio S

- Steroid-responsive encephalopathy associated with autoimmune thyroiditis (SREAT/Hashimoto)
- Autoimmune (NMDAR Ab)
- Paraneoplastic (Caspr2 Ab)

The Landolt’s phenomenon

“Forced Normalization is the phenomenon characterised by the fact that, with the occurrence of the psychotic states, the EEG becomes more normal or entirely normal as compared with previous and subsequent EEG findings”

Hans Landolt (1917 – 1971)
ILAÉ Vice - President 1965-1969
The Nature of Aggression during Epileptic Seizures

Antonio V. Delgado-Escueta, M.D., Richard H. Mattson, M.D., Lambert King, M.D., Eli S. Goldensohn, M.D., and Herbert Spiegel, M.D., Jack Madsen, M.D., Paul Crandall, M.D., Fritz Dreifuss, M.D., Roger J. Porter, M.D.

- 1:1000 seizures

- Aggressive conduct towards nearby objects/persons

- Violent motor automatisms misinterpreted as threatening or assaultive

- Full amnesia and profound remorse
a) An established diagnosis of epilepsy

b) The video-EEG documentation of epileptic automatisms

c) The video-EEG documentation of the aggressive behaviour

d) The aggressive act should be characteristic of the patient's habitual seizures

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- EEG is NOT helpful for:
  - Specifying aetiology
  - Distinction between acute and chronic processes
  - Early detection of dementia

- Periodic patterns:
  - FIRDA (Frontal Intermittent Rhythmic Delta Activity)
  - PLEDs (Periodic Lateralised Epileptiform Discharges)
  - TW (Triphasic Waves)
Electroencephalographic Cerebral Dysrhythmic Abnormalities in the Trinity of Nonepileptic General Population, Neurobehavioral Disorders

<table>
<thead>
<tr>
<th>Disorder</th>
<th>EEG abnormalities</th>
<th>N papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schizophrenia</td>
<td>20% - 60%</td>
<td>10</td>
</tr>
<tr>
<td>Mood disorders</td>
<td>20% - 40%</td>
<td>18</td>
</tr>
<tr>
<td>Panic attack</td>
<td>25% - 30%</td>
<td>8</td>
</tr>
<tr>
<td>Borderline personality disorder</td>
<td>6.3% - 46%</td>
<td>11</td>
</tr>
<tr>
<td>Antisocial personality disorder / Violent behaviour</td>
<td>24% - 78%</td>
<td>20</td>
</tr>
<tr>
<td>PNES without epilepsy</td>
<td>12.3% - 53.8%</td>
<td>11</td>
</tr>
</tbody>
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Confounders:
Psychotropic drug treatment; Hx alcohol and substance abuse; Hx brain insults; Multiple head injuries

Usefulness of screening EEGs in a psychiatric inpatient population
Warner MD, Boutros NN, Peabody CA

698 psychiatric inpatients:

- EEG abnormal 31%
- Change in diagnosis because of EEG 1.7%
- QEEG
- Low Resolution Electromagnetic Tomography (LORETA)
- Event related potentials (ERP)

- Distinguish between dementia and depression
- Distinguish between schizophrenia and mood disorders
- Distinguish between environmentally induced and endogenously mediated behavioural disorders
- POOR EVIDENCE!

Psychotropic drugs and seizures
The Chronology

- **1952 Chlorpromazine**

- **1958 Imipramine**
  - Blair D. Treatment of severe depression by imipramine: an investigation of 100 cases. J Ment Sci 1960; 106: 891-905
EEG changes with TCAs

- Redding FK. EEG activation with amitriptyline. Electroencephalogr Clin Neurophysiol 1969; 26: 630-6

Drugs modifying dopaminergic activity and behaviour, the EEG and epilepsy in papio papio.

Meldrum B, Anlezark G, Trimble M.
EEG alterations and seizures during treatment with clozapine. A retrospective study of 283 patients.
Gunther W, Baghai T, Naber D, Spatz R, Hippius H

680 EEGs 593 pts
- EEG abnormalities:
  - Clozapine 59%
  - Lithium 50%
  - Haloperidol 44%
  - Maprotiline 37%

- GTCS over 3.5 year FUP period:
  - 1% clozapine
  - <0.5% other medications
Psychotropic drug-related seizures
Risk factors

- Patient-related
  - Hx of epilepsy
  - Family Hx of epilepsy
  - Brain disorder (post-natal brain damage, head injury, dementia)

- Treatment-related
  - High-dose or overdose
  - Rapid titration
  - Abrupt withdrawal of other drugs (i.e. benzodiazepines or antiepileptic drugs)
  - Pharmacodynamic interactions (i.e. effect on seizure threshold)
  - Pharmacokinetic interactions (i.e. inhibition -> overdose/high-dose)

Stimmel & Dopheide CNS Drugs 1996; Mula et al. Expert Opin Pharmacother 2004
Pharmacovigilance
Definitions

- **Adverse event** (temporally related but not necessarily casually related)
- **Adverse reaction** (noxious and unintended; occurring at normal doses)
- **Unexpected adverse reaction** (not consistent with drug information)
- **Serious adverse reaction** (any untoward medical occurrence that at any dose results in death, hospitalization or prolongation of existing hospitalization or persistent of significant disability or incapacity)
- **Side effect** (unintended; occurring at normal doses; biologically plausible)

Evidence for seizures as side effects of antidepressants?

- Accurate time frame
- Evidence for biological gradient (dose-dependency)
- Evidence for a biological mechanism
- Increased prevalence of seizures in the exposed population

  - Mostly
  - Established for:
    - Clomipramine/amitriptyline
    - Maprotiline
    - Bupropion (IR vs XR)
    - Clozapine

  - Established for maprotiline
  - Established for:
    - Clomipramine/amitriptyline
    - Maprotiline
    - Bupropion (IR vs XR)
    - Clozapine
Conclusions

- Low cost, low morbidity, non-invasive, easily repeatable
- NOT for diagnosis, aetiology, distinguish between acute and chronic, screening purposes
- Specific question/indication
- Should be always part of routine investigations for:
  - Acute confusional state
  - Cognitive, attentional and developmental disorders in children