CLINICAL EEG: AN **INTRODUCTION**

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EEG IS....



The recording of electrical activity along the scalp produced by the firing of neurons within the brain.

IMMENSELY USEFUL IN ASSESSING-

- Seizures / pseudoseizures
 - Helps to classify seizures
 - Aids the decision on drug discontinuation
- Delirium
- Coma / dissociative stupor

THE LANGUAGE OF EEG

Electrode Channel

Montage

Sensitivity

ELECTRODE POSITIONS IN Routine EEG



CHANNELS

FP2-A2 .







EXAMPLE OF A BIPOLAR MONTAGE

EXAMPLE OF A MONOPOLAR MONTAGE







FP2-A2
F4 - A2
C4 - A2
P4 - A2
02-A2
F8 - A2
T4 - A2
T6-A2
FP1-A1
FP1-A1 F3-A1
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EXAMPLES OF MONTAGES







CHANGING MONTAGE

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### SENSITIVITY



### SENSITIVITY



# NORMAL EEG



### **ALPHA WAVES**



### ALPHA WAVES (9 HZ)

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### ALPHA WAVES (11.5 HZ)



### THETA WAVES



### THETA WAVES (5 HZ) IN A SLEEPING CHILD



## **DELTA WAVES**



# **WARNING** Presence in awake adults indicate brain damage.

### **DELTA WAVES IN A SLEEPING INFANT**



### HIGH AMPLITUDE DELTA WAVES IN A Sleeping Child



### **BETA WAVES**



### **BETA WAVES BY PHENOBARBITONE (15 HZ)**

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# SLEEP

## **STAGE 1 SLEEP (N1)**

• Decrease in amplitude of waking alpha rhythm

## STAGE 1 SLEEP – SLIDE 1

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## STAGE 1 SLEEP – SLIDE 2



## **STAGE 2 SLEEP (N2)**

# Sleep spindles

K-complexes

### **SLEEP SPINDLES**



### **K COMPLEXES**



## **SLOW WAVE SLEEP (N3)**

 Delta waves (0.5–2 Hz) occupy more than 20% of the background.

## **SLOW WAVE SLEEP (N3)**



## INTERICTAL EPILEPTIFORM DISCHARGES: GENERALIZED

### Spikes

• <70 msec in duration</p>

### Sharp waves

• 70-200 msec in duration


#### GENERALIZED SPIKE-AND-WAVE DISCHARGES IN SLEEP



#### GENERALIZED POLYSPIKE-SLOW WAVE DISCHARGES IN SLEEP



## GENERALIZED SHARP AND SLOW WAVE COMPLEXES



### **GENERALIZED SHARP WAVES**



### GENERALIZED IEDS AND PSYCHIATRY

- Forced normalization
- Clozapine can produce epileptiform abnormalities
- In ADHD, IEDs might increase the risk for seizures with Methyl Phenidate.

## IN TERICTAL EPILEPTIFORM **DISCHARGES:** FOCAL

### LOCALIZATION TECHNIQUES: MONOPOLAR MONTAGES

• Note the electrode which records the highest amplitude of the abnormal pattern.

#### **LOCALIZATION IN A MONOPOLAR MONTAGE**



### LOCALIZATION TECHNIQUES: BIPOLAR MONTAGES

- Look for two adjacent channels with opposite phases (**phase reversal**).
- The electrode common to those channels gives the localization of the abnormality.

#### **PHASE REVERSALS**



#### **LOCALIZATION TO P3 IN MONOPOLAR MONTAGE**



#### **LOCALIZATION TO P3 IN BIPOLAR MONTAGE**



#### LIKELIHOOD OF SEIZURES WITH Focal epileptiform Discharges

Temporal

• 91%



## FOCAL IEDS & PSYCHIATRY

- Some evidence exists that argues for cognitive, behavioral, or emotional disturbances associated with paroxysmal discharges.
- Spikes can be found in psychiatric patients with no obvious seizure manifestations.
- Presence of episodic aberrant behavior (particularly explosive aggressiveness) in such cases may be empirically treated with a trial of anticonvulsants.

Boutros, N.N., Iacono, W.G., & Galderisi, S. (2009). Applied electrophysiology. In Sadock, B.J., Sadock, V.A., & Ruiz, P. (Eds.), Kaplan & Sadock's *Comprehensive textbook of psychiatry*, V. 1, Ninth Edition (pp. 211-248). Baltimore: Lippincott, Williams, & Wilkins.

## SLOWING

#### **FRONTAL DELTA WAVES**



# **SLOWING & PSYCHIATRY**

- Diffuse slowing can be present in drug toxicities, hypothyroidism, electrolyte imbalance, etc.
- Dissociative stupor will usually have a normal EEG that will show responsiveness to visual or auditory stimuli.
- After five sessions of ECT diffuse slow waves are often seen.

## EEG AND DELIRIUM

- In hyperactive delirium, EEG is often helpful in indicating whether the cause is:
  - A diffuse encephalopathic process
  - Nonconvulsive status epilepticus
  - A focal brain lesion
- EEG is particularly useful in diagnosing hypoactive delirium

Boutros, N.N., Iacono, W.G., & Galderisi, S. (2009). Applied electrophysiology. In Sadock, B.J., Sadock, V.A., & Ruiz, P. (Eds.), Kaplan & Sadock's *Comprehensive textbook of psychiatry*, V. 1, Ninth Edition (pp. 211-248). Baltimore: Lippincott, Williams, & Wilkins.

## EEG AND DELIRIUM...

- Patients with delirium shows slow activity, except in delirium tremens, which often is associated with a fast activity.
- If abnormal slow activity is found in a patient with DT, consideration should be given to a Wernicke encephalopathy or to a hepatic disorder.
  - Hughes JR. (1996) A review of the usefulness of the standard EEG in psychiatry. Clin Electroencephalogr, 27(1), 35-39.
  - Kelley JT, Reilly EL: EEG, alcohol, and alcoholism, in EEG and Evoked Potentials in Psychiatry and Behavioral Neurology, edited by Hughes JR, Wilson WP. London, Butterworth, 1983, pp 55–77
  - American Psychiatric Association Practice Guidelines for the Treatment of Delirium.

## ACTIVATION Procedures

### **ACTIVATION PROCEDURES**

- Sleep deprivation
  - Partial
  - Total
- Hyperventilation
- Photic stimulation

#### **NORMAL, SYMMETRICAL SLOWING DURING** HYPERVENTILATION



#### GENERALIZED SPIKE-AND-WAVE DISCHARGES DURING HYPERVENTILATION



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#### SHARP WAVES, SPIKE-AND-WAVE DISCHARGES, AND SHARP AND SLOW WAVE COMPLEXES DURING PHOTIC STIMULATION



### YIELD-ENHANCING TECHNIQUES

- Minimization of confounding variables (e.g., medications)
  - Anticonvulsants may be withdrawn prior to EEG studies in patients suspected of having pseudoseizures.
- A patient should not fast before an EEG because hypoglycemia can influence a tracing.

# ARTIFACTS

### **ECG ARTIFACTS**



#### **MOVEMENT ARTIFACT**



#### **EYE MOVEMENT ARTIFACT**



#### **ELECTRODE MOVEMENT ARTIFACT IN FP2**

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#### **SINGLE ELECTRODE ARTIFACT: P4**



## SOME TAKE Home points

- A normal EEG never excludes any clinical condition.
- Perhaps 10-15% of normal subjects show some abnormality on EEG.
- As many as 64 68% of EEGs in psychiatric patients provide evidence of pathophysiology.
- The thoughtful integration of EEG data with material from clinical history and examination is fundamental to the EEG remaining a useful component in a psychiatric diagnostic armamentarium.


## **SPIKES IN RIGHT CENTRAL REGION**

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- VFP2-A	2 ~~~			$\sim$	m	h		~~~	~~~	m		h	$\sim$	$\sim$	~~~		harring	~~~	~~~	~~~
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## **SINGLE ELECTRODE ARTIFACT: F4**



#### **SHARP WAVES FROM RIGHT FRONTAL REGION**

🤝 542 L	BY JOSEPH	27/M	RecTime(0	0:38:42)	TestTime(1	5:58:15)	Chs:1/16	Page:233/295			- 7 🛛
File Option	ns Show Brit	Param <b>Sc</b>	roll Events T	Tabs Tools	M:MONOPOLA	R3(R) Sn:10	uV/mm Sw:30 mm	/s L:1.0 Hz H:15 H:	z N:50 Hz Emg On I	Help	
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)O:Time/Ev	00:38:	43	00:38:44	00:3	38:45	00:38:46	00:38:47	00:38:48	00:38:49	00:38:50	00:38:51
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# **BIFRONTAL SHARP WAVES**



### SHARP AND SLOW WAVE COMPLEXES FROM LEFT FRONTAL REGION



