

EEG patterns in Encephalopathy

Dr.Pasiri Sithinamsuwan

Division of Neurology
Department of Medicine
Phramongkutklao Hospital

Scope

- Diffuse encephalopathy
- EEG in specific encephalopathies
- Encephalitides & degenerative encephalopathies

EEG in adult patients with Diffuse encephalopathy

Diffuse encephalopathy

- Common
- Clinical varieties
- Causes
 - Metabolic
 - Septic
 - Toxic
 - Anoxic

EEG in diffuse encephalopathy

- General concepts
 - Diffuse or generalized abnormalities
 - The most common = slowing (< 8 Hz)
 - Adult: more frontal (anterior)
 - Children: more occipital (posterior)
 - No specific patterns for any etiologies
 - Serial EEG
 - Diagnosis, prognosis and Rx assessment

EEG patterns in diffuse encephalopathy

- Common pattern
- More severe pattern
- Less common pattern

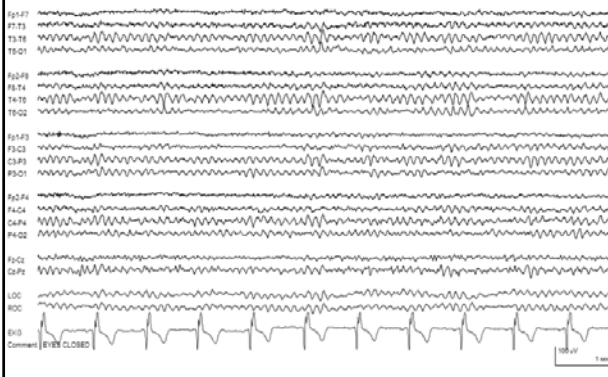
Common EEG patterns

- Generalized slowing
 - Background slowing
 - Intermittent slowing
 - Continuous slowing

Background slowing: mild severity



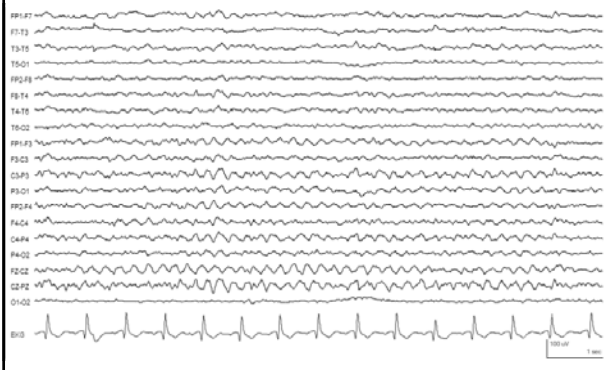
Slow posterior basic rhythm



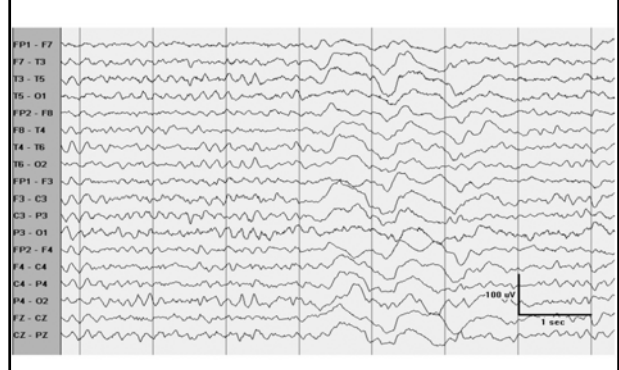
Intermittent slowing: moderate severity

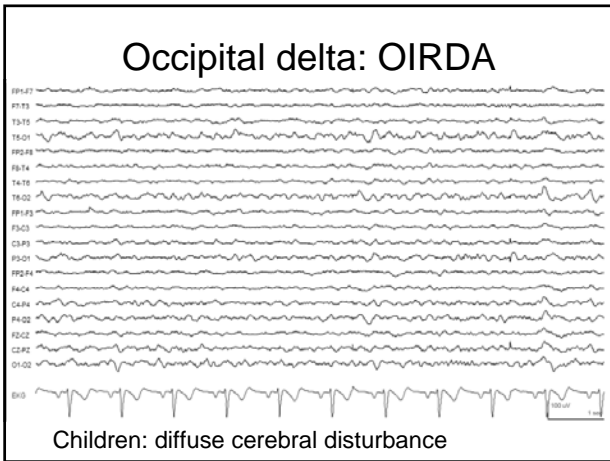
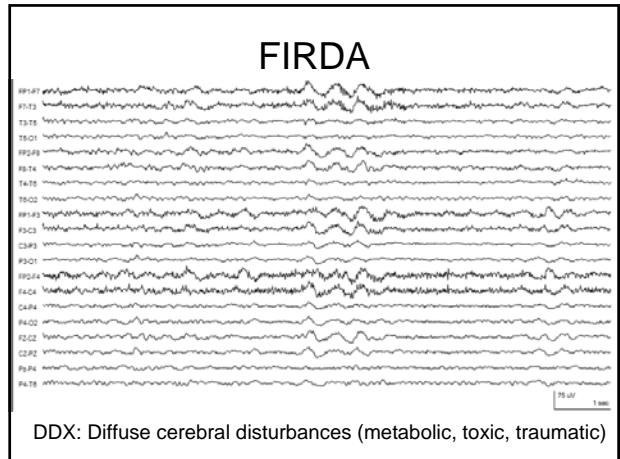
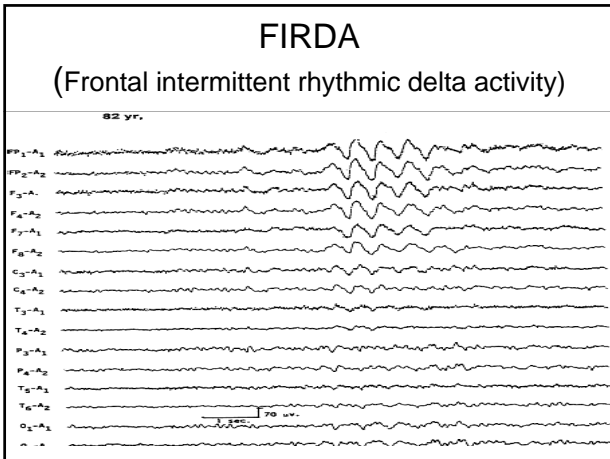
- Posterior dominant background and reactivity
- Burst of high amplitude rhythmic generalized slowing
 - Polymorphic delta
 - Intermittent burst of theta
- FIRDA
 - Frontal intermittent rhythmic delta activity
- OIRDA
 - Occipital intermittent rhythmic delta activity

Intermittent central theta



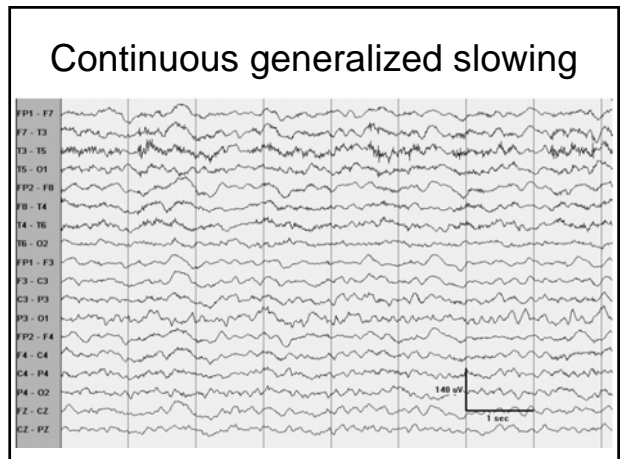
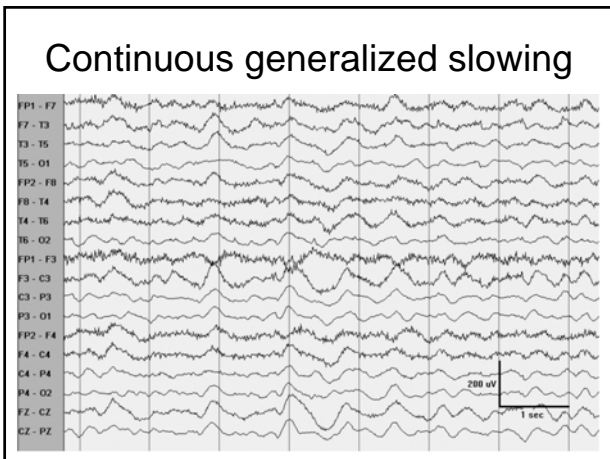
Burst of generalized slowing



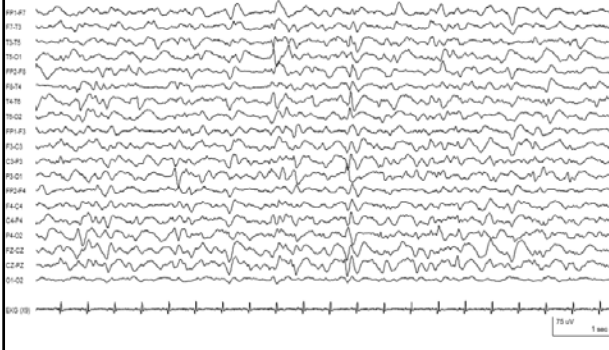


Continuous slowing: severe severity

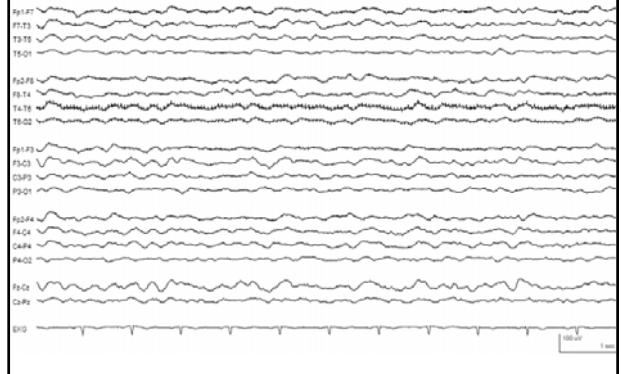
- Polymorphic delta activity (PDA) > 80%
- No posterior dominant background
- No reactivity
- Very severe case: low amplitude delta activity



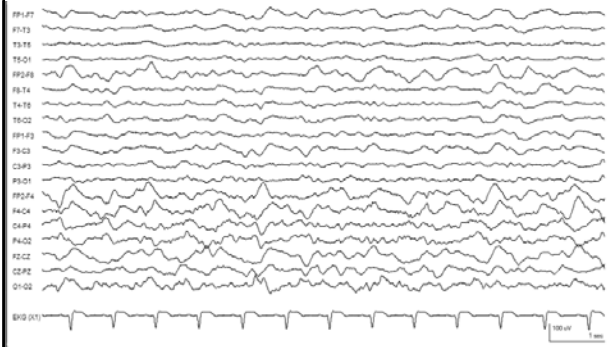
Severe encephalopathy with epileptic



Generalized slowing



Generalized and focal slowing



i.e. brain tumor and increased intracranial pressure

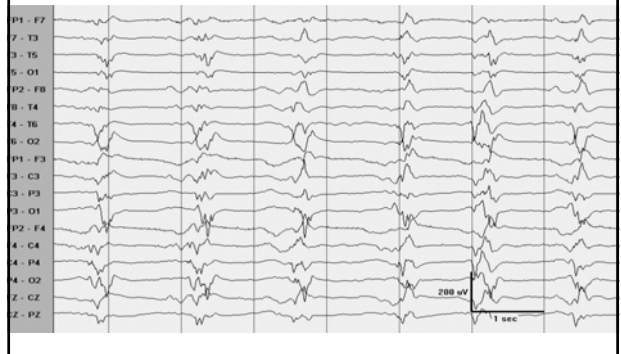
More severe EEG patterns

- Periodic patterns
- Burst-suppression pattern
- Electroencephalographic inactivity

Periodic patterns

- Periodicity
- Complex / multiphasic (epileptiform-like)
- Bilateral occurrence
 - Bilateral periodic epileptiform discharges
 - (Bi-PEDs)
 - Generalized periodic epileptiform discharges
 - (GPEDs)
 - NOT Bi-PLEDs (*independent*)

Generalized periodic pattern



Generalized periodic pattern with myoclonus in anoxic enceph.



Burst-suppression pattern

- Periodic pattern
- Burst period
 - Mixture of sharp & slow waves ~ 1-3 seconds
- Suppression period
 - Activity < 10 µvolt ~ 5-10 seconds
- Common pattern of anoxic encephalopathy
 - DDx: drug & hypothermia

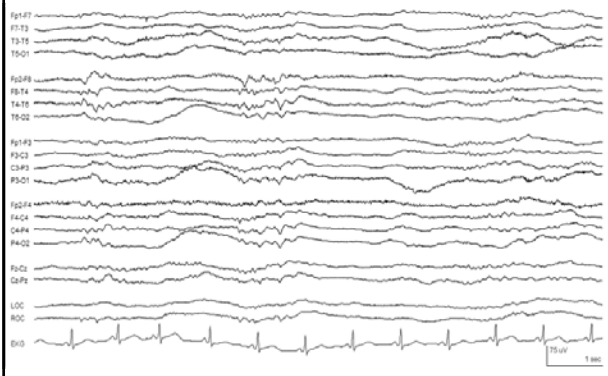
Burst-suppression pattern



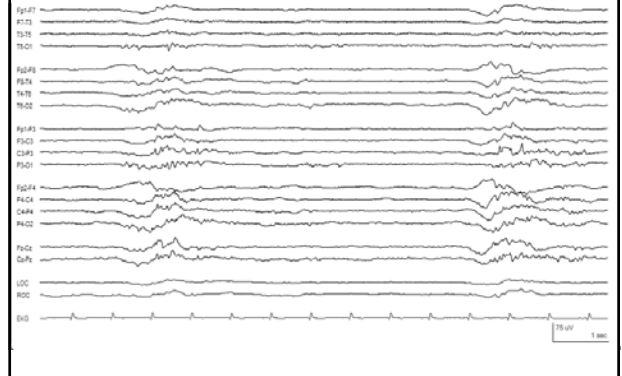
Burst-suppression pattern



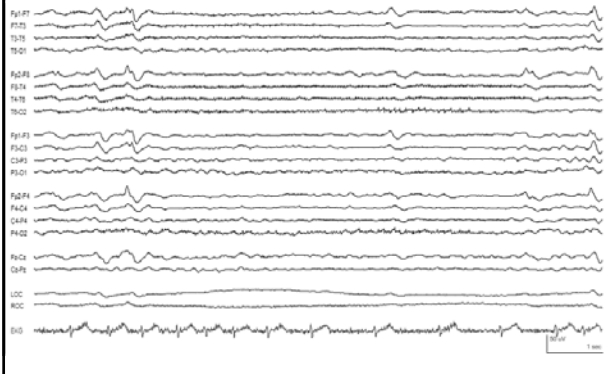
Burst suppression



Burst suppression



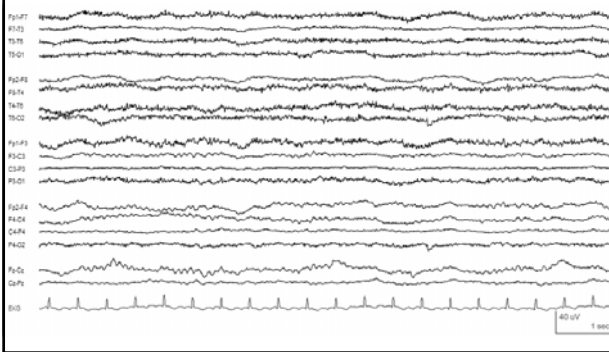
Burst suppression



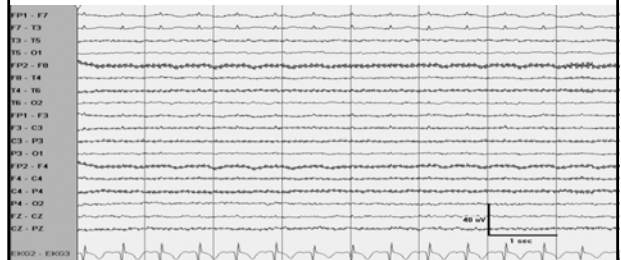
Background suppression

- A nearly flat EEG
- Amplitude < 10 µV
- No reactivity

Nearly flat EEG

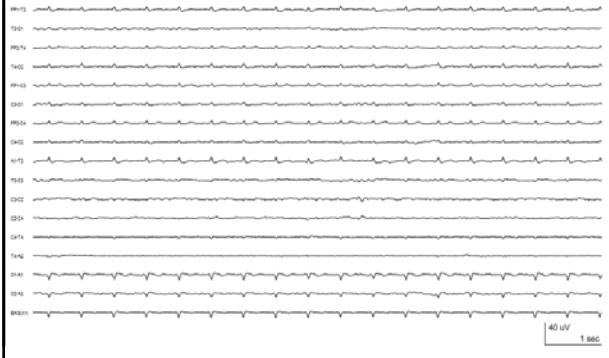


Electrocerebral inactivity



- Amplitude < 2 µV
- One of brain death confirmation criteria

Isoelectric



Less common EEG patterns

- Alpha coma
- Beta coma
- Spindle coma
- Triphasic wave

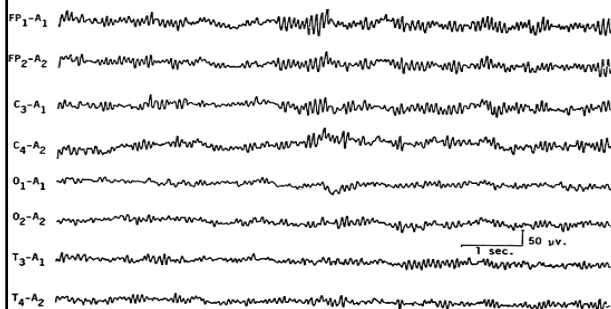
Alpha, beta and spindle waves

- Normal or abnormal
- In comatose patients
 - Amplitude
 - Widespread or unusual spatial distribution
 - Near continuous
 - Non-reactive
- Impression: very severe diffuse encephalopathy

Alpha coma (anoxia > others)

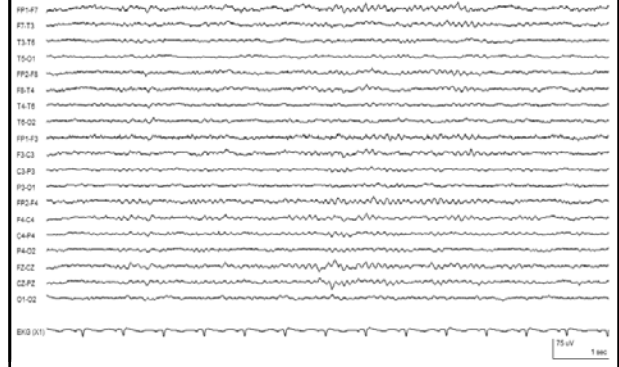


Alpha coma

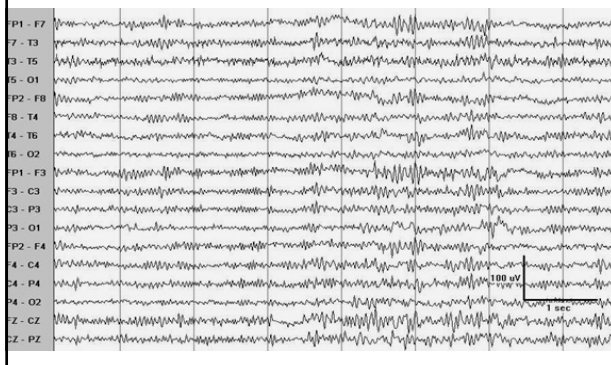


Post arrest day 4th, patient died 2 days later

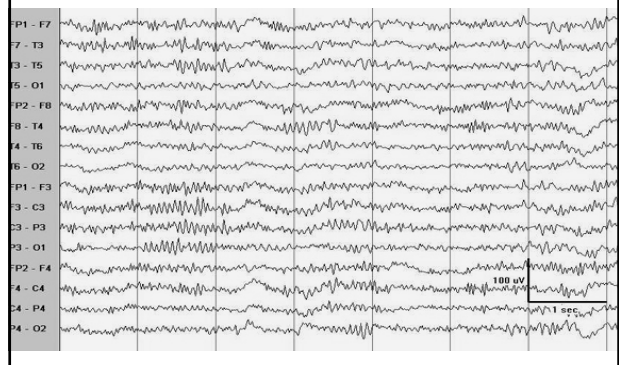
Alpha coma



Beta coma (drug > others)



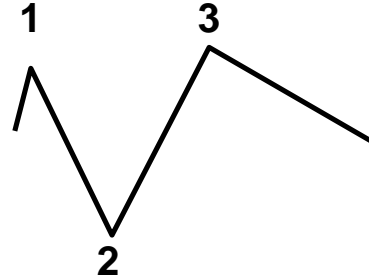
Spindle coma



Triphasic waves

- Amplitude > 70 μV (200-300 μV)
- Fronto-central predominant
 - Frontally positive sharp transients
- Symmetrical bilaterally synchronous
- Burst of repetitive waves, frequency 1-3 Hz
- Un-reactive
- Anterior-posterior lag
- Not only hepatic encephalopathy
- Adult > children

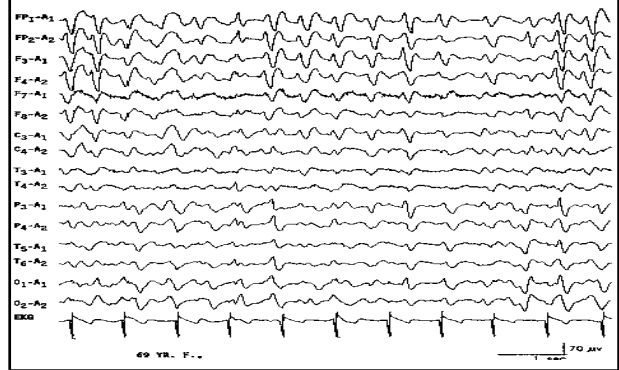
Why do we call it a “Triphasic wave”?



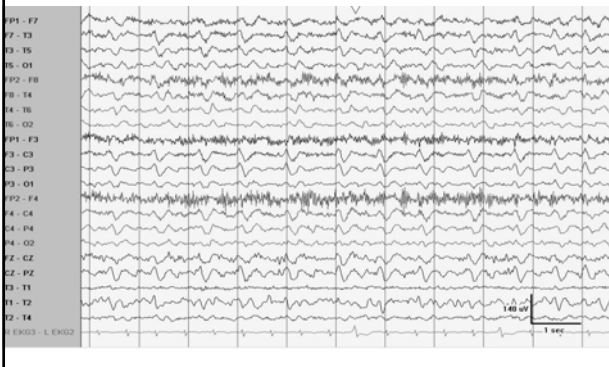
Triphasic wave



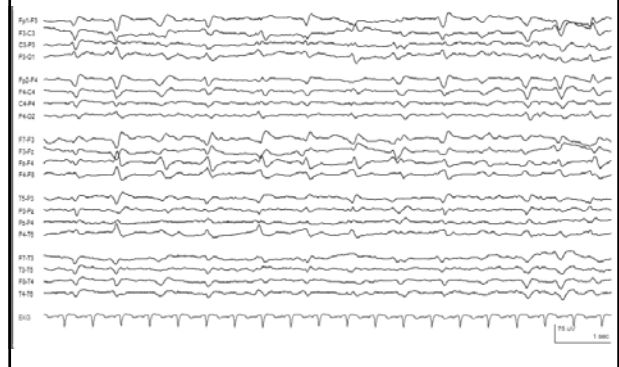
Triphasic wave

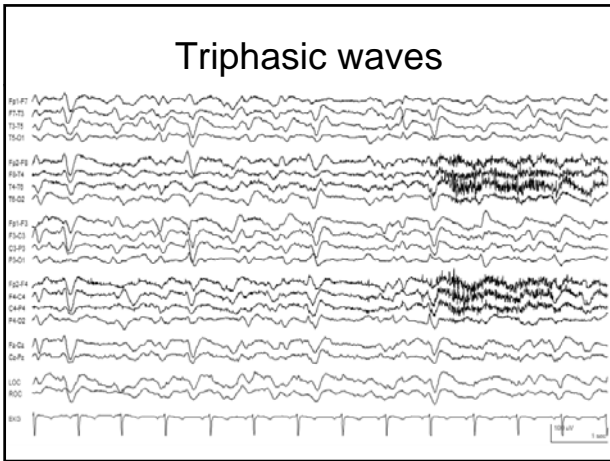


Triphasic wave



Triphasic waves



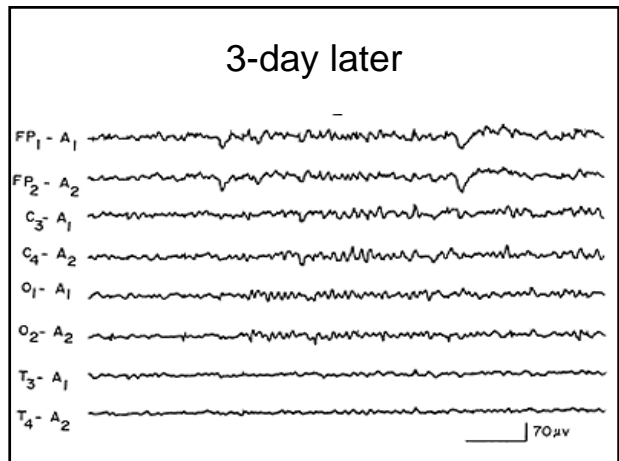
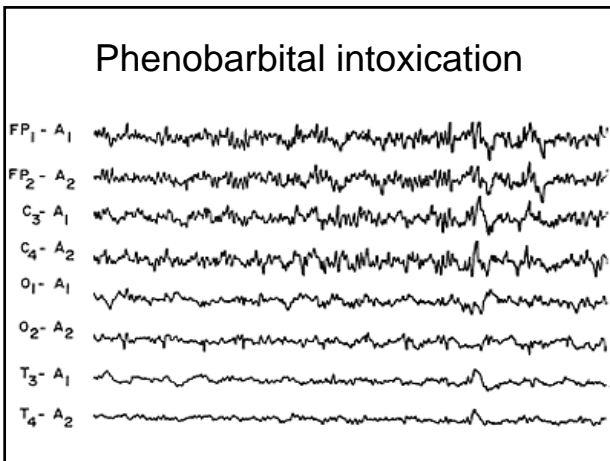


Severity assessment

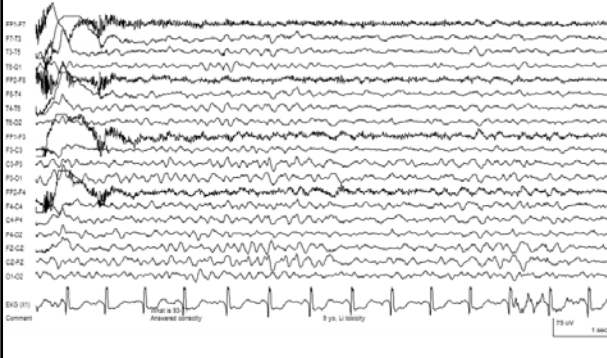
Grade	Characteristics
Grade I	Dominant activity is alpha rhythm with minimal theta activity
Grade II	Dominant theta background with some alpha and delta activities
Grade III	Continuous delta activity predominates, little activity of faster frequencies
Grade IV	Low-amplitude delta activity or suppression-burst pattern
Grade V	Nearly "flat" tracing or electrocerebral inactivity

EEG in specific encephalopathies

- ### Toxic encephalopathy
- Sedative-hypnotic agents overdose
 - Pathognomonic
 - Excessive beta activity over anterior head regions
 - More severe: generalized theta-delta activity
 - Very severe: Suppression-burst & electro-cerebral inactivity
 - Better prognosis than other causes
 - A full neurological recovery



Mild to moderately severe slowing (Lithium intoxication)



Anoxic encephalopathy

- Evaluate 5-6 hours after cardio-pulmonary arrest
- Severity and prognosis assessment
 - Grade 1: fully recovery
 - Grade 4-5: death or persistent vegetative

Cerebral death

- More important
 - Clinical assessment: brainstem function
 - Exclude potential reversible factors affecting the brain
- Other assessment tools
 - Blood flow studies
- EEG
 - Amplitude < 2 μ V lasting at least 30 minutes
- 2nd assessment
 - Adult 6-12 hours later
 - Children 24-48 hours later

Summary EEG in diffuse encephalopathy

- Diffuse or generalized abnormalities
- The most common = slowing (< 8 Hz)
 - Adult: more frontal (anterior)
 - Children: more occipital (posterior)
- No specific patterns for any etiologies
- Serial EEG
 - Diagnosis: DDX with seizures
 - Prognosis
 - Rx assessment

EEG in adult patients with

Encephalitides & degenerative encephalopathies

Introduction

- Viral encephalitis
 - Herpes simplex encephalitis
 - Subacute sclerosing panencephalitis
- Creutzfeldt-Jakob disease
- Degenerative encephalopathies
 - White matter disease
 - Cortical gray matter disease
 - Huntington's disease
 - Infratentorial lesion

Encephalitides & Degenerative encephalopathies

- Common
- Clinical diagnosis > EEG
- Some EEG: ? Pathognomonic

EEG in viral encephalitis

- Generalized slowing
- Depending on severity
- Non-specific finding

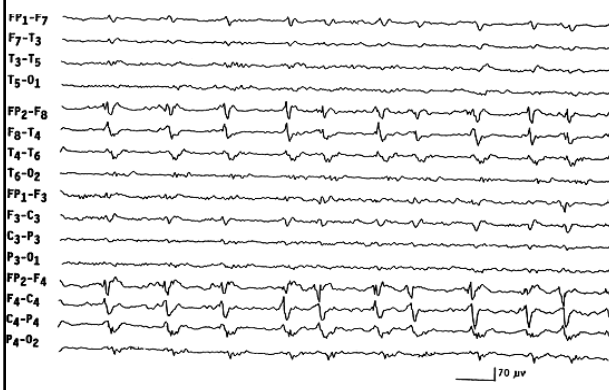
Herpes simplex encephalitis (HSE)

- A prominent focal abnormality
 - Focal polymorphic delta activity
 - Temporal region > frontal > others
- Pseudo-periodic, focal/unilateral, large amplitude, sharp wave complexes
- Repeat every 1-3 seconds
- Periodic lateralized epileptiform discharges (PLEDs)

PLEDs in HSE

- Appearing ~ day 2nd -15th of condition
- Another side affecting
- Synchronous or dependent PLEDs
- Asynchronous or independent PLEDs
- DDX:
 - Acute focal cerebral hemispheric processes
 - Abscess, infarction, neoplasm

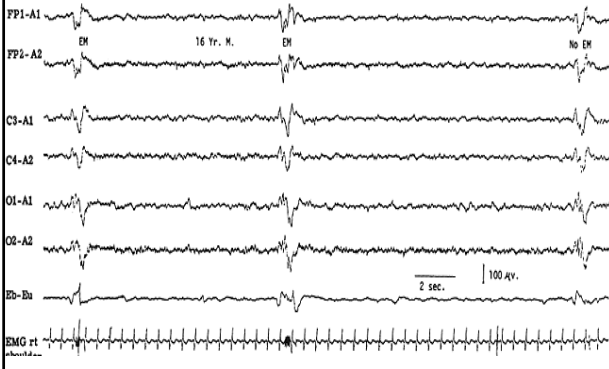
HSE and PLEDs over Rt temporal region



Subacute sclerosis panencephalitis (SSPE)

- Pediatrics
- Measles
- EEG:
 - Initial EEG
 - Abnormal during sleep
 - Asymmetry discharge with contralateral myoclonic jerks
 - Late EEG
 - Bilateral synchronous & symmetrical high-amplitude periodic complexes
 - Repeat every 4-10 seconds with myoclonic jerks

EEG in SSPE



Creutzfeldt-Jakob disease (CJD)

- Transmittable disease from Prion protein
- Spongiform encephalopathy
- Clinical
 - Rapidly progressive dementia
 - myoclonus

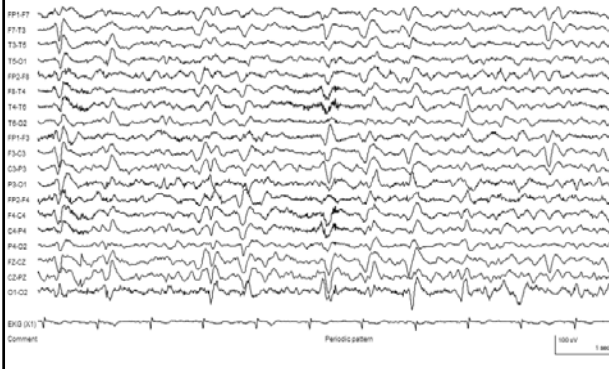
Creutzfeldt-Jakob disease (CJD)

- EEG
 - Early or intermediate disease (first 3 months)
 - Periodic, bilaterally synchronous wave forms
 - Diphasic or triphasic sharp waves
 - Repeat regularly ~ 1Hz with myoclonic jerks
 - Late disease
 - Bilateral symmetrical & synchronous periodic discharges superimposed on a flat background

Periodic patterns: periodic sharp wave complexes



Periodic slow waves in CJD



Degenerative encephalopathies

- Lesions
 - Cortical white matter
 - Cortical gray matter
 - Infratentorial lesion

Cortical white matter diseases

- Leukoencephalopathies
- EEG
 - Abnormal background
 - High-amplitude continuous generalized polymorphic delta activity

Cortical gray matter

- EEG:
 - Normal, or disorganized background
 - Slow, irregular and low in amplitude abnormal
- Alzheimer's & Pick's disease
 - Non-specific findings
 - Minimal continuous generalized polymorphic delta activity
 - Severe case: sharp or triphasic waves over posterior head region, not persistent

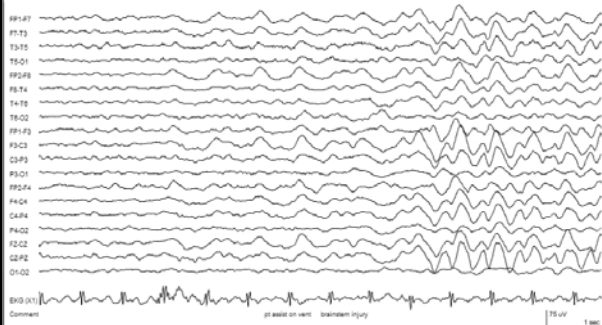
Huntington's disease

- Clinical diagnosis and genetic test
- EEG
 - A flat tracing absence of any EEG activity in excess of 10 μ V (even hyperventilation)
 - No rhythmic activity

Infratentorial lesion

- Examples
 - Spinocerebellar degeneration
 - Parkinson's disease
 - Progressive supranuclear palsy
- EEG
 - Normal
 - Non-specific slowing of background activity

Polymorphic slowing



DDx: brainstem injury

Summary EEG in Encephalitides & Degenerative encephalopathies

- General concepts
 - Common
 - Clinical diagnosis > EEG
 - Some EEG: ? Pathognomonic
 - CJD
 - SSPE
 - Serial EEG