

Neuro-monitoring in Hypoxic ischemic Encephalopathy



Scope

- Importance of Neuro-monitoring in HIE
- **Tools**
 - Neurological Examination
 - Conventional cEEG
 - Amplitude integrated EEG
 - Near Infra-red Spectroscopy
 - MRI brain
 - MR spectroscopy
 - Ultrasonography and Dopplers
 - Heart rate variability, Biomarkers and VEP/SEP

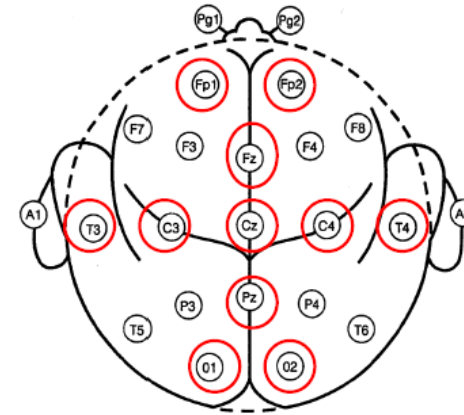


Introduction

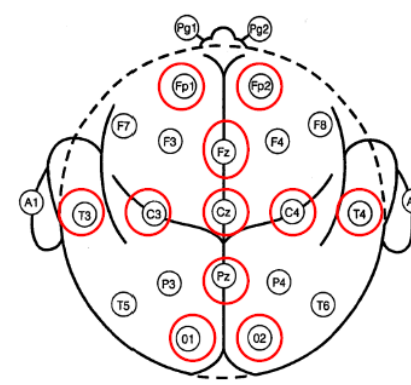
- HIE-significant risk for adverse outcomes
- Neuro-monitoring –Brain function
 - Functional activity/Structural /Oxygenation/Blood Flows/Metabolites
 - Continuous/Real time/Intermittent
- Provides critical diagnostic information
- Real time assessment of irreversible neuronal loss/injury
- Individualised Neuroprotective and Neuro-restorative therapy
- Prognostic Information

Conventional cEEG

- Spot EEG/ cEEG (24 h or more)/Video EEG
- Electrographic Seizures
- Prognostication based on background
- American Clinical Neurophysiology guidelines
 - Neonatal depression due to Perinatal Asphyxia
 - cEEG for 24 hrs to screen for seizures/ for 24 h after last electrographic seizure
- **Gold standard for seizure detection**
 - Electro-clinical dissociation
 - Degree on encephalopathy



Conventional cEEG



- **Electrographic Seizures**

- Avoid over-treating non-epileptic movements or under-treating true seizures.
- Benefits of treating sub-clinical seizures in HIE
- Reduction of dose and duration of AEDs
- High Electrographic activity –risk factor for mortality/Poor NDO

- **Background**

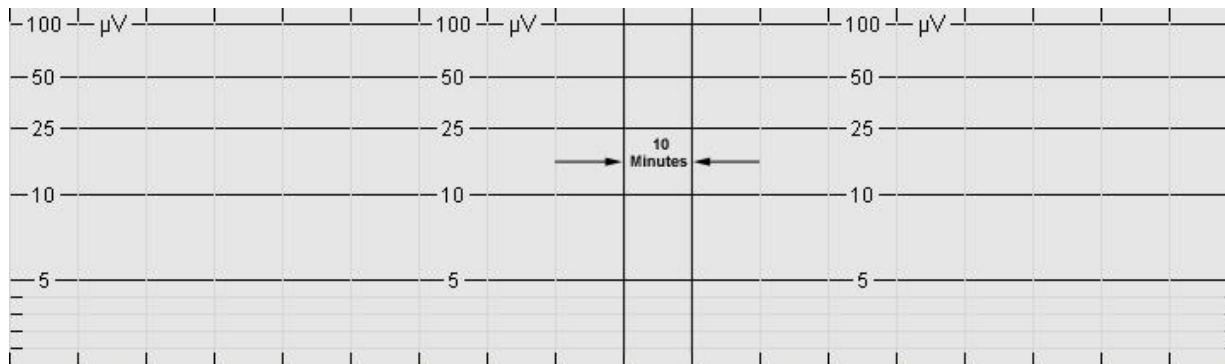
- Normal
- Excessive Discontinuity
- Low amplitude/Burst Suppression
- Asymmetry-lateralised brain injury

| EEG Background | Neurological Sequelae |
|-------------------------------------|-----------------------|
| Normal | ≤10% |
| Severe abnormalities [†] | ≥90% |
| Moderate abnormalities [‡] | ~50% |

*Based primarily on data reported in references 401, 402, and 404 and includes both full-term and premature infants.
[†]Burst-suppression pattern, prolonged (>20-second) interburst interval, marked voltage suppression, and electrocerebral silence.
[‡]Voltage asymmetries and "immaturity."

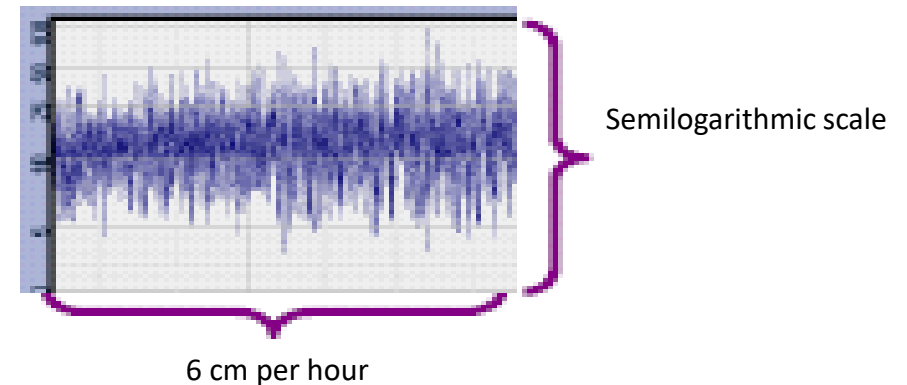
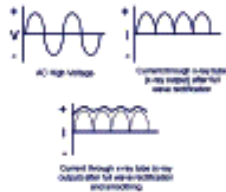
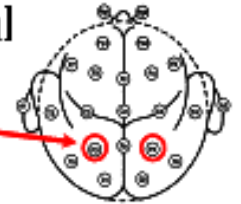
Amplitude Integrated EEG (aEEG)

- Modification of raw EEG
- Special Wide band Filter- $<2\text{Hz}$ to $>15\text{Hz}$
- Semi-logarithmic amplitude compression
 - Linear between 0 and 10 mcv
 - Logarithmic from 10 to 100 mcv
- Peak-to-peak Rectification/Monophasic
- Time Compression



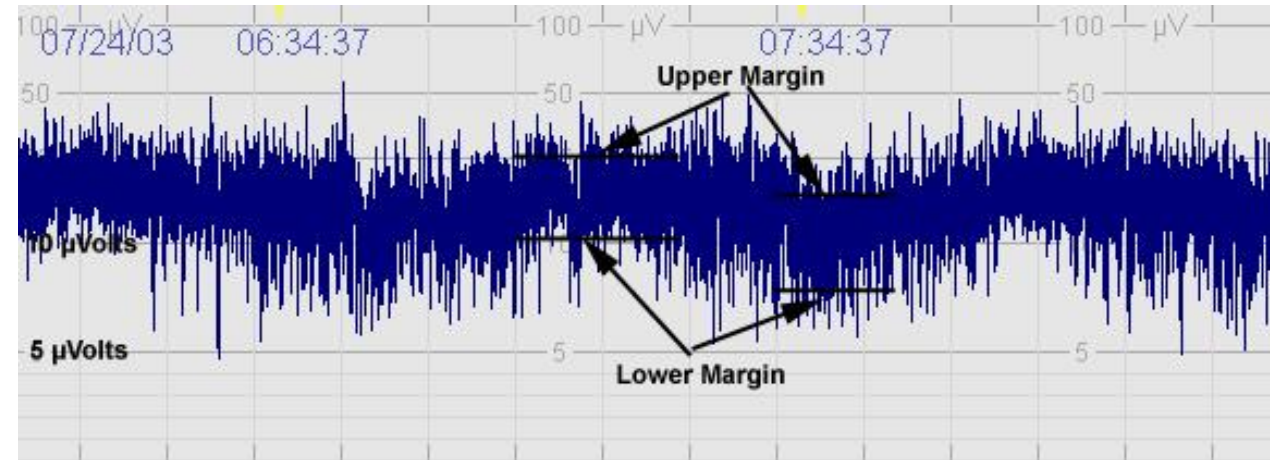
aEEG Signal Processing

- **Amplification of EEG signal**
 - from P3/P4
- **Filtering:**
 - $<2\text{Hz}$, $>15\text{Hz}$: Sweating and muscle artifact
 - Asymmetric band pass filtering
 - Equal emphasis to different frequencies
- **Rectification and smoothing**
 - Of EEG wave



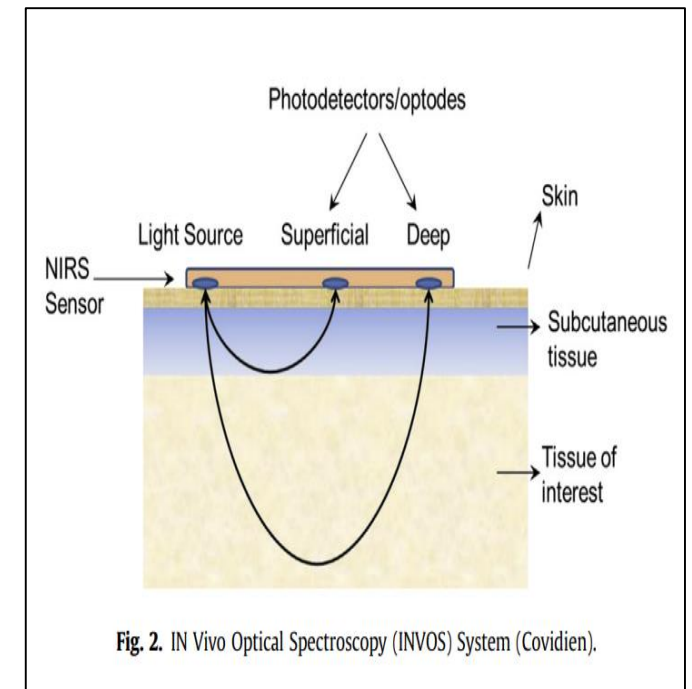
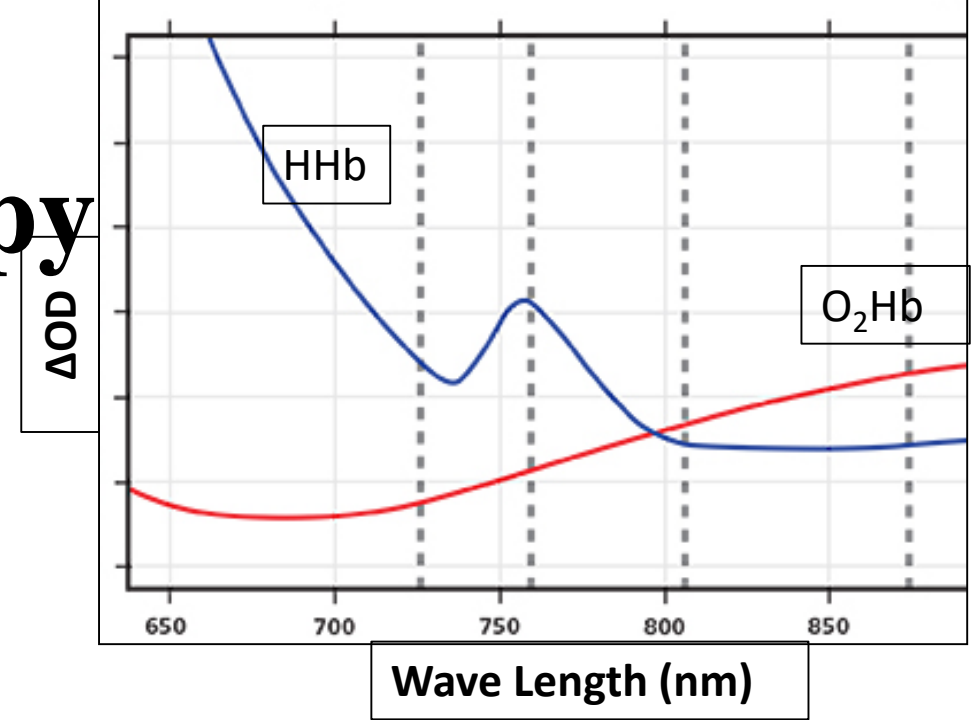
Amplitude Integrated EEG (aEEG)

- Hellstrom Westas/AI Naqeeb
- Global Electrocortical Activity
- Limited number of electrodes
- Global activity only
- Will not localize lesion/May not see focal seizures
- **Poor Outcome**
 - Poor background pattern within 6 h
 - Delayed onset of SWC after 36 hours after birth
- In infants with good outcome- background pattern normalises by 24-36 hours when treated with normothermia and by 48-72 hours when treated with hypothermia

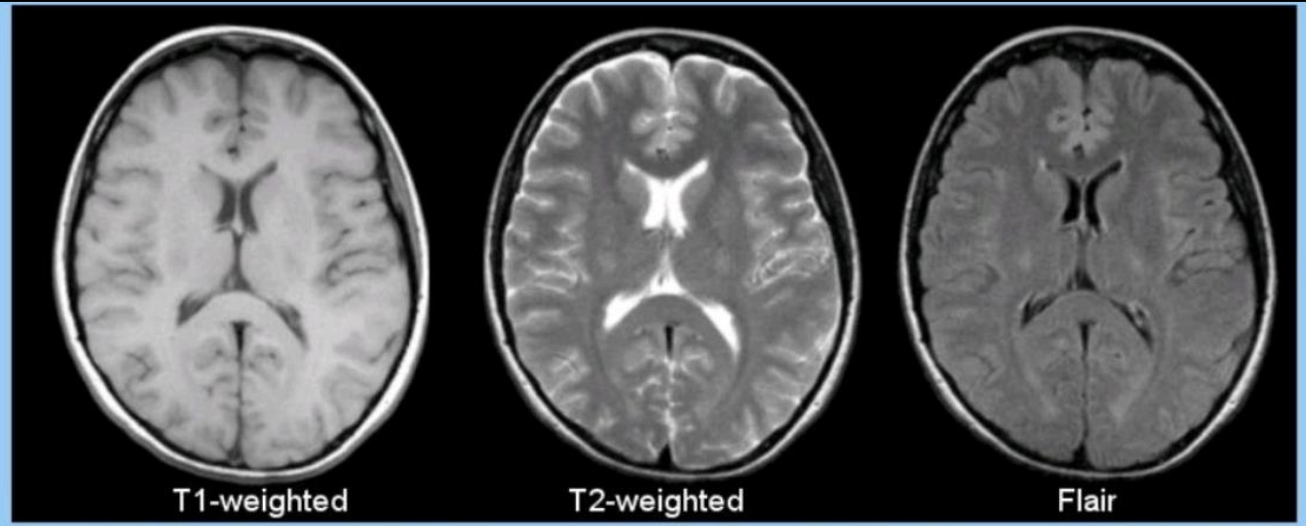
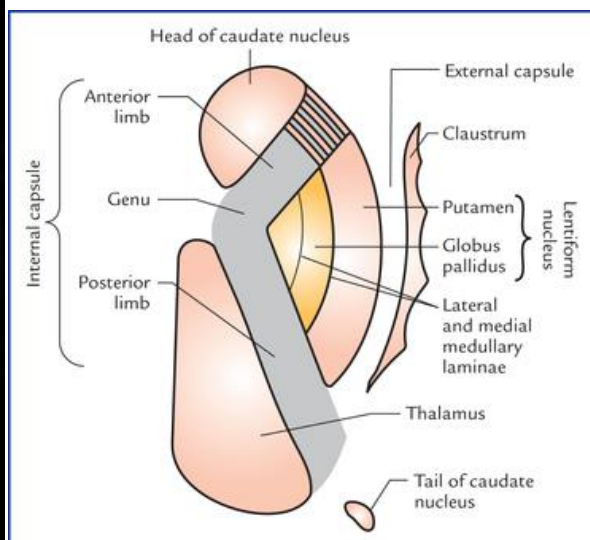
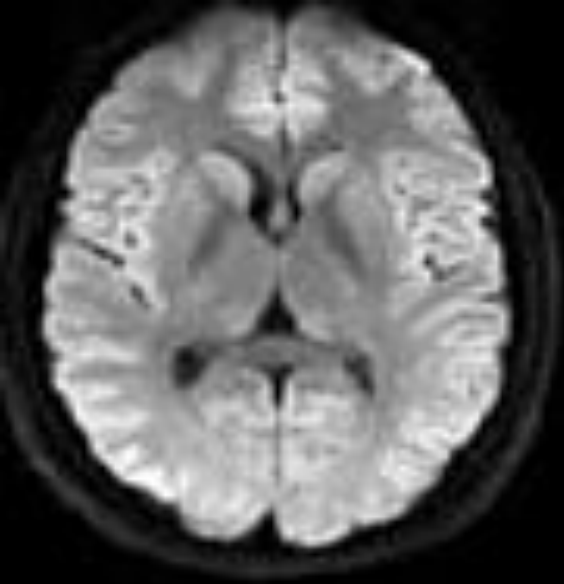
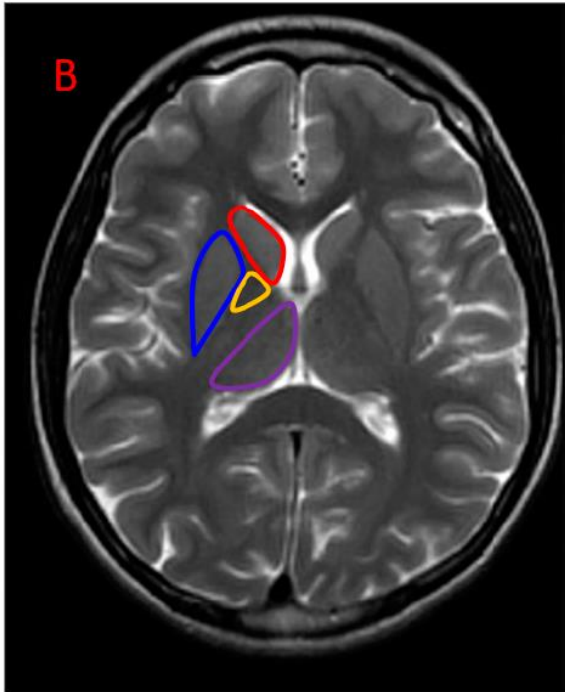
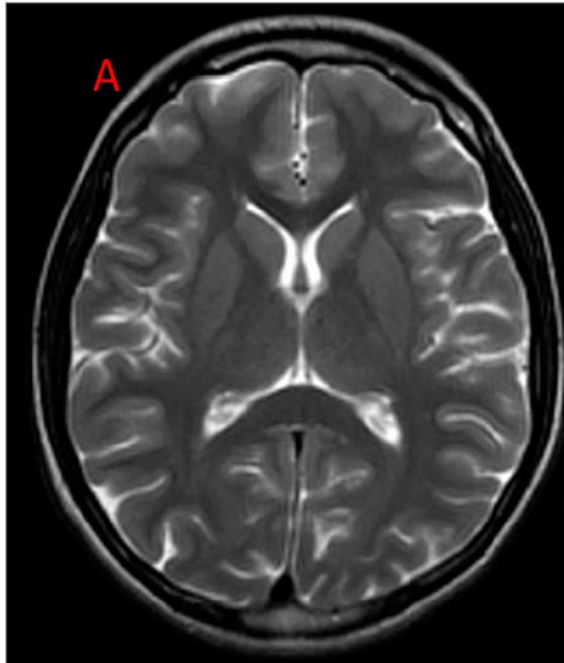


Near Infra-red Spectroscopy

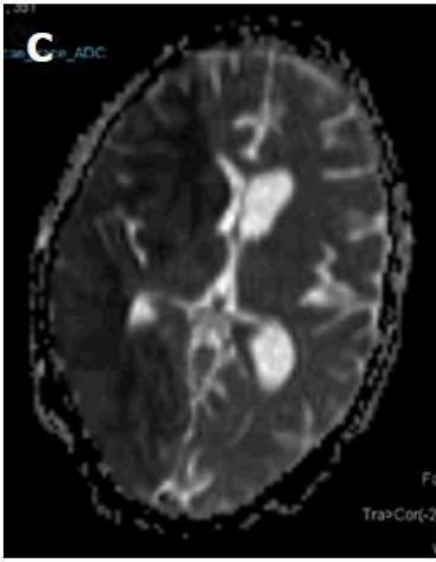
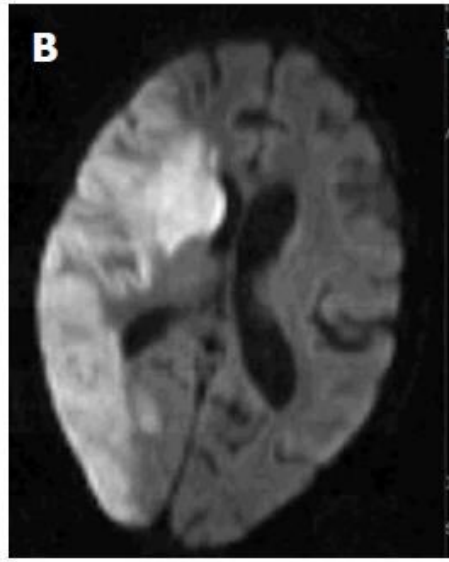
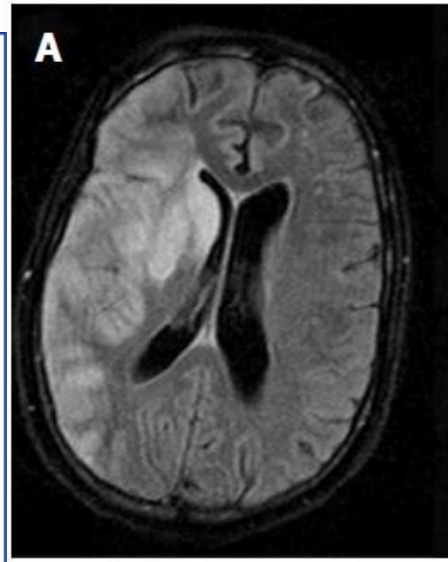
- Detector emits infrared light
- Absorbed differentially by hemoglobin
- Residual light reflected back-detectors
- Calculates regional oxygen saturation (rSO₂)
- Fractional tissue oxygen extraction (FTOE)
- Balance between O₂ Delivery and consumption
 - $FTOE = [(SaO_2 - rSO_2) / SaO_2]$
- In HIE
 - Higher rSO₂
 - With TH Inc rSO₂ and low FTOE (dc utilization)
- Prognosis



MRI Brain

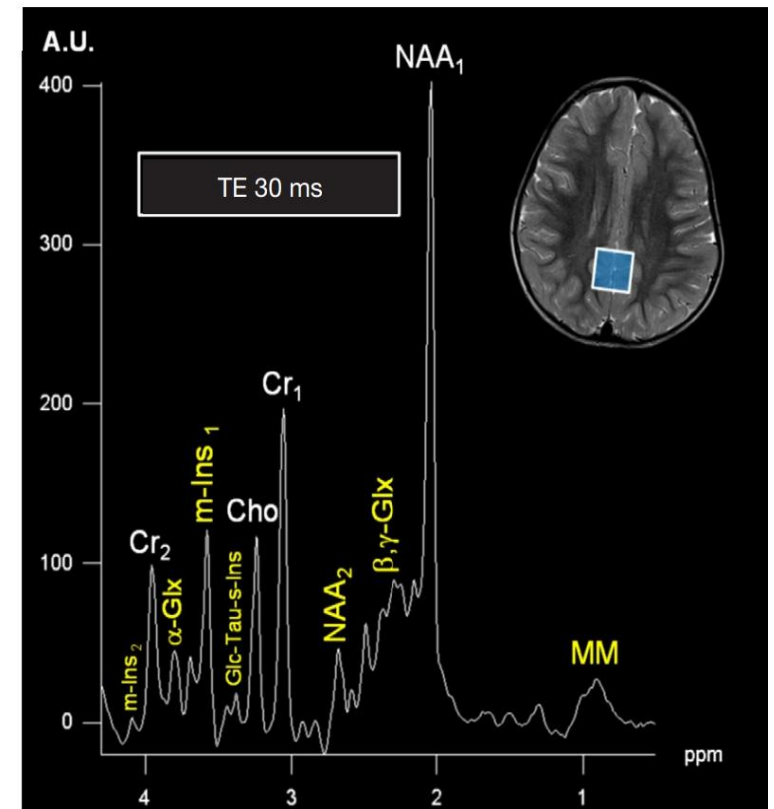
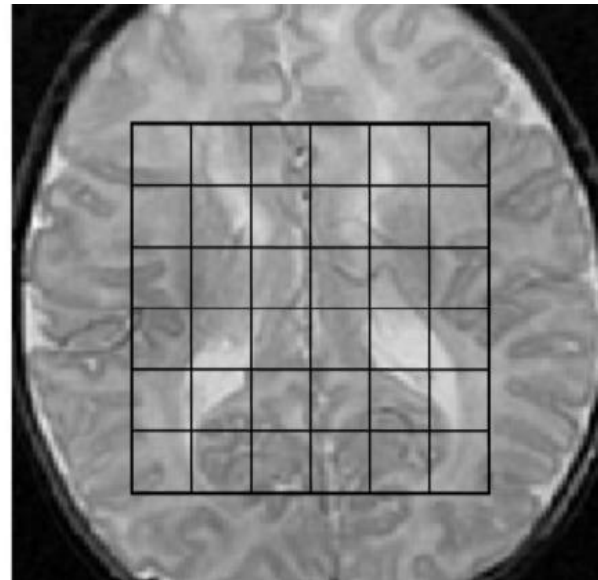
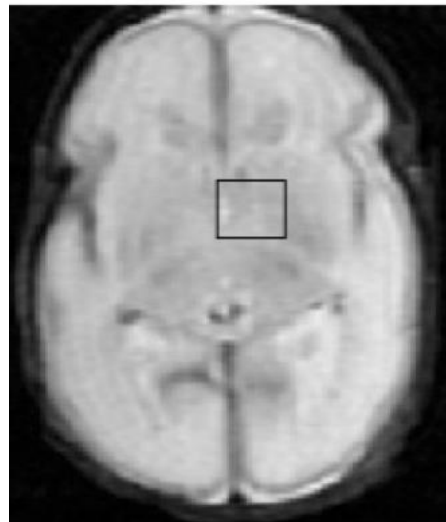


| Tissue | T1-Weighted | T2-Weighted | Flair |
|---------------------------|-------------|-------------|------------|
| CSF | Dark | Bright | Dark |
| White Matter | Light | Dark Gray | Dark Gray |
| Cortex | Gray | Light Gray | Light Gray |
| Fat (within bone marrow) | Bright | Light | Light |
| Inflammation (infection,) | Dark | Bright | Bright |



MR Spectroscopy

- Metabolic status in the tissue-often precedes anatomical changes
- Different metabolites-characteristic resonant frequencies
- X axis- chemical shift axis
- Y-axis-signal intensity
- Voxels



Miscellaneous

- Cranial USG
- Cranial Dopplers
- Heart Rate Variability-Autonomic
- Evoked Potentials-VEP/SEP
- Biomarkers
 - Blood
 - CSF

