

Clinical Utility of EEG

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Historical perspective

- 1930s • Psychiatry
- 1950s • Neuro-imaging
- 1990s • Appropriate uses
 - epilepsy
 - acute encephalopathy
 - chronic encephalopathy

Clinical indications

- Uncertain episodic events
- Established epilepsy
- Acute encephalopathy
- Chronic encephalopathy (dementia)
- Psychiatry

EEG & Epilepsy

- Uncertain episodic events
- Established epilepsy

Clinically Definite Epilepsy

New diagnosis

- confirm diagnosis
- classify epilepsy syndrome
- need for imaging
- prediction of recurrence
- choice of therapy

Sensitivity & Specificity in Epilepsy

False +

- Misreading sharp transients
- Normal variants
- Artifacts
- Pre-clinical
- True false +

False +

Normal sharp transients

- POSTS
- V waves
- Mu
- Posterior slow of youth
- Photic driving responses

False +

Normal variants

- 6Hz spike-wave
- 14 & 6 Hz positive spikes
- Small sharp spikes/BETS
- Psychomotor variant
- Breach rhythm
- Wicket spikes

False +

Artifacts

- filtered EMG
- lateral rectus spikes
- ECG
- electrode
- etc, etc

True false +

Zivin & Ajmone Marsan 1968

2% of 6,497 non-epilepsy *patients*

- esp. those with structural brain lesions
- 14% developed epilepsy
- included several normal variants

True false +

Robin, Tolan, Arnold 1978

1% of 7,760 USAF aircrew

- Probably more than half had previous seizures or significant head injury
- 1 later developed epilepsy

True false +

Gregory, Oates, Merry 1993

0.5% of 13,658 RAF recruits

- more than half had photoparoxysmal only
- Probably 2% developed epilepsy

False +

- 5-8% normal children may have spikes, esp central/ parietal/occipital

False -

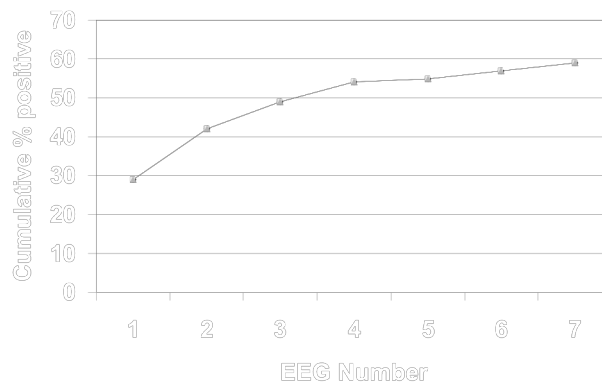
Ajmone Marsan & Zivin 1970

308 patients with epilepsy had av. 5 EEGs

- 56% were +ve on 1st EEG
- 82% eventually positive

False -

429 patients with epilepsy (CPSz) had up to 7 EEGs



Salinsky, Kanter, Dasheiff 1987

False -

King et al.1998

- EEG < 24 hrs post-ictal +ve in 51%
- EEG > 24 hrs post-ictal +ve in 34%
- Sleep EEG
 - Cumulative yield increased from 43% to 61%

False -

Binnie 1994

- 3000 patients with epilepsy
- Waking EEG → Sleep EEG → Further EEGs
 - 49% 81% 92%

Syndrome Classification

Specific examples

- GTC seizures without *apparent* focal onset
- JME with focal myoclonus v partial motor sz
- Complex absence v complex partial sz
- Tonic sz v complex partial sz
- Benign syndromes of childhood. e.g. BECTS

Need for imaging

- Generalised epileptiform activity implies a lack of structural pathology
 - No MRI lesion found in 1st seizure patients with generalised EEG *King et al.1998*
- If initial imaging -ve, focal activity may provide target for further imaging

Prediction of Recurrence after First Seizure

Berg & Shinnar 1991

Meta-analysis of predictive factors

- Strongest predictors were aetiology and EEG
- Epileptiform EEG doubles risk

Prediction of Recurrence after First Seizure

TABLE 4. Adult Seizure Recurrence After First Unprovoked Seizure

Study	No. of Patients	Recurrence
Annegers et al. (1986)	424	Idiopathic Abnormal EEG is predictive of seizure recurrence: RR, 2.2 (95% CI, 1.1–4.3) Symptomatic Abnormal EEG not predictive of recurrence
van Donselaar et al. (1992)	157	EEG is normal, 12% Epileptiform abnormalities are present, 83%
Das et al. (2000)	76	EEG is normal, 17% EEG is abnormal, 75%
Schreiner and Pohlmann-Eden (2003)	157	EEG is abnormal: RR, 4.5 (95% CI, 1.8–11.3) Focal but not generalized epileptiform abnormalities are predictive of recurrence
Kim et al. (2006)	1,443	EEG is abnormal: RR, 1.54 (95% CI, 1.27–1.86)
Hopkins et al. (1988)	408	EEG is not significantly predictive, but an abnormal EEG may be associated with greater risk of recurrence
First Seizure Trial Group (1993)	193	Patients with epileptiform abnormalities had 1.7-fold higher recurrence rate
Bora et al. (1995)	147	Abnormal EEG may be associated with greater risk of recurrence
Hui et al. (2001)	132	Patients with epileptiform abnormalities may have a higher recurrence rate
Lindsten et al. (2001)	107	Abnormal EEG may be associated with greater risk of recurrence

CI, confidence interval; RR, relative risk.

Wirrell 2010

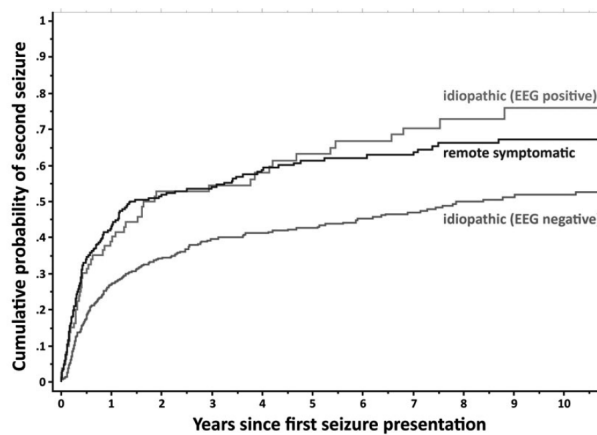
Prediction of Recurrence after First Seizure

TABLE 3. Pediatric Seizure Recurrence After a First Unprovoked Seizure

Study	No. of Patients	Recurrence
Camfield et al. (1985)	168	EEG is normal or shows nonspecific changes only, 41% Epileptiform abnormalities are present, 66%
Shinnar et al. (1996)	407	2-year recurrence rate Cryptogenic EEG is normal, 28% Epileptiform abnormalities are present, 60% Symptomatic EEG is not predictive of recurrence
Stroink et al. (1998)	156	2-year recurrence EEG is normal, 40% Epileptiform abnormalities are present, 71%
Ramos Lizana et al. (2000)	217	2-year recurrence Idiopathic-cryptogenic EEG is normal, 42% Epileptiform abnormalities are present, 62% Symptomatic EEG is not predictive of recurrence
Scotoni et al. (2004)	213	EEG is normal, 27% EEG is abnormal, 60%
Bouloche et al. (1989)	119	Those with epileptiform abnormalities tend to have higher recurrence rates than those with normal EEG or nonspecific slowing

Wirrell 2010

Prediction of Recurrence after First Seizure



Lawn, Chan, Lee, Dunne. Epilepsia 2015

Established Epilepsy

The “progress” EEG is rarely useful except

- adequacy of therapy in absence epilepsy?
- unexpected clinical evolution
 - review of diagnosis (?epilepsy, ?classification)
- Driving

AED Withdrawal

Most studies find EEG predictive (including after epilepsy surgery)

VPA (+?Lamotrigine) may suppress EEG
?Post-withdrawal EEG

Acute encephalopathy

- Confused patient
 - Metabolic cause
 - Non-convulsive status epilepticus
 - Herpes simplex encephalitis
- ICU
 - Non-convulsive status epilepticus
 - Post anoxia

Chronic encephalopathy

- Dementia
 - Low sensitivity
 - Low specificity (except Creutzfeldt Jakob)
- Pseudodementia (depression/anxiety)

Psychiatry

- Psychotic behaviour
 - Low yield but useful in selected cases, e.g. metabolic disorders, herpes encephalitis
 - Post-ictal psychosis
- Violent behaviour
- Pseudoseizures (psychogenic non-epileptic seizures)

Summary

- True false positive EEGs are rare
- False negative EEGs can be reduced to 10-20% by
 - Sleep-deprived EEG
 - Repeating EEGs
- Once an EEG is +ve, there are few occasions when it needs to be repeated

Good EEG is a Team Effort

Requirement	Team member
Good technical quality	EEG technician
Reliable reading and reporting	EEGer
Intelligent clinical correlation	Neurologist