

# Clinical Applications of Electroencephalogram in Children

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## ABSTRACT

**Introduction:** To obtain a baseline for clinical application of Electroencephalography in children and to evaluate the Electroencephalography findings in children with various acute and chronic CNS disorders and non epileptic events.

**Methods:** Electroencephalography records of 250 patients were studied in neurophysiology departments of Queen Rania AL-Abdullah Hospital for children in Jordan. For each patient who had undergone Electroencephalography the following data were recorded: age, sex, source of referral (inpatient or outpatient department), reason for electroencephalography Electroencephalography, diagnostic impressions, clinical presentation, the result of the Electroencephalography examinations and clinical correlation between the seizure type and Electroencephalography finding.

**Results:** Males slightly outnumbered females: 55% males. The majority of cases were Electroencephalography between 6-12 years, Total of 63.2 % of all referrals for Electroencephalography were from outpatient clinics while inpatients accounted for 36.8% of referred cases, with pediatric neurology department referrals being the highest (28.8 %). majority of diagnosis at referral were suspected epilepsy (80%) with epileptiform Electroencephalography abnormalities in 32%. Over all 64 % the Electroencephalography records were normal, including all Electroencephalography records of children with syncope and headache.

**Discussion:** We conclude that there are many unnecessary routine Electroencephalography recordings in children. Investigation of epilepsy and acute encephalopathies appear to be the most valuable indications for routine pediatric Electroencephalography. Electroencephalography can be helpful in classification of seizures. Finding a way to reduce Electroencephalography requests is recommended.

## Key Words:

Epilepsy,

Electroencephalography,

Paroxysmal Event

## 1. Introduction

A large number of publications have documented the type and frequency of electroencephalography Electroencephalography abnormalities in many different childhood disorders (Goldensohn E 1997). Electroencephalography is very important in investigating chil-

dren with various neurological disorders, particularly epilepsy. Electroencephalography is also a sensitive marker of diffuse cortical dysfunction as seen in toxic, metabolic or hypoxic encephalopathies (Saunders etl 1997).

Although the diagnosis of seizures and epileptic syndromes is primarily clinical, Electroencephalography

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often provides supportive evidence and helps in seizure classification (Sundaram et al 1999).

Many episodic events may simulate epilepsy including breath holding spells, syncope, tics, migraine related phenomena (e.g. benign paroxysmal vertigo), and psychogenic seizures (Barron, T. 1991). These events are associated with normal neurological examination and interictal Electroencephalography. However, although Electroencephalography is requested, complete description of the event can accurately identify the nature of these events in most cases (Wyllie 1991).

Practice parameters endorsed by the American Academy of Pediatrics, recommended use of Electroencephalography after non febrile seizure in children, as standard of care (Blume, and Kaibara, M. 1999). However, non neurologist physicians differ in their expertise in clinically identifying seizures and many of them have a tendency to include almost any paroxysmal events such as syncope, tics or staring spells in attention deficit hyperactivity disorders in their definition of seizure (Donat, J. F. and Wright, F. S. 1990). Moreover Electroencephalography is now easily accessible because of its safety and low cost-benefit ratio (about 100 US dollar in Jordan) (Metrick et al 1991), this has led to an indiscriminate overuse of Electroencephalography in clinical practice decreasing the yield of clinical useful information. In one study, up to 40% of Electroencephalography requests were considered to be unnecessary (Nicolaidis et al 1991).

New software has been developed which facilitates interpretation of Electroencephalography results, though they are in the primitive stages and have not gained clinical acceptance yet.

The present study was done to obtain a baseline for clinical application of Electroencephalography in children who visit pediatric departments of Queen Rania AL-Abdullah Hospital regularly, to evaluate Electroencephalography findings in children with various acute and chronic CNS disorders, to assess relationship between clinical indications and Electroencephalography abnormalities and the predictability of a normal Electroencephalography result.

## 2. Methods

This retrospective study included 250 consecutive Electroencephalography records, which had been requested by pediatricians, child neurologists, and family doctors. All Electroencephalography s were performed

in neurophysiology unite of Queen Ranai Abdullah Hospital for children at Jordan.

For each patient who had undergone Electroencephalography, the following data were recorded: Electroencephalography age, sex, source of referral (inpatient department or outpatient), reason for Electroencephalography, diagnostic impressions, clinical presentation, the result of Electroencephalography examinations and clinical correlation between the seizure type and Electroencephalography finding.

All Electroencephalographys had been recorded digitally and reviewed according to standard clinical practices at the clinical neurophysiology laboratory of Queen Rania Abdullah Hospital for children. All studies had utilized both bipolar and average referential montages performed by using an 8-16 -channel digital recording with electrodes placed according to the international 10-20 systems. Routine Electroencephalography consisted of a normal recording of 20-30 minutes, including three minutes of hyperventilation and intermittent photic stimulation at various frequencies.

Electroencephalography abnormalities were classified to: focal or multifocal spike waves, generalized epileptiform discharges, focal or diffuse background disturbance, burst suppression pattern and spindle coma.

Requests for Electroencephalography are a written requisition, indicating the indication of the request. Clinical indications responsible for requesting the Electroencephalography can be divided into the following categories: (1) established epilepsy; (2) non-epileptic paroxysmal events (e.g. migraine, syncope, breath holding spells); (3) acute CNS disorders (e.g. toxic metabolic, infectious, or hypoxic encephalopathy); and (4) non-epileptic chronic CNS disorders (e.g. mental retardation, autism, attention disorder).

In patients with both clinical and Electroencephalography evidence of epilepsy, seizures were classified according to international classification of the International League Against Epilepsy (ILAE) (Noachtar 1999).

At the end of each assignment, the Electroencephalography requisitions were reviewed for clinical correlation. At this stage the relationship between the clinical indication and Electroencephalography result was recorded for further studies.

### 3. Results

A total number of 250 recorded Electroencephalography s were studied. Among these, males slightly outnumbered females (55% males). The patients ranged in age between four months and 14 years with patients less than 10 years constituted more than 50 % of the study populations and with majority of cases between 6-12 years. The age distribution of all patients is as shown in Figure I.

Total of 63.2 % of all referrals for Electroencephalography were from outpatient clinics while inpatients accounted for 36.8% of cases. Referrals were from various specialties like, pediatrics, psychiatry, neurosurgery and intensive care unit, with pediatric neurology department having the highest referral rate (28.8 %). The source of referrals of patients for Electroencephalography is as shown in Figure 2.

The majority of diagnoses at referral were suspected epilepsy (80%) with epileptiform Electroencephalography abnormalities detected in 32% of cases. The diagnoses at referral are shown in Figure 3.

The seizure types in patients with history of epileptic seizures and epileptiform Electroencephalography abnormalities are shown in the table 1; the majority of seizures were partial seizure with secondary generalization. Primary generalized seizures were uncommon, with petit mal absences accounting for only 9.3 % of total seizures. The majority of patients with epilepsy were referred for Electroencephalography to confirm the diagnosis; 5.5% were referred because of poor sei-

zure control and 1.6% referred to exclude any space occupying lesion.

### 4. Discussion

This study highlights certain important issues in the utility of Electroencephalography in children. Electroencephalography was very helpful in diagnosing epileptic syndrome and in seizure classification. Electroencephalography s of some patients with epilepsy also revealed completely unexpected findings that strongly influenced their management. This highlights the very important role of Electroencephalography in patients with epilepsy.

The age distribution of patients in this study, showing patients under 8 years constituting 50 % of the study population, probably reflects the fact that majority of cases with epilepsy belong to this age group. A progressive increase in the proportion of patients with normal Electroencephalography with increasing age is well known in patients with epilepsy (Falope et al 1993 , Marsan and Zivin. 1970), who make up some 65 % of our patients.

Two thirds of our referrals were outpatients, similar to findings for neurophysiology investigations in developed countries (Binnie 1994).

Most children (98%) with non-epileptic paroxysmal events (e.g. migraine, syncope, and breath holding spells) had a normal Electroencephalography . Other investigators found normal Electroencephalography s in up to 87.5% of adults with non- epileptic paroxysmal

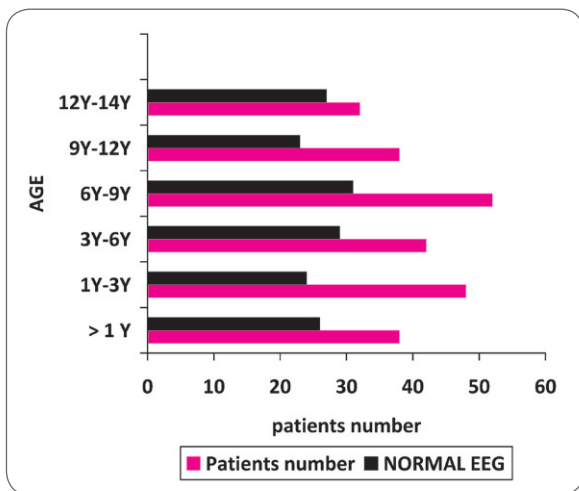


Figure 1. normal electroencephalography in different age ranges

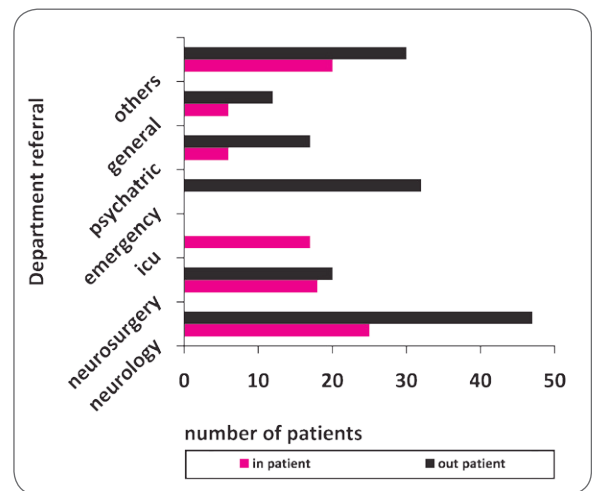


Figure 2. Source of patients referral for Electroencephalography

events (headache, syncope, and vertigo) (Airoldi et al 1999).

We think that there should be some special reasons that lead to Electroencephalography request for non epileptic disorders. The first reason is to exclude epilepsy. It is well known that a small percent of children without any neurologic disorder have Electroencephalography abnormalities (Petersen et al 1965). As well, children with epilepsy may not show interictal Electroencephalography abnormalities (Camfield et al 1995). Second reason may be a lack of knowledge in the limits of Electroencephalography recording and interpretation (Airoldi et al 1994). Therefore, Electroencephalography is not helpful in these children and a complete event description will accurately identify the nature of these events in most cases rather than Electroencephalography (Camfield et al 1995). More than 10% of normal population may have non-specific Electroencephalography abnormalities and approximately 1% may have ‘epileptiform paroxysmal activity’ without seizures (Niedermeyer E. (1999). The prevalence of these abnormalities is higher in children, with 2–4% having functional spike discharges.

In a review of Electroencephalography s in people with epilepsy, it was revealed that 30% of patients’ Electroencephalography s, contained epileptiform discharges which is close to our study (Binnie 1996). Taken together, these studies suggest an 80% chance of showing epileptiform activity in a first wake-and- sleep Electroencephalography in people with epilepsy. Provided there is no other evidence of cerebral disease, epileptiform activity is rare in those who are and will remain free of epilepsy. . This policy reduces costs and inconvenience to patients in an epilepsy service but is inappropriate for patients with a low chance of having epilepsy, and therefore requires some discrimination by doctors (Adrian 2000).

Electroencephalography has many applications in epilepsy but it may also be misused. The situations in which the Electroencephalography can contribute to

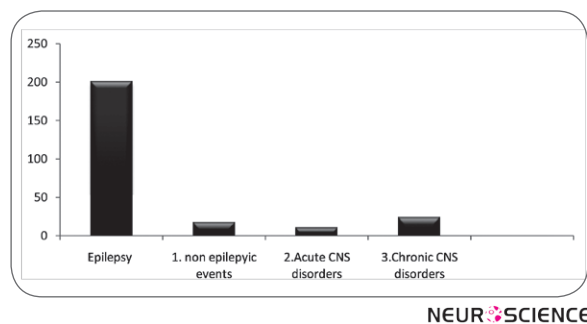
the diagnosis of epilepsy are rare. Once the diagnosis of epilepsy is established Electroencephalography is probably the most important tool in helping to define the type of epilepsy, the prognosis, and the initial approach to therapy. In partial seizures, Electroencephalography is our first choice for localization and is an important part of the work-up for few patients who come for epilepsy surgery (Small JG1993).

Some investigators found that HV and photic stimulation contributed little to the final Electroencephalography report (Airoldi et al 1999). Many of our children with focal or generalized epileptiform discharges had spike activation on photic or HV (19%). HV was particularly helpful in children with absence epilepsy, which is consistent with the findings of other investigators (Phillips et al 1993).

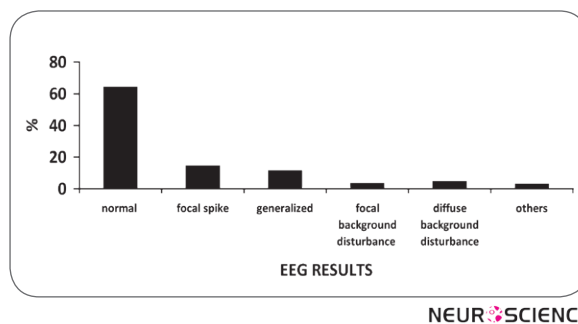
In a recent review of Electroencephalography studies of children with ADHD, it was concluded that 30% to 60% of these children showed abnormal Electroencephalography findings, including generalized and/or intermittent slowing. Furthermore, there was some evidence that Electroencephalography abnormalities decreased with age, with contradictory reports of poor or no correlation between abnormal Electroencephalography s and treatment response (Williams 2001).

### Conclusion and Recommendations

We conclude that there are many unnecessary routine Electroencephalography recordings in children. Investigation of epilepsy and acute encephalopathies appear to be the most valuable indications for routine pediatric Electroencephalography . A way should be fined to reduce Electroencephalography requests. After Electroencephalography Electroencephalography is requested; the effect of cancelling the test may undermine the patient’s confidence in their physician. So physician education seems more palatable.



**Figure 3.** Reason for referral Electroencephalography



**Figure 4.** Electroencephalography results

**Table 1.** Clinical and Electroencephalography classification in patients with seizure confirmed by Electroencephalography

	No of patients	%
<b>Primary generalized</b>		
Tonic –clonic	12	18.6
Petite mal	6	9.3
Myoclonic	10	15.6
<b>Partial</b>		
Simple	18	28.2
Complex partial	14	21.9
With secondary generalization	4	6.3
<b>Total</b>	<b>64</b>	<b>32</b>

NEURSCIENCE

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