Original paper

Spectrum and Patterns of EEG Abnormalities in a Peripheral Outpatient Centre in Kenya

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Abstract

Background: Electroencephalography (EEG), which records electrical activity in the brain, is a valuable tool for assessing epilepsy and other paroxysmal events. However, despite the high prevalence of epilepsy in Africa, EEG remains underutilised.

Objective: This study aimed to evaluate the indications for and patterns of EEG abnormalities in a busy outpatient neurophysiology laboratory in Kenya.

Methods: This was a retrospective observational, non-interventional study. We abstracted and analysed EEG reports and recordings from 1st June 2021 to 31st December 2023. The sociodemographic data, handedness, reasons for referral, clinical diagnoses, EEG abnormalities, types of epileptiform and non-epileptiform patterns, and EEG diagnoses were encoded and entered into IBM SPSS version 27.

Results: A total of 445 EEGs were carried out during the study period, with males constituting 53.9% of the cases. The majority of patients (40.4%) fell within the 10-19-year age group. Additionally, 59.6% of patients were already receiving anticonvulsant medications. The most common reason for referral was suspected seizure in 34.6% of cases, followed by loss of consciousness without abnormal movement in 32.8% of cases. Among males, abnormal movement suspected to be a seizure was the most frequent presentation, while unconsciousness was the predominant presentation among females. The EEG revealed epileptiform abnormalities in 68.3% of cases, with generalised seizure observed in 48.0% of cases. Furthermore, 40.6% of subjects in the 10 - 19 year age group showed no abnormalities on the EEG.

Conclusions: The current study underscores the high prevalence of seizure abnormalities in this rural setting, the common reasons for referral, and the demographic features of patients who present for EEG. It highlights the importance of EEG in distinguishing seizure and non-seizure episodes, especially in paediatric and adolescent age groups.

Key words: Electroencephalogram (EEG) abnormalities, Peripheral outpatient centre

Introduction

An electroencephalogram (EEG) is a recording of the brain's electrical activity using an electronic device, with electrodes attached to the scalp or directly on the brain surface, and the signal passed through an amplifier (1). Hans Banger recorded human electrical cerebral activity for the first time in 1924 (2). The primary use of this non-invasive test is in epilepsy to detect seizure activity, assess organicity, and evaluate encephalopathy. An electroencephalogram is not used as the sole determinant for diagnosing epilepsy due to the presence of epileptiform discharges in 1-5% the normal population (3). Furthermore, only about 50-60% of epileptic patients will exhibit an abnormal EEG in a routine outpatient recording. Nevertheless, EEG is useful in predicting the risk of recurrent seizures following a first unprovoked seizure (4). EEG is also recommended in the clinical assessment of other conditions such as headaches,

head injuries, fainting spells, organic brain disorders, and psychiatric disorders (5).

Epilepsy is one of the most common neurological conditions, affecting over 50 million people globally, with an estimated prevalence of 12.7 cases per 1,000 individuals in rural areas of Low Middle-Income Countries (LMICs) (6). A multi-site study conducted in South Africa, Kenya, Tanzania, Uganda, and Ghana revealed that the age-standardised prevalence of active convulsive epilepsy ranges from 7.0 to 14.8 cases per 1,000 individuals (7). Although these studies concentrate on active convulsive epilepsy, non-convulsive epilepsies may account for half of all epilepsy cases (8). There is little literature on neurophysiological indications for EEG and the spectrum of abnormalities seen in EEGs in Kenya, despite the importance of EEG in distinguishing epilepsy from other paroxysmal events. This study aimed to outline the clinical indications for EEG, the spectrum of abnormalities seen in EEG cases, and the types of seizures seen. It will add more information on the characteristics of epileptic and non-epileptic abnormalities facing patients in rural Kenya.

Materials and methods

This was a retrospective cross-sectional study conducted in an outpatient physician clinic offering EEG services in Meru. We analysed the medical records of all EEG cases performed in the facility from 1st June 2021 to 31st December 2023. Each EEG recording was obtained using digital equipment with a minimum duration of 30 minutes, and the electrode placement on the scalp followed the 10-20 international system. Recordings were conducted in both awake and sleep states. Provocation with photic stimulation and hyperventilation was performed in all cases except where contraindicated. All recordings were carried out by a trained neurophysiology technologist, while interpretation was conducted by a physician or neuroscientist trained in EEG.

A structured questionnaire was used to record variables such as age, gender, handedness, current medications, reasons for referral, probable clinic diagnosis, the most common presenting symptom, abnormalities, EEG diagnosis, types of abnormality, and the site of abnormality. The EEG findings and diagnoses were tabulated from the EEG report. The abnormalities were categorised as either present or absent. The EEG diagnoses were classified as normal, generalised epilepsy, focal onset epilepsy, or encephalopathy. The variables were coded, and patients' data were entered and analysed using IBM SPSS (Statistical Package for the Social Sciences) Version 26. Frequencies were analysed, and chi-square tests were applied to categorical variables to assess associations

Results

A total of 445 patients underwent EEG during the study period for various indications, of which 240 (53.9%) were males. The mean age was 21.84 years, median 16 years (interquartile range of 16.0). The youngest patient was 1.5 years old, and the oldest was 89 years. Most patients (143; 55.7%) were already on anti-seizure medications before the EEG study. The commonest reasons for EEG referral were confirmation of seizure disorder and evaluation of response to treatment. The pre-test diagnosis indicated before EEG were encephalopathy (27.9%), epilepsy (66.5%) and psychosis (5.6%) (Table 1).

Table 1: Sociodemographic, clinical and referral characteristics of the patients for EEG

Characteristic	Categories	No.	(%)
	Male	240	53.9
Gender	Female	205	46.1
Age category (years)	Under 10	107	24.0
	10-19	180	40.4
	20-29	55	12.4
	30-39	33	7.4
	above 40	70	15.7
Reasons for referral	To confirm seizure disorder	250	56.2
	To evaluate response to treatment	36	8.1

	Organicity workout	159	35.7
Probable clinical diagnosis at referral	Seizure	296	66.6
	Psychosis	25	5.6
	Encephalopathy	124	27.9
Commonest presenting symptom	Seizure	154	34.6
	Unconsciousness	146	32.8
	Altered behaviors	60	13.5
	Headache	30	6.7
	Others	55	12.4
Abnormality	Present	304	68.3
	Absent	141	31.7

Of all the cases, 304 (68.3%) displayed abnormalities on the EEG, with 42.7% and 19.3% exhibiting generalised and focal seizures, respectively. This information is presented in Table 2. The most prevalent type of abnormality was slow wave, accounting for 160 (36.0%). The location was generalized at 146 (47.3%), followed by frontotemporal at 52 (16.8%).

Table 2: The spectrum of EEG abnormalities among the study subjects

EEG characteristic	Categories	No.	(%)
Abnormality	Present	304	68.3
	Absent	141	31.7
EEG diagnosis	Normal	139	31.2
	Generalised epilepsy	190	42.7
	Focal epilepsy	86	19.3
	Encephalopathy	30	6.7
Types of abnormality	Slow wave	160	36.0
	Spike wave	43	9.7
	Slow wave and spike wave	33	7.4
	Sharp wave	45	10.1
	Sharp wave and spike wave	14	3.2
	Slow wave and sharp wave	15	3.4
	Normal	139	31.7
Abnormality site	Generalised	146	33.0
	Hemisphere	37	8.4
	Frontal	26	5.9
	Frontal temporal	52	11.8
	Frontal parietal	23	5.2
	Occipital frontal	2	0.5
	Temporo parietal	22	5.0
	Paracentral	1	0.2
	None	139	31.7

Patients aged 10 to 19 years accounted for the highest percentage of individuals with generalised epilepsy (75; 39.5%). Further evaluation of the relationship between age category and EEG diagnosis revealed a statistically significant correlation. The age category demonstrated statistical significance in the presence of abnormalities and EEG diagnosis. In contrast, gender was found to be statistically insignificant in both the site of abnormalities and EEG diagnosis. There was no statistical association between clinical diagnosis and EEG diagnosis.

A logistic model was conducted to ascertain whether the presence of abnormalities can be predicted based on gender, age category, and current medication. The model is statistically significant, $X^2(3) = 13.633$, $P < 0.005$. It explained 4.2% (Nagelkerke R^2) of the variance in the presence of abnormality and accurately classified 68.3% of the cases. Males were 0.825 times as likely to exhibit abnormalities as females. Increasing age was associated with a decreased presence of abnormalities. Figures 5 and 6 demonstrates some of the EEG patterns obtained from patients.

Figure 1: The management of the patients at the time of referral

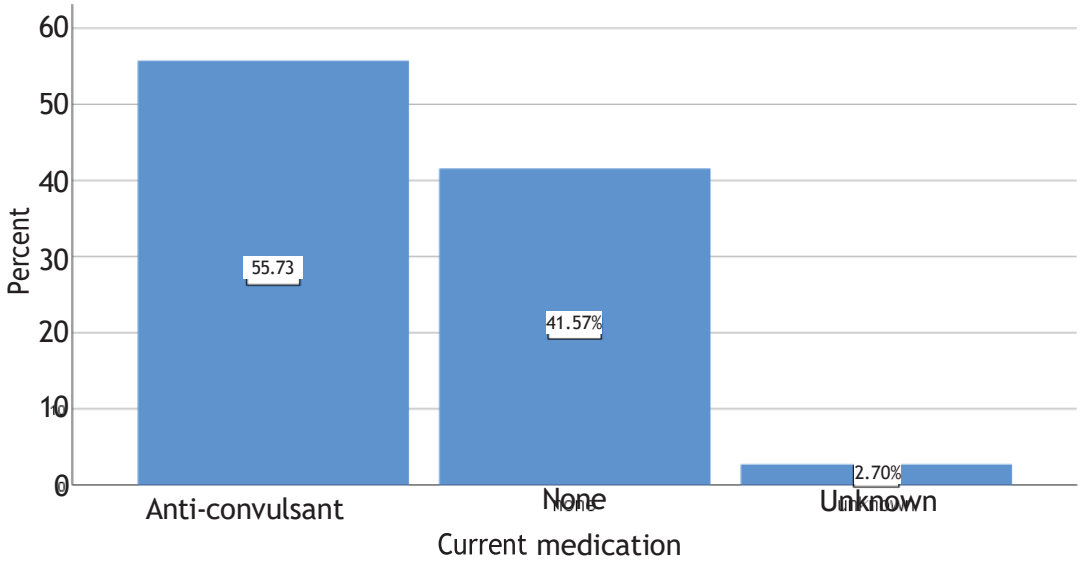


Figure 2: The commonest complaints at EEG referral

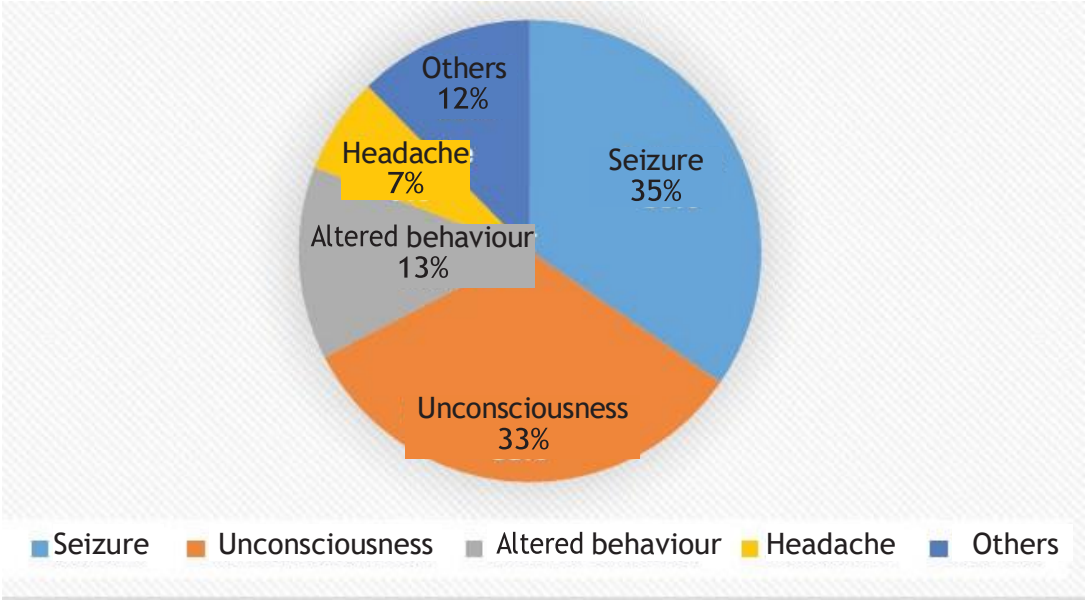


Figure 3: The various EEG diagnoses obtained among study subjects

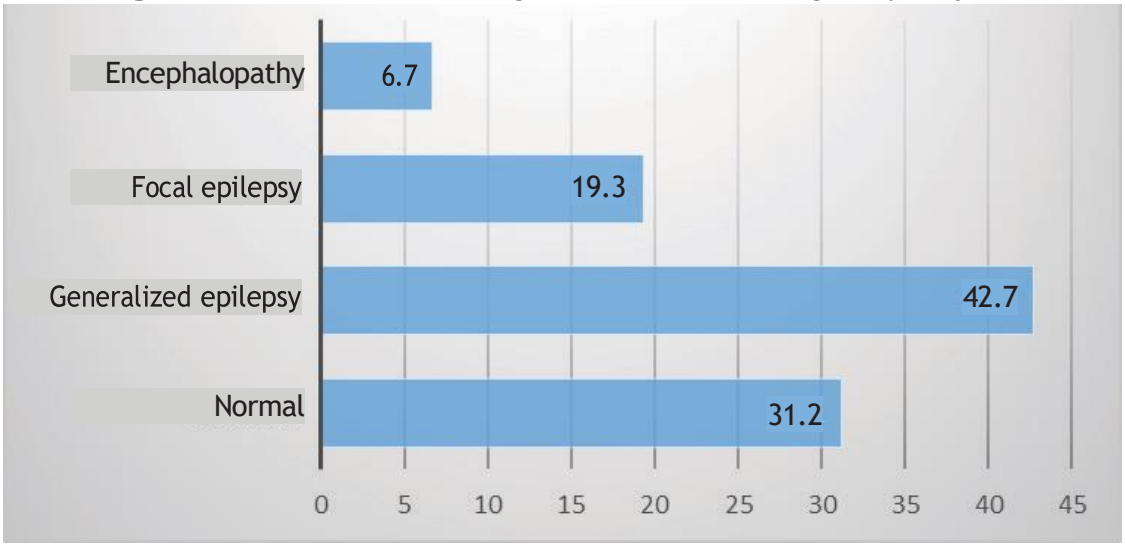


Figure 4: The distribution of EEG abnormalities among the various age categories of patients

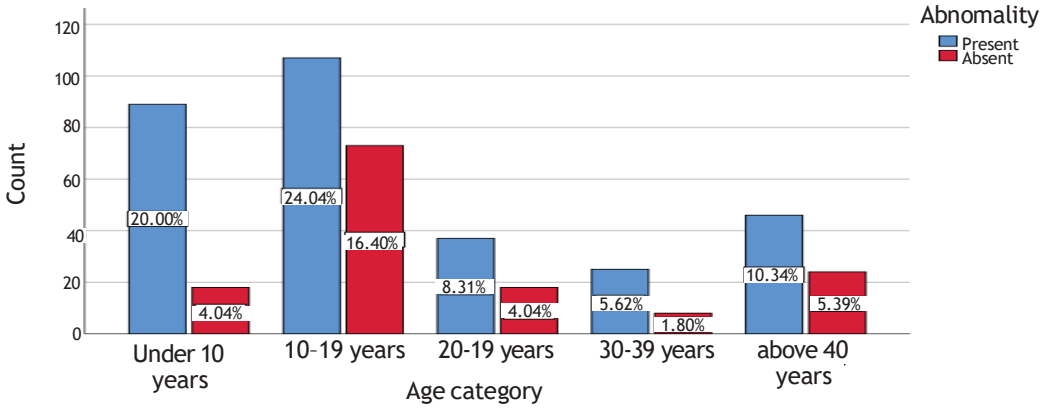


Figure 5: Sharp wave discharges on the left parieto-central region, with maximum positivity at C3, indicative of focal epileptiform discharges (Bipolar longitudinal montage)

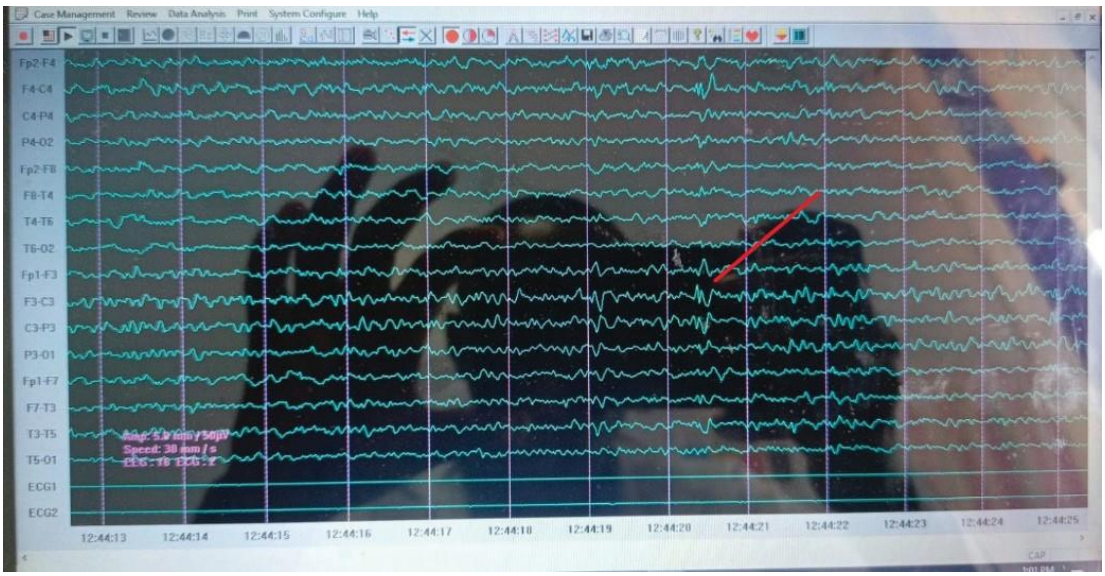
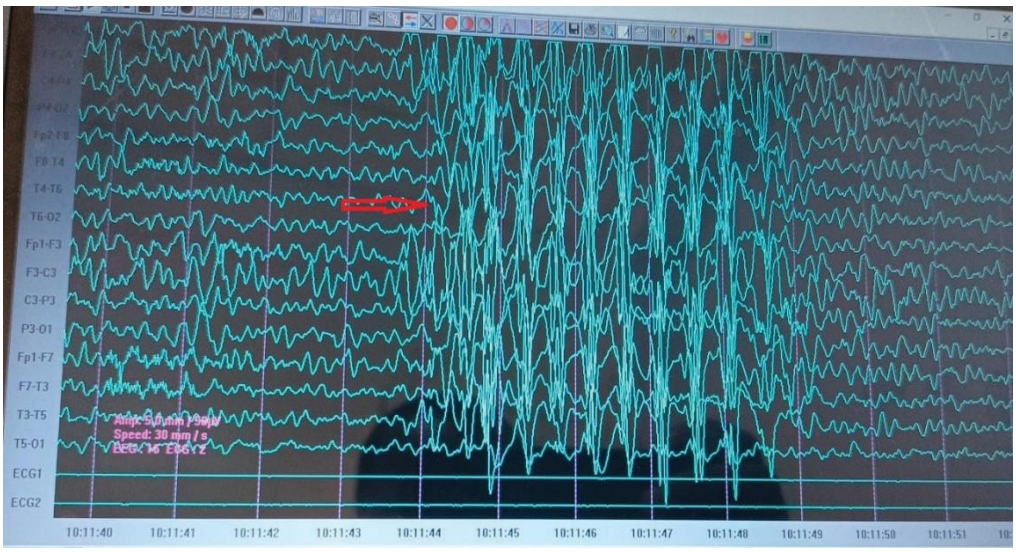


Figure 6: Generalized 2-3Hz spike and wave discharge typically seen in absence epilepsy syndromes. The arrow indicates the beginning of the discharge



Discussion

The majority of the 445 patients referred for EEG studies during the period under consideration were male. This reflects the prevalence of epilepsy in Kenya, where a study conducted in informal settlements of Nairobi indicated a prevalence of 11.9 cases per 1000 people in the population (9). Most of the patients referred for EEG are below 20 years of age, reinforcing the population demographic associated with epilepsy and other paroxysmal events in Kenya (8,9). This demographic has been shown elsewhere to correlate with a high incidence of seizure (10).

The primary reason for referral for EEG was to confirm the diagnosis of epilepsy, which aligns with a study conducted in Nigeria that found 79.5% of attendees were referred with a provisional diagnosis of seizure disorder (11). Patients exhibiting behavioural changes, some suspected of having psychosis or functional neurological abnormalities, were referred for EEG in 35.7% of cases, compared to 10% in the Nigerian study (11,12).

Our study demonstrated abnormal EEG in 68.3% of subjects, within the range reported in studies conducted elsewhere in Africa (13,14) and Asia. However, the yield of EEG is not sensitive, and prolonged EEG monitoring and video EEG are usually needed for further diagnosis and characterisation of epileptic activity. The absence of EEG abnormalities does not rule out seizure activity(16).

We demonstrated generalised slow wave activity as the commonest seizure event among abnormal EEGs. This was described in a study conducted in Uganda by Kaiser *et al* (13) in the East African region. Knowledge of the population patterns of epileptiform activity and the waveform patterns may help the neurophysiologist during EEG evaluation (5). The finding of generalised seizure disorder in 42.7% of our subjects is in keeping with other studies that have found it the commonest seizure type in hospital-based studies, as opposed to community-based studies where complex partial seizure was found to be more prevalent (12,14). It is also possible that the severe nature of the clinical presentation of generalised seizures prompts patients to visit hospitals (17). Furthermore, generalised seizures are the most common among children (18), who represent a significant proportion of our study subjects.

Normal EEG diagnoses were also frequently observed within the population, at 31.2%. Altered behaviours, headaches, and unconsciousness were common among patients with normal EEG results. These symptoms led clinicians to suspect a seizure disorder, prompting them to refer patients for EEG evaluation, as evidenced by the study conducted in Nepal (10). Further analysis to examine the association between clinical diagnosis and EEG diagnosis indicated that the association was statistically insignificant. The study recommends that clinicians, when referring patients for EEG evaluation, conduct a thorough review of the patient's medical history, including any relevant symptoms, to achieve a comprehensive understanding.

Our study also demonstrated a positive correlation between the referring clinicians'

provisional diagnosis and the EEG diagnosis, especially for seizure disorders. This was observed in the under-20 year age groups. This underscores the usefulness of EEG in providing additional diagnostic information and screening for the organic basis of psychosis and other brain disorders.

The study found a congruency between provisional diagnoses made by referring physicians and EEG diagnoses. There was a strong association between provisional diagnoses and EEG diagnoses, especially for seizure disorders. This implies that EEG is useful in evaluating seizure disorders. The EEG was also found useful in screening for an organic basis for psychosis and other organic brain disorders.

This is among the few studies in the region that outline the utility of EEG and referral patterns for EEG. It lays the basis for more insights into the role of EEG as an additional investigation among patients with suspected seizures and other paroxysmal events.

Conclusions

The present study demonstrates the crucial role of EEG in patient management and underscores the significance of its careful application. Our findings highlight that while EEG is effective for confirming a diagnosis of epilepsy, it is not reliable for excluding it, emphasizing the need for thorough clinical evaluation and judicious use of EEG in diagnostics. EEG should not be regarded as the definitive investigation for seizure disorders but as an extension of clinical assessment. When the recording is equivocal, repeated recordings with sleep deprivation, ambulatory EEG, and sleep recordings should be obtained to support the clinical suspicion.

Conflict of interest statement: The authors declare that they have no competing interests.

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