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Electroencephalographic features of convulsive epilepsy in Africa: A multicentre study of prevalence, pattern and associated factors

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HIGHLIGHTS

- Electroencephalographic abnormalities are common in Africans with epilepsy, with an adjusted prevalence of 2.7 (95% confidence interval, 2.5–2.9) per 1000 population.
- Electroencephalographic abnormalities are associated with preventable factors such as adverse perinatal events and frequent seizures.
- Electroencephalography is helpful in identifying focal epilepsy in Africa, where timing of focal aetiologies is problematic and there is a lack of neuroimaging services.

ABSTRACT

Objective: We investigated the prevalence and pattern of electroencephalographic (EEG) features of epilepsy and the associated factors in Africans with active convulsive epilepsy (ACE).
Methods: We characterized electroencephalographic features and determined associated factors in a sample of people with ACE in five African sites. Mixed-effects modified Poisson regression model was used to determine factors associated with abnormal EEGs.
Results: Recordings were performed on 1426 people of whom 751 (53%) had abnormal EEGs, being an adjusted prevalence of 2.7 (95% confidence interval (95% CI), 2.5–2.9) per 1000. 52% of the abnormal EEG had focal features (75% with temporal lobe involvement). The frequency and pattern of changes differed with site. Abnormal EEGs were associated with adverse perinatal events (risk ratio (RR) = 1.19 (95% CI, 1.07–1.33)), cognitive impairments (RR = 1.50 (95% CI, 1.30–1.73)), use of anti-epileptic drugs (RR = 1.25 (95% CI, 1.05–1.49)), focal seizures (RR = 1.09 (95% CI, 1.00–1.19)) and seizure frequency (RR = 1.18 (95% CI, 1.10–1.26) for daily seizures; RR = 1.22 (95% CI, 1.10–1.35) for weekly seizures and

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RR = 1.15 (95% CI, 1.03–1.28) for monthly seizures)).
Conclusions: EEG abnormalities are common in Africans with epilepsy and are associated with preventable risk factors.
Significance: EEG is helpful in identifying focal epilepsy in Africa, where timing of focal aetiologies is problematic and there is a lack of neuroimaging services.

1. Introduction

Epilepsy in Africa is associated with significant morbidity and mortality and a large treatment gap (Newton and Garcia, 2012). Focal features defined by seizure semiology and neurological deficits are common in people with epilepsy from Africa and may be related to perinatal complications, head injuries, and central nervous system infections (Kariuki et al., 2014). Active convulsive epilepsy (ACE) in Africa is associated with childhood onset in 60% of cases, convulsive status epilepticus in about 30%, non-adherence to treatment in 60% and psychosocial problems such as being single in over 60% (Mbuba et al., 2012; Kariuki et al., 2015b). The pattern of neurophysiological features and their association with clinical and psychosocial factors have not been fully ascertained in low and middle-income countries.

Electroencephalography (EEG) is a well-established investigation for evaluating epilepsy and is useful in confirming the diagnosis, classifying seizures, and identifying epilepsy syndromes and epileptogenic zones (Fish and Spencer, 1995). The proportion of abnormal EEGs varies between epilepsy syndromes and may differ between hospital- and community-based samples (Binnie and Stefan, 2003). In a broad sample of people with different types of epilepsy, the yield of interictal epileptiform activity in a single 30-min awake EEG recording is up to 50%, although there is substantial variability between individuals (Cockerell et al., 1996; Binnie and Stefan, 2003). The diagnostic yield of EEG can be improved through increased recording time, serial recordings, sleep and activation procedures such as hyperventilation and photic stimulation (Nuwer, 2012).

In Kenya, the EEG was abnormal in 41% of people with ACE (Munyoki et al., 2010), but this study did not relate the EEG findings to medical and psychosocial factors and cannot be extrapolated to other African settings, where clinical features and risk factors of epilepsy may differ (Ngugi et al., 2013; Kariuki et al., 2014). EEG services are becoming more readily available in Africa and are more common than neuroimaging (Wilmshurst et al., 2011). Studies characterizing the patterns of EEG abnormalities and their clinical and psychosocial correlates may contribute to improving the evaluation and management of epilepsy.

We performed EEGs on people with ACE in five African sites to determine prevalence and patterns of abnormality and to characterize the clinical and psychosocial correlates. We further determined whether these factors differed across these sites.

2. Methods

2.1. Population and sites

We performed EEG on people with ACE identified from a previous epidemiological survey conducted across five sites in Africa, (Agincourt in South Africa; Ifakara in Tanzania; Iganga in Uganda; Kilifi in Kenya and Kintampo in Ghana) (Ngugi et al., 2013). Specific details for the participating sites are available at: http://www.indepth-network.org/index.php?option=com_content&task=view&id=753&Itemid=635. The prevalence of ACE ranged from 7 to 15 per 1000 across the five sites and was associated with exposure to multiple parasites (Kamuyu et al., 2014).

2.2. Investigations and procedures

Electroencephalography was performed using a 16 channel digital recording system (Grass Technologies, Warwick, RI, USA) with electrode placement according to the international 10–20 system (Japer, 1958). All hyperventilated for 3 min and had photic stimulation (Binnie, 2003). EEGs were reported by one physician (EC), using a protocol developed under the guidance of an experienced neurophysiologist (SW). This protocol followed standard definitions of the EEG features commonly assessed in clinical practice (Binnie, 2003; Binnie and Stefan, 2003). Briefly, the report commented on the general background activity classified as normal or abnormal if there was a mild, moderate or severe excess of generalized slow activity. Significant background asymmetries between the hemispheres and non-epileptiform focal features (mainly focal theta and slow activity) were coded. Interictal epileptiform discharges (IEDs) were identified. These were defined as sharp waves, spike discharges, spike and wave complexes, polyspike and wave bursts. IEDs were classified as generalized (diffuse abnormal EEG pattern involving the entire brain), focal (localized abnormal EEG pattern involving a region of the brain) or multifocal (involving 3 or more discrete brain regions). Abnormalities during hyperventilation (focal or asymmetric slowing; focal or generalized epileptiform activity) and evidence of photosensitivity (photoparoxysmal responses) were noted. An EEG was categorized as abnormal if there was evidence of an abnormal background, focal changes, interictal epileptiform activity or an abnormal response to either of the activation procedures (hyperventilation and photic stimulation).

A sample of EEGs recordings and reports were checked for accuracy and consistency by SW. A clinician recorded use of antiepileptic drugs (AEDs) and history of febrile or non-febrile seizures in the family.

2.3. Definition of terms

Epilepsy, defined as $\geqslant$2 unprovoked seizures (ILAE, 1993), was classified as active if seizures had occurred in the previous 12 months. Seizures were classified as focal, generalized, or other using a classification system devised for epidemiologic studies (Thurman et al., 2011). Seizure frequency was categorized into daily (at least one each day; coded 3), weekly (at least one a week; coded 2), monthly (at least one a month; coded 1), and yearly (at least one a year; coded 0). Status epilepticus was defined as a history of seizures lasting 30 min or more, while for those without watches, culturally appropriate events such as boiling a pot of maize were used to estimate time as defined previously (Kariuki et al., 2015b). Status epilepticus was considered febrile if it occurred with a febrile illness. Children were defined as those <18 years. A clinician assessed cognitive status by asking standardized questions about awareness of place, person and time. Determination of malnutrition was described previously (Kariuki et al.,