

## Research paper

## EMG indications and findings in a sub-Saharan African neurorehabilitation center

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## ABSTRACT

**Objective:** This study aims to assess the frequency and indication for electrodiagnostic referrals as well as to summarize the findings from the procedure at a neurorehabilitation center in Ibadan, Nigeria.**Methods:** This is a retrospective cross-sectional study. Data from referrals to Blossom Medical Centre/World Federation for Neurorehabilitation (BMC/WFNR) center, Ibadan, Nigeria, from April 2014 to December 2016 were collated and analyzed.**Results:** Sixty referrals were received during the period of evaluation. Neurologists referred most of the patients (47; 71.7%). Disorders of the peripheral nerves were the most frequent reasons for electromyography (EMG), and they were the most common electrodiagnosis with better classified into axonal and demyelinating types. The overall congruence between the suspected diagnosis and final diagnosis was 58.3%. Requests by neurologists were significantly more appropriate than those by other specialists ( $p$  value = 0.02).**Conclusion:** Polyneuropathy, entrapment neuropathy, and disorders of the motor nerve root and plexus were the most common reasons for electrodiagnostic requests, and the majority of the referrals were from neurologists.**Significance:** EMG has changed the approach towards the diagnosis and management of neuromuscular disorders in Nigeria. It is hoped that with more neurophysiology education in this environment, neurophysiological practice will become widely available.© 2018 International Federation of Clinical Neurophysiology. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## 1. Introduction

Being an extension of the neurological examination, nerve conduction studies (NCs) and electromyography (EMG) are performed to assess the integrity of the peripheral nervous system and diagnose the diseases affecting it (Fuller, 2005). Without doubt, electrodiagnostic studies play an important role in neurology and neurorehabilitation medicine. In addition to objectifying neurologic damage, it assists in prognosticating the outcome of neuromuscular disorders. For example, NCs are useful in mapping the recovery from a compression neuropathy or a neuropraxic lesion. In patients with Guillain-Barré Syndrome (GBS), electrodiagnostic testing is perhaps the most important predictor of outcome, as patients with severe axonal loss have poorer outcomes (Gutierrez

and Sumner, 2014). Additionally, EMG is pivotal in movement analysis. In particular, surface EMG (sEMG) provides a simple, non-invasive method to assess the activation of muscles involved in performing specific tasks; hence, sEMG analysis has been widely employed in the field of ergonomics, biomechanics, sports science, and kinesiology (Gutierrez and Sumner, 2014).

Although electrodiagnostic study is becoming available in Nigeria, it is still unavailable at most neurorehabilitation centers. With an aim to improve service delivery and health outcomes at the Blossom Medical Centre (BMC)/World Federation for Neurorehabilitation (WFNR) center, EMG service was started in April 2014 following partnership with Monitor Healthcare Limited (UK/Nigeria) to align with the TREAT (treatment, research, enlightenment, advocacy, and training) mantra of the center (WFNR, 2017). This study aims to assess the frequency and indication for electrodiagnostic referrals while summarizing the findings in this neurorehabilitation center between April 2014 and December 2016.

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## 2. Methods

In this retrospective, cross-sectional study, data from consecutive patients referred for EMG for the first time at the BMC/WFNR Center, Ibadan, Nigeria, from April 2014 to December 2016 were collated and analyzed. Direct referrals to the electromyographer were also included. Patients who had a repeat study were excluded.

A spreadsheet was created and the following data imputed; age, sex, and type of referring physicians (neurologist, orthopedic surgeon, other specialist, or general practitioners), the working diagnosis of the referring physician, and electrodiagnosis; the final diagnosis was made according to the results of electrodiagnostic assessments. Conduction studies for common nerves in the upper and lower limbs were performed. This included both sensory and motor studies. F-wave studies (Fig. 1) were equally performed to evaluate proximal portions of nerves for conduction abnormalities. The blink reflex and electroneurography of the facial nerve were performed for patients referred for peripheral facial nerve paresis. In addition, repetitive nerve stimulation was performed in suspected cases of neuromuscular junction disorders. Needle EMG was performed with concentric EMG needle to confirm diagnosis whenever necessary (Fig. 2). EMG with interference pattern analysis was also performed for movement analysis (Fig. 3).

The working diagnosis before electrodiagnostic study as well as the final diagnosis were classified according to the World Federation of Neurology (WFN) neuromuscular disease categories (Swash and Schwartz, 1997): (1) SMA and other Disorders of the Motor Neurons, (2) Disorders of the Motor Nerve Roots, (3) Disorders of the Peripheral Nerves, (4) Disorders of the Neuromuscular Transmission, (5) Disorders of the Muscles, and (6) Disorders of Supraspinal Tonal Regulation. Appropriateness of EMG request, as well as congruence of working diagnosis and electrodiagnosis, was determined. The EMG request was deemed appropriate if the electromyographer (PBA) felt that the procedure would validate the suspected diagnosis or elaborate on the patient's symptoms or signs. EMG was considered useless when it produced normal findings in patients with clinical features that indicated diseases not involving the peripheral nervous system according to Di Fabio et al. (2013). Congruence was established when the working diagnosis and post-EMG diagnosis are in agreement irrespective of the presence of an additional diagnosis. In this respect, cases of suspected GBS were regarded as congruent if the electrodiagnostic study showed evidence of acute polyneuropathy regardless of the variants.

All statistical analyses were performed using SPSS version 20.0 (SPSS; IBM, Chicago, IL, USA). Descriptive statistics were expressed as mean values and standard deviation as well as frequencies and percentages. The chi-square test was used to compare referring physicians (neurologist vs. non-neurologist) with regard to frequency of referrals, appropriateness, and the congruence of suspected diagnosis and final diagnosis. A  $p$  value  $<0.05$  was considered to be statistically significant.

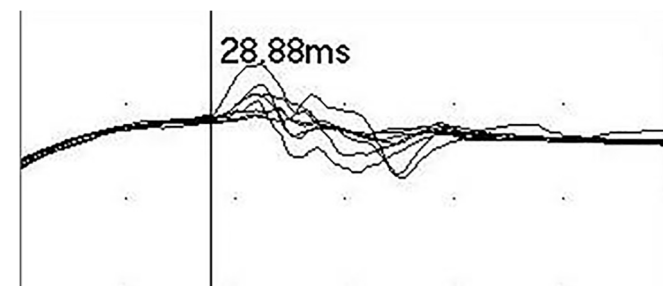


Fig. 1. Superimposed median nerve F waves showing F wave<sub>min</sub> of 28.88 ms.

## 3. Results

### 3.1. Demography, referral rates, and sources

Sixty referrals were received during the period of evaluation. Thirty-four referrals were received between April 2014 to December 2015 (referral rate  $<2$ /month), whereas in 2016, 26 referrals were received (referral  $>2$ /month). There were 32 males (mean age  $\pm$  SD,  $48.7 \pm 18.3$  years) and 28 females (mean age  $\pm$  SD,  $42.9 \pm 18.9$  years). Overall, the mean age (range) of the total examinees was 45.9 (11–77) years. Fig. 4 shows the age and gender distribution of patients referred for EMG. Neurologists referred 47 (71.7%) patients, whereas orthopedic surgeons referred 8 (13.3%) patients. Nine patients (15.0%) were referred by other specialists including general practitioners (GPs).

### 3.2. Indications and findings

Disorders of the peripheral nerves were the most frequent reason for EMG. Chronic polyneuropathy was the most frequently suspected diagnosis (10; 16.7%). Disorders of the motor nerve root were the next commonest reason for EMG request. Cervical radiculopathy (4; 6.7%) and brachial plexopathy (3; 5.0%) were the most frequent suspicion in this category. Seven (11.7%) requests had no working diagnosis, whereas 8 (13.3%) studies were normal. Table 1 shows the suspected diagnosis prompting the request for EMG and the electrodiagnosis.

### 3.3. Congruence and appropriateness

Table 2 shows the congruence between clinical and electrodiagnosis. The overall congruence between the suspected diagnosis and final diagnosis was 58.3%. Among neurologists, congruence was 65.1%, whereas among other specialists, congruence was 41.1%. There was no statistical difference in the congruence of diagnosis between neurologists ( $p$  value = 0.90) and other specialists, although requests by neurologists were significantly more appropriate than those by other specialists ( $p$  value = 0.02).

## 4. Discussion

Neurorehabilitation medicine is a developing subspecialty in Nigeria, and it is currently burdened with inadequate number of professionals, increasing number of road-traffic injury-related neurological disorder, as well as poor interprofessional relationship among neurorehabilitation team members (Hamzat, 2016). At the BMC/WFNR Center, however, the core value of team work involves the integration of the electrodiagnostic services provided by Monitor Healthcare Limited, UK/Nigeria. Although the number of referrals received during this period appeared very modest, the referral rate actually improved in 2016. This improvement could indicate an increased awareness of the availability of this service at the center.

More than two-third of the referrals were received from neurologists, whereas non-neurologists referred less than one-third of the patients. This could still reflect the fact that most of the other physicians had no indication for referrals or are unaware of the availability of this service. On the flip side, this outlook could also be due to the fact that neurologists are the ones who actually perform the EMG in our environment; hence, they are more aware of the utility, sensitivity, specificity, and the indications for EMG. A study carried out in Italy found that 25% of the 3900 requests were referred by GPs (Cocito et al., 2006), and another study, also in Italy, found that 57% of the 1317 requests were referred by the GPs (Di Fabio et al., 2013) (more than neurologists and orthopedic



Fig. 2. Needle EMG showing neurogenic motor unit potentials.

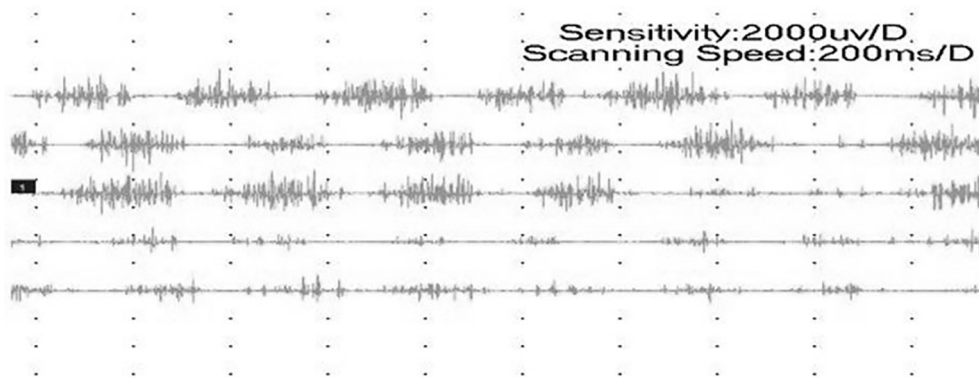


Fig. 3. Right masseter needle EMG showing tremor (4 Hz) on attempt to open the mouth by a patient with trismus.

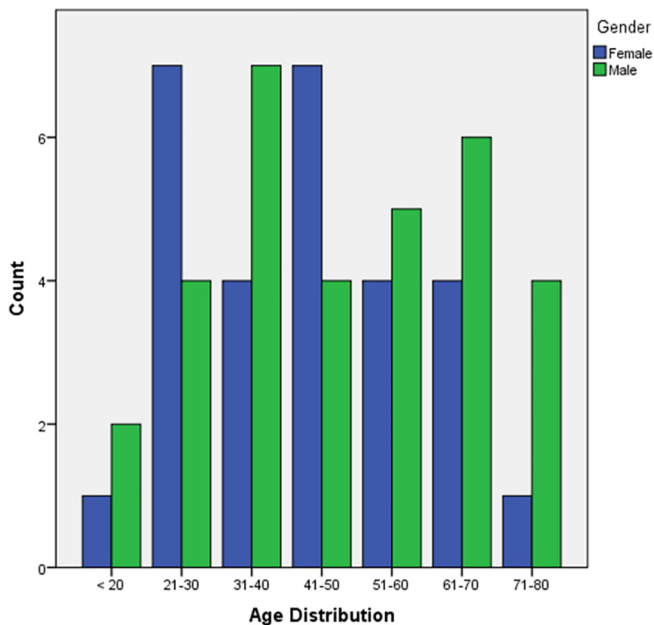


Fig. 4. Age and gender distribution of the patients referred for electrodiagnostic evaluation.

surgeons); this probably reflects an increased awareness of the usefulness of EMG by other physicians in addition to neurologists and orthopedic surgeons over time. The odds of inappropriate requests were, however, higher among GPs.

Polyneuropathy was the commonest indication for EMG request accounting for 45% of the suspected diagnosis and 46.6% of electrodiagnosis. EMG clarified the variants of GBS in all the suspected cases (Table 1). For Carpal Tunnel Syndrome (CTS), although it was suspected in only two of the referrals, EMG confirmed CTS in 6 subjects. In patients with suspected chronic polyneuropathy (Di Fabio et al., 2013), 7 were of the demyelinating type, whereas 4 had chronic axonal polyneuropathy. Clearly, in the patients with peripheral neuropathy, EMG provided a clear electrophysiological diagnosis which assisted with prognostication and neurorehabilitation planning. Only 1 of the 3 suspected cases of motor neuron disease (MND) met the modified El Escorial criteria for probable amyotrophic lateral sclerosis (ALS) (Joyce and Carter, 2013), whereas 1 case met electrodiagnostic criteria for multifocal motor neuropathy with conduction block (MMNCB); the third patient had polyradiculopathy. The performance of MND electrodiagnostic protocols enables the exclusion of treatable neuropathies such as multifocal motor neuropathy in which conduction block and temporal dispersion are the usual findings (Joyce and Carter, 2013).

Our study found an overall congruence of 58.3%, a rate higher than that found by earlier studies where a lower degree (<45%) of congruence was reported (Mondelli et al., 1998; Podnar, 2005). The higher rate of congruence in our study is probably due to the higher number of referrals from neurologists in this cohort, as the congruence among referrals by other specialist mirrors previously documented findings. As a matter of fact, Di Fabio et al. (2013) found a much less level of congruence (<20%) among their study; again, this probably reflected the higher number of referrals coming from GPs in that study. The GPs were also more likely to make nonspecific requests hence driving the congruence low.

**Table 1**

Suspected diagnosis and electrodiagnosis according to their categories.

WFN Neuromuscular Diseases Categories	Suspected Diagnosis (n = 60)	n(%)	Electrodiagnosis (n = 60)	n (%)
SMA and other Disorders of the Motor Neurons	Motor Neuron Disease	3(5.0)	Probable ALS	1(1.7)
Disorders of the Motor Nerve Roots	Brachial Plexopathy	3(5.0)	L4/L5 Radiculopathy	2(3.3)
	Cervical Radiculopathy	4(6.7)	L4/L5/S1 Radiculopathy	2(3.3)
	Lumbosacral Radiculopathy	2(3.3)	C5/C6 Radiculopathy	3(5.0)
			C5/C6/C7 Radiculopathy	1(1.7)
			Brachial Plexopathy	2(3.3)
Disorders of the Peripheral Nerves	Guillain-Barré Syndrome	3(5.0)	Bell's Palsy	3(5.0)
	CIDP	5(8.3)	AIDP	2(3.3)
	Bell's Palsy	3(5.0)	AMAN	2(3.3)
	Axillary Neuropathy	1(1.7)	Chronic Demyelinating Polyneuropathy	7(11.7)
	Peroneal Neuropathy	1(1.7)	Carpal Tunnel Syndrome	6(10.0)
	Sciatic Nerve Injury	1(1.7)	Mononeuropathy Multiplex	1(1.7)
	Charcotte-Marrie Tooth Disease	2(3.3)	Chronic Axonal Polyneuropathy	4(6.7)
	Carpal Tunnel Syndrome	2(3.3)	Sciatic Neuropathy (Above the Knee)	1(1.7)
	Tarsal Tunnel Syndrome	1(1.7)	MMNCB	1(1.7)
	Neuralgic Amyotrophy	1(1.7)	Anterior Interosseous syndrome*	1(1.7)
	Postdiphtheritic Polyneuropathy	1(1.7)		
	Polyneuropathy	5(8.3)		
	Distal Sensory Polyneuropathy	1(1.7)		
Disorders of the Neuromuscular Transmission	Myasthenia Gravis	1(1.7)	Post Synaptic NMJ disorder	1(1.7)
	Periodic Paralysis	1(1.7)		
Disorders of the Muscles	Myopathy	2(3.3)	Myopathy	3(5.0)
	Polymyositis	2(3.3)	Necrotizing Myopathy	2(3.3)
	Steroid-Induced Myopathy	1(1.7)		
	Congenital Myopathy	1(1.7)		
Disorders of Supraspinal Tonal Regulation	Cervical Dystonia	3(5.0)	Spasmodic Torticollis	3(5.0)
	Jaw Dystonia	1(1.7)	Dystonic Jaw Tremor	1(1.7)
	Tremors	2(3.3)	Tremor	1(1.7)
			Enhanced Physiological Tremor	1(1.7)
			Central Pattern	1(1.7)
Unclassified	No Suspected Diagnosis	7(11.7)	Normal Studies	8(13.3)

AIDP = acute inflammatory demyelinating polyneuropathy; AMAN = acute motor axonal neuropathy; MMNCB = multifocal motor neuropathy with conduction block.

\* = Additional diagnosis in a patient with cervical spondylotic radiculopathy.

**Table 2**

Requests, congruence, and appropriateness of referral between neurologist and other specialist.

EMG (n = 60)	Request by Neurologist 43(100%)	Request by other Specialist 17(100%)	$\chi^2$	OR	95% CI	P-value
Appropriate EMG Request	43(100)	15(88.2)	5.23	1.13	0.95–1.35	0.02
Congruent Clinical and Electrodiagnosis	28(65.1)	7(41.2)	2.87	0.38	0.12–1.19	0.90
Need for Neurorehabilitation	36(83.7)	15(88.2)	0.19	1.46	0.27–7.85	0.65

 $\chi^2$  = Chi-square test; EMG = electromyography.

Although we had fewer referrals from other specialties, it is still good for the other physicians to know the diagnostic limits of EMG (Smith et al., 2001). The appropriateness of referral was significantly higher among neurologists than other physicians. This outlook probably reflected the fact that neurologists being better aware of the usefulness and limits of EMG would make more appropriate request than other specialties. More than 80% of the patients observed needed physical rehabilitation and were referred to the rehabilitation team accordingly. We, however, did not follow-up to see what mode of physical rehabilitation they had.

Our study is limited by its modest sample size and the fact that it is a retrospective single institution report. To the best of our knowledge, this is the first study in our environment profiling electrodiagnostic findings. With the growth of electrodiagnostic studies in Nigeria, future, larger studies will address other issues such as the duration of the procedure, number of needle pricks, improving appropriateness of requests by other specialties and detailing the normative data, and organizing specific electrodiagnostic protocol.

In conclusion, this survey found a steady increase in request for electrodiagnostic studies in our environment, with polyneuropathy, entrapment neuropathy, and disorders of the motor nerve root

and plexus being the most common reasons for electrodiagnostic requests.

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### Conflict of interest

Nil.

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Nil.

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