Neurological disorders encountered at an out-patient clinic in Ghana's largest medical center: A 16-year review

Albert Akpalu [a,b,*], Patrick Adjei [a,b], Kodwo Nkromah [b], Foster Osei Poku [b,c], Fred Stephen Sarfo [d]

[a] University of Ghana Medical School, Accra, Ghana
[b] Korle Bu Teaching Hospital, Accra, Ghana
[c] Akwatia Hospital, Ghana
[d] Kwame Nkrumah University of Science and Technology, School of Medical Sciences, Kumasi, Ghana

A B S T R A C T

Background: With a rising age of its population, sub-Saharan Africa(SSA) is currently experiencing an unprecedented rise in burden of neurological disorders. There is limited data on the demographic profile of neurological diseases in SSA.
Objective: To describe the spectrum of neurological disorders at the adult neurology clinic at Ghana's leading medical center.
Methods: This retrospective study was conducted at the adult neurology clinic at the Korle Bu Teaching Hospital between 2003 and 2019. We retrospectively reviewed charts of all cases seen at the clinic over the period to document main neurological diagnosis, and captured age and sex of participants. Neurologic diseases were classified using the revised International Statistical Classification of Diseases and Related Health Problems ICD 11 tool.
Results: There were 7950 patients sought consultation over the period with 7076 having a primary neurological disorder. The mean age ± SD of patients included in the analysis was 43.0 ± 19.8 years with 3777 (53.4%) being males. The frequencies of the top 5 neurological disorders were epilepsy (23.0%), peripheral neuropathies (19.6%), movement disorders (14.7%), cerebrovascular diseases (11.1%) and headache disorders (7.7%). Neurocognitive disorders, autoimmune demyelinating disorders of the nervous system, and motor neuron disorders were infrequently observed.
Conclusion: A wide spectrum of neurological disorders were encountered in this clinic, similar to previous report from other centers in SSA. There is an urgent need to build local capacity to provide optimal care to meet the demand of the rising burden of neurological diseases in Ghana.

1. Introduction

Across several regions of the globe, neurological disorders remain the leading cause of disability and the second leading cause of death [1]. Between 1990 and 2015, the absolute number of people who were affected by, disabled or died dying from neurological disorders across the globe increased. However, age-standardized incidence, mortality and prevalence rates of several neurological disorders declined over the period [1] . These worrying statistics mean that progress towards mitigating the burden of neurological disorders may not meet the UN Sustainable Development Goal target by 2030 [2,3]. Sub-Saharan Africa is a

region experiencing a rapid surge in non-communicable diseases due to increasing growth in the ageing population and urbanization fueling an epidemiologic transition from communicable to non-communicable diseases (NCDs). SSA unfortunately is saddled with a myriad of challenges in controlling NCDs including neurological disorders [2]. For instance, the neurologist-to-population ratio is estimated at 0.3:1,000,000 on the African continent with a population of 1 billion. Ghana unfortunately is no different with 9 neurologists serving a population of 31 million people [4]There is therefore the need to provide data on the burden and spectrum of neurological disorders to guide evidence-based health-care policy planning and resource allocation in

this region. This study aims to provide directly enumerated data over a 16-year period on the spectrum of neurological disorders presenting to the adult neurology clinic of the Korle Bu Teaching Hospital, Ghana's premiere tertiary medical center.

2. Methods

2.1. Study design & settings

This is a retrospective study of out-patient adult neurological consultations between January 2003 and December 31, 2019 at the neurology clinic of the Korle Bu teaching hospital (KBTH). KBTH is situated in Accra, the capital city of Ghana with a population of 5.05 million. The clinic is run by three neurologists (AA, PA and KN). Adult patients with neurologic symptoms are referred from several of the 16 regions of Ghana for evaluation and management. We collated de-identified data from a total of 7950 patient medical charts capturing primary neurological diagnosis, age and sex. The requirement for informed consent was waived by the Institutional Review Board due to use of de-identified data from medical health records.

The Neurology unit is supported by a Neurophysiology laboratory (Cadwell Electroencephalogram [EEG], Electromyography [EMG] and Nerve conduction studies, Visual evoked Potentials [VEP]) and a functioning Neuroradiology department with 64 slice CT scan, 1.5Tesla MRI, carotid doppler USG scan. Adequate laboratory support is available to support cerebrospinal fluid analysis inclusive of oligoclonal bands, Aquaporin-4 antibodies, Acetylcholine receptor antibodies and anti-muscle specific kinase antibodies. A full multidisciplinary team (MDT) stroke unit was established in 2014 with a capacity of 20 beds. The neurology unit is also accredited for training of neurologists by the postgraduate colleges and receives exchange students and neurology trainees.

2.2. Classification of neurologic diseases

Neurologic disorders were classified according to the 11th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-11) [5] in the following table:

ICD 11 Classification of diseases https://icd.who.int/en [5].

1	Movement disorders
2	Disorders with neurocognitive impairment as a major feature
3	Multiple sclerosis or other white matter disorders
4	Epilepsy or seizures
5	Headache disorders
6	Cerebrovascular diseases
7	Spinal cord disorders excluding trauma
8	Motor neuron diseases or related disorders
9	Disorders of nerve root plexus or peripheral nerves
10	Diseases of neuromuscular junction or muscle
11	Cerebral palsy
12	Nutritional or toxic disorders of the nervous system
13	Disorders of cerebrospinal fluid pressure or flow
14	Disorders of autonomic nervous system
15	Human prion diseases
16	Disorders of consciousness
17	Other disorders of the nervous system
18	Postprocedural disorders of the nervous system
19	Miscellaneous: Injuries of the nervous system; Neoplasms of the nervous system; Structural developmental anomalies of the nervous system; Syndromes with central nervous system anomalies as a major feature; Non-viral and unspecified infections of the central nervous system; Symptoms, signs or clinical findings of the nervous systeParalytic symptoms; Dissociative neurological symptom disorder; Other specified diseases of the nervous system and
20	Not classified.

2.3. Statistical analysis

Means and medians were compared using either the student's t-test or Mann-Whitney's U test for paired comparisons or ANOVA or Kruskal Wallis tests for more than 2 group comparisons. Statistical significance was set at a two-tailed p-value <0.05 with no adjustment for multiple comparisons. Statistical analysis was performed using GraphPad Prism version 7 (GraphPad Software, Inc).

3. Results

3.1. Basic demographic characteristics of study population

Between 2003 and 2019, 7950 patients sought medical care at the neurology clinic. We excluded 874 patients who did not have a primary neurological disorder from further analysis, leaving 7076 patients for inclusion in the present analysis. The mean age $\pm$ SD of patients included in the analysis was 43.0 ± 19.8 years with 3777 (53.4%) being males.

3.2. Profile of neurological disorders

The frequencies of the broad categories of neurological disorders encountered at the clinic as classified according to the ICD 11 coding are presented in Table 1. In brief, the top 5 neurological disorders were epilepsy (23.0%), peripheral neuropathies (19.6%), movement disorders (14.7%), cerebrovascular diseases (11.1%) and headache disorders (7.7%). There were no reported cases of human prion diseases. Presented in the following sections are age and sex as well as clinical descriptors of the disorders by ranking.

(1) **Epilepsy & Seizure disorders ($n = 1627$):** The average age of patients with epilepsy and seizure disorders was 30.8 ± 16.9 years, with 858 (52.7%) being males and 769 (47.3%) being females. There were 1317 (80.9%) primary epilepsy diagnoses, 298 (18.3%) symptomatic seizure disorders and 12 (0.8%)

Table 1

Frequency of neurological disorders classified according to ICD 11 Coding Top blocks.

ICD code 11	Category of Neurological disorder	Number	Percentage
1	Movement disorders	1037	14.7
2	Disorders with neurocognitive impairment as a major feature	284	4.0
3	Multiple sclerosis or other white matter disorders	150	2.1
4	Epilepsy & other seizure disorders	1627	23.0
5	Headache disorders	543	7.7
6	Cerebrovascular diseases	784	11.1
7	Spinal cord disorders excluding trauma	240	3.4
8	Motor neuron diseases or related disorders	157	2.2
9	Disorders of nerve root, plexus or peripheral nerves	1384	19.6
10	Diseases of neuromuscular junction or muscle	286	4.0
11	Cerebral palsy and other neurodevelopmental disorders	67	0.9
12	Nutritional or toxic disorders of the nervous system	6	0.1
13	Disorders of cerebrospinal fluid pressure or flow	64	0.9
14	Disorders of autonomic nervous system	17	0.2
15	Human prion diseases	0	0.0
16	Disorders of consciousness	8	0.1
17	Other disorders of the nervous system	164	2.3
18	Post procedural disorders of the nervous system	5	0.1
19	Miscellaneous	115	1.6
20	Not classified	138	2.0
	TOTAL	**7076**	**100.0**

psychogenic nonepileptic seizures (PNES) with respective mean ages of 28.3 ± 15.2 years, 41.9 ± 19.7 years and 28.3 ± 15.3 years, $p < 0.0001$. Among those with primary epilepsy disorders ($n = 1317$), 26.0% were focal-onset, 36.6% were of generalized-onset and 37.4% were unclassified by seizure onset with no significant differences in the mean ages. The etiologies of symptomatic seizures by decreasing frequency are presented in Table 2, with Post stroke epilepsy, systemic/metabolic derangements and post traumatic brain injury being the most common.

(2) **Disorders of nerve root, plexus or peripheral nerves ($n = 1384$):** The proportions of disorders affecting nerve root, plexus or peripheral nerves according to distribution of nerve injury include spondyloses with radicular symptoms 60.4%, various mononeuropathies 16.5%, polyneuropathies 11.0%, peripheral neuropathies 5.3%, Guillain Barre syndrome 3.1%, plexopathies 1.4%, chronic inflammatory demyelinating polyradiculopathy 1.3%, radiculopathies 0.6%, mononeuritis multiplex 0.3%, and post-electrocution 0.2%.

(3) **Movement disorders ($n = 1037$):** There were 613 cases with hypokinetic movement disorders, 381 with hyperkinetic movements disorders and 43 movements were not classified as either hyperkinetic or hypokinetic. The age and sex distribution as well as the specific movement disorders are shown in Table 3.

(4) **Cerebrovascular diseases ($n = 784$):** Among patients with CVDs, 54.8% were ischemic stroke survivors, 29.5% had untyped strokes, 6.8% were Intracerebral hemorrhagic stroke survivors, 5.0% had recurrent stroke, 1.9% had transient ischemic attack, 1.7% had sub-arachnoid hemorrhage and 0.4% had cerebral venous sinus thrombosis.

(5) **Headaches ($n = 543$):** Migraine occurred at a frequency of 43.5%, followed by tension-type headaches at 19.9%, unspecified headaches at 18.4%, with the remainder shown in Table 4.

(6) **Diseases of muscle and Neuromuscular junction ($n = 286$):** The frequencies observed in decreasing order were myasthenia gravis at 72.0%, myopathies 8.4%, limb girdle dystrophy 5.6%, other muscular dystrophies 5.6%, Duchenne muscular dystrophy 2.8%, periodic paralysis 2.4%, polymyositis 1.4%, Becker's muscular dystrophy 1.0% and dermatomyositis 0.7%.

(7) **Disorders with neurocognitive impairment as a major feature ($n = 284$):** The mean age of patients with neurocognitive impairment was 53.5 ± 20.6 years with 164 (57.7%) being males.

Table 2
Etiology of symptomatic seizure disorder at out-patient clinic in Ghana.

Rank	Etiology	Number	Percentage
1	Post-stroke epilepsy	89	29.9
2	Systemic/metabolic derangements	48	16.1
3	Intracranial lesions of uncertain etiology	39	13.1
4	Post traumatic brain injury	34	11.4
5	Brain tumors	21	7.0
6	Post-infectious intracranial diseases	20	6.7
7	Congenital malformations	14	4.7
8	Alcohol-related	11	3.7
9	Vascular malformations	7	2.3
10	Post-procedural	7	2.3
11	Autoimmune disorders	3	1.0
12	Drug abuse	2	0.7
13	Sickle cell anemia	2	0.7
14	Post-eclampsia	1	0.3
	TOTAL	**298**	**100.0**

Table 3
Demographic characteristics of patients with movement disorders at a tertiary out-patient clinic in Ghana.

Movement disorder	Number	Age Mean ± SD	Age Median (IQR)	Male	Female	M/F ratio
Hypokinetic disorders						
Idiopathic Parkinson's disease	539	63.2 ± 13.4	65 (57–72)	344	195	1.76
Parkinsonism, vascular	43	66.4 ± 11.1	67 (59–74)	29	14	2.07
Parkinsonism, drug-induced	8	53.6 ± 12.4	58 (40–64)	4	4	1.00
Parkinson plus syndrome	5	53.2 ± 16.2	59 (37–67)	5	0	N/A
Multiple System Atrophy	4	54.8 ± 17.2	54 (39–72)	2	2	1.00
Progressive Supranuclear Palsy	4	68.0 ± 9.4	67 (60–78)	4	0	N/A
Cortico-basal degeneration	3	56.0 ± 27.5	55 (29–84)	1	2	0.50
Parkinsonism, unclassified	3	26.3 ± 9.3	22 (20–37)	3	0	N/A
Parkinsonism, post infectious	2	54 ± 11.3	54 (46–62)	1	1	1.00
Parkinsonism, Manganese toxicity	1		61	1	0	N/A
Parkinsonism, Head injury	1		30	1	0	N/A
Hyperkinetic disorders						
Dystonia	180	46.7 ± 17.7	49 (33–61)	110	70	1.57
Essential tremors	106	45.4 ± 20.6	44 (26–65)	64	42	1.52
Tremors-other causes	28	44.0 ± 16.6	39 (30–58)	16	12	1.33
Spinocerebellar ataxia	17	31.3 ± 17.8	26 (14–50)	10	7	1.43
Cerebellar disorders	14	48.9 ± 22.6	47 (30–76)	6	8	0.75
Tardive dyskinesia	10	52.2 ± 17.2	49 (38–66)	5	5	1.00
Myoclonus	9	47.4 ± 23.4	44 (31–62)	4	5	0.80
Huntington's disease	3	59 ± 17.4	55 (44–78)	1	2	0.50
Dyskinesia-drug induced	3	52 ± 7.8	56 (43–57)	1	2	0.50
Psychogenic movements	3	41 ± 22.1	49 (16–58)	0	3	0.00
Tremors-drug induced	3	51.0 ± 7.6	52 (43–58)	1	2	0.50
Tics	2	57 ± 7.1	57 (52–62)	1	1	1.00
Unclassified	46	47.5 ± 18.4	50 (31–63)	23	23	1.00
TOTAL	**1037**			**637**	**400**	**1.59**

The frequencies of disorders encountered under this group are vascular dementia 31.3%, pseudodementia 24.3%, Alzheimer's dementia 12.3%, mild cognitive impairment 12.0%, dementia unclassified 10.9%, and mixed dementias 2.8%. The rest include post-traumatic, dementia with Lewy bodies, normal pressure hydrocephalus, post-infectious, HIV associated dementia and fronto-temporal dementia at frequencies below 1%.

(8) **Spinal cord disorders excluding trauma ($n = 240$):** There were 103 (42.9%) unclassified myelopathy, 100 (41.7%) compressive myelopathy, 15 (6.3%) Potts disease, 5 (2.1%) hereditary spastic paraparesis, 5 (2.1%) syringomyelia, 4 (1.3%) spinal deformity, 3 (1.3%) HTLV associated myelopathy, 3 (1.3%) subacute

Table 4
Frequencies of headache types at a tertiary out-patient clinic in Ghana.

Types of headaches	Number	Percentage
Migraine	236	43.5
Tension headache	108	19.9
Headache unspecified	100	18.4
Headache attributed to infection	25	4.6
Headache due to trauma to head or neck	12	2.2
Cluster headaches	11	2.0
Headache-cervicogenic	11	2.0
Headache attributed to non-vascular intracranial disorder	10	1.8
Trigeminal autonomic cephalgia	9	1.7
Headache attributable to cranial and/or cervical vascular disorder	7	1.3
Idiopathic Intracranial hypertension	7	1.3
Headache-psychogenic	3	0.6
Headache attributed to disorder of homeostasis	2	0.4
Post-coital headache	1	0.2
Temporal arteritis	1	0.2
TOTAL	543	100.0

combined degeneration of cord and 2 (0.8%) with HIV myelopathy. Among the 100 cases with compressive myelopathy, 46 were due to disc protrusion, 11 were from malignancies, 1 from connective diseases, but 42 were still unclassified.

(9) **Motor neuron diseases or related disorders ($n = 157$):** There is a male predominance of motor neuron disease in a ratio of 2.6:1 and the average age of 41.0 ± 15.0 years (age and sex distribution
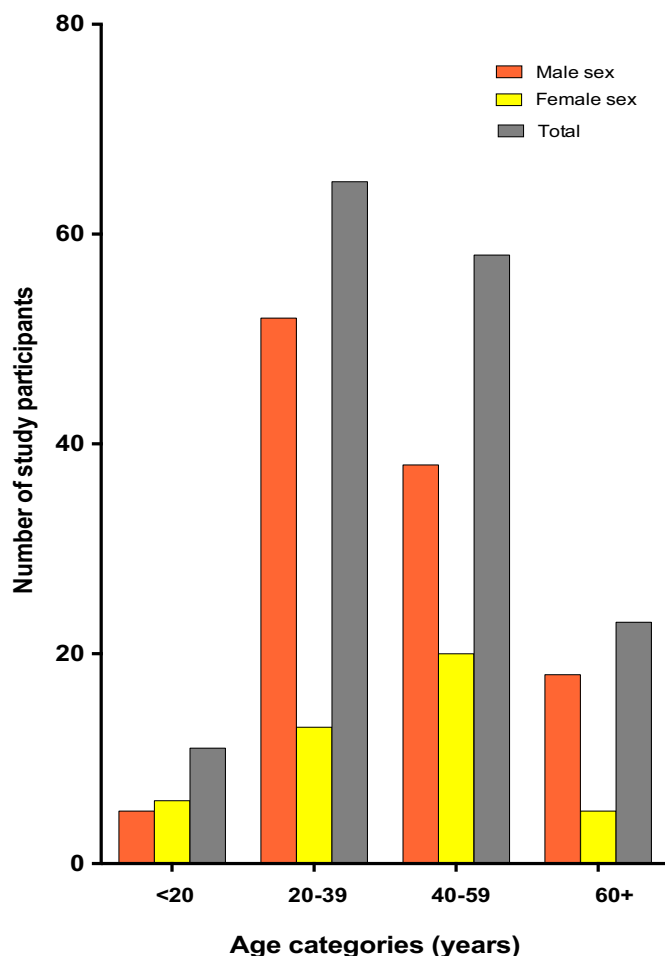

Fig. 1. Age and sex distribution of patients with motor neuron disease in a Ghanaian Tertiary Medical Center.

shown in Fig. 1). There were 31 (19.7%) with amyotrophic lateral sclerosis, 12 (7.6%) with progressive muscular atrophy, 7 (4.5%) with primary lateral sclerosis, 4 (2.5%) with progressive bulbar palsy with the remainder (65.6%) simply classified as motor neuron disease without any subtype description available. (See Fig. 2.)

(10) **Multiple sclerosis or other white matter disorders ($n = 150$):** The frequencies of diseases under this category of disorders are multiple sclerosis 50 (33.3%), neuromyelitis optica 44 (29.3%), optic neuritis 25 (16.7%), acute disseminated encephalomyelitis 17 (11.3%) and transverse myelitis 14 (9.3%). The mean age was 33.3 ± 14.2 years and proportion of females was 109 (72.6%).

(11) **Remaining neurological disorders:** Among those with Cerebral palsy and neurodevelopmental disorders ($n = 67$), 55.2% had cerebral palsy, 22.4% had neurodevelopmental delay or regression 22.4%, autistic spectrum disorder 16.4% and attention deficit hyperactivity disorder 6.0%. Included in the disorders of cerebrospinal fluid pressure or flow ($n = 64$) were idiopathic intracranial hypertension 48.4%, normal pressure hydrocephalus 35.9%, obstructive hydrocephalus 6.3% and communicating hydrocephalus 4.7%. The frequency of disorders classified 'other disorders of the nervous system' is shown in Table 5.

4. Discussion

This is arguably the largest case series of neurological disorders published from an adult neurology clinic in West Africa. Due to the broad collecting team, and the number of years included in the retrospective review, we deployed the WHO ICD11 classification of neurological disorders. This is easier to use than earlier revisions for both low and high resource settings, leading to better data capture, and offering the tools to monitor and improve individual country's health with reduced costs [5,6]. The top 5 neurological disorders were epilepsy (23.0%), peripheral neuropathies (19.6%), movement disorders (14.7%), cerebrovascular diseases (11.1%) and headache disorders (7.7%), these contributed to 76.1% of the entire cohort. Broadly, the spectrum of cases in our cohort is comparable to other studies done in Africa and high-income countries [6–10]. There are however differences in frequency ranking of specific neurological disorders in these studies compared with ours. For instance, while epilepsy was the leading disorder in our series, Sarfo et al. [10] found cerebrovascular diseases as the topmost neurological disorder in Kumasi, Ghana while Adebayo et al. [6] found headache disorders in Tanzania. This trend may reflect differences in referral patterns across countries and in-hospital referral policies for neurological case management. Furthermore, while older studies [11–14] reported a paucity of CNS demyelinating disorders and neurodegenerative diseases, our cohort has a fair representation of these disorders.

This could be attributed to an increased awareness, globalization, availability of imaging and changing patterns of diseases.

Epilepsy was the leading neurological disorder in our cohort. A recent drive by the World Health Organization and the Ghana Ministry of health and Ghana health service to scale up training through the Ghana Fights against Epilepsy initiative (GFAEI) [15] has increased awareness and has reduced the treatment gap. The prevalence of Epilepsy in Ghana is estimated at 1:10,000 [16,17]. Our center has provided the experts to lead the national effort at Epilepsy control which may in part contribute the high number of cases in our clinic. Currently through the efforts of the GFAEI all medications are available on the National health Insurance except Levetiracetam. Furthermore, studies on the social impact of epilepsy such as stigma has been spearheaded by clinicians from our center [18,19] and efforts are being made to address this perception of stigmatization using the GFAEI. Nearly 81% of all epilepsies in our cohort were idiopathic and the remainder thought to be
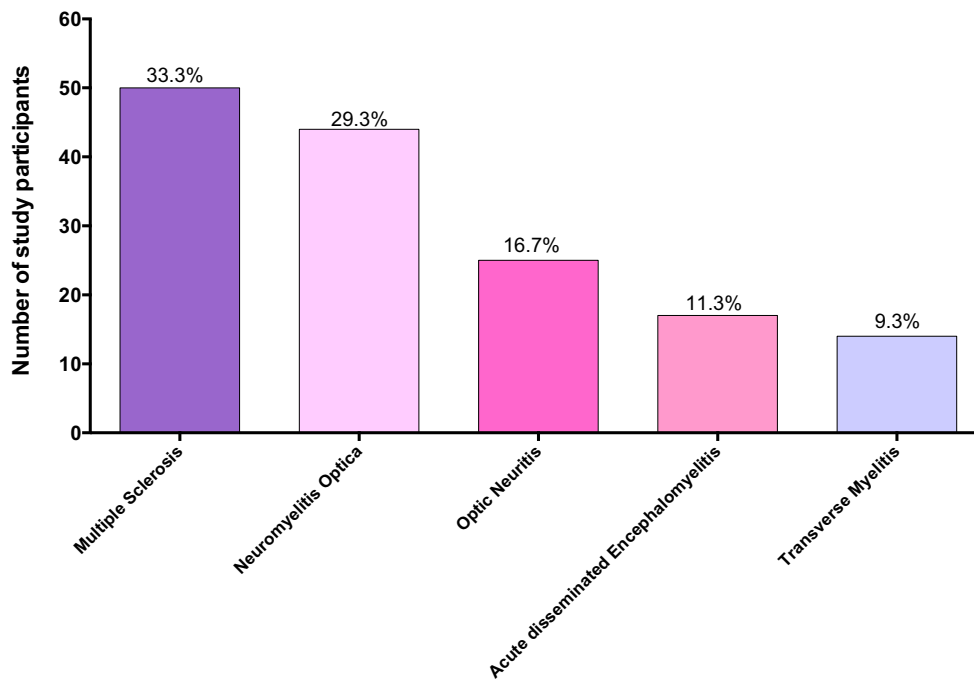
Fig. 2. Frequency of CNS Autoimmune demyelinating disorders in a Ghanaian Tertiary Medical Center.

Table 5
Frequency of disorders classified under 'other disorders of the nervous system'.

Disorders	Number
Cerebellar disorder unclassified	69
HIV with intracerebral space occupying lesion	20
Cerebellitis	17
Neurofibromatosis	17
Cerebellar disorder from alcoholism	12
Tuberculous meningitis	6
Leprosy	4
Neurosyphilis	3
Post-meningitis	3
Cerebellar disorder HIV related	2
Neurocysticercosis	2
Subacute Sclerosis Panencephalitis	2
Cerebellar disorder- drug side effect	1
Cerebellar disorder-heavy metal poisoning	1
Cerebellar disorder, inflammatory	1
Cerebellar disorder, mass lesion	1
Pituitary macroadenoma	1
Tuberous sclerosis	1
Tetanus	1
	164

provoked or symptomatic. As expected, symptomatic epilepsies were dominated by post-stroke epilepsy, like previous studies and a reflection of the significant rise in the burden of stroke in Africa [6,20]. .A recent study reported 11.4% of 1101 Ghanaian stroke survivors had post-stroke epilepsy [21].

As the third leading disorder, movement disorders were predominantly composed of idiopathic Parkinson's disease. The median age for idiopathic Parkinson's at 65 years (57–72 years) was similar to other cohorts from Kumasi, Ghana [10] and in Lagos Nigeria [22] but lower than the global average [23]. The Parkinson's disease in Africa project, has led to the formation of a dedicated multidisciplinary team of a physiotherapist, psychologist and a neurologist working together to improve the motor and non-motor outcomes of our patients living with Parkinson's. Levodopa is provided at no extra cost to patients [24] via

the Instituti Clinci di Perfezionamento of Milan, Italy. These collaboratives have led to studies with insights into the natural history of Parkinson's disease and motor symptoms in the African context [25,26]. and the potential of the use of *Mucuna pruriens* a tropical legume, native to Africa and South America containing relatively high levels of levodopa (L-DOPA) [27,28]. On the other hand, hyperkinetic disorders were dominated by dystonia and essential tremors.

It is quite curious that cerebrovascular diseases featured as the fourth leading disorder at our site when a previous study conducted at the second leading hospital in Kumasi, Ghana found it to be the topmost neurological disorder encountered in that clinic. The most plausible explanation is that in-patients with stroke at our center are discharged for follow-up at other hospitals in proximity to patients for secondary prevention and rehabilitation. The city of Accra has several secondary level hospitals for provision of post-stroke care compared with the scenario in Kumasi, Ghana. These observations notwithstanding, a dedicated stroke clinic has been set up for outpatient care of patients discharged from our stroke unit [29,30] This set-up has facilitated processes for involvement of our site for involvement in the largest epidemiological study on stroke in Africa [31–34]. With the rising burden of strokes in Africa, it is not surprising that vascular dementia was more prominent than Alzheimer's disease in our setting. This observation is in consonance with findings from Tanzania, Ghana, and Cameroon [6,10,35]. .An expected explosion of persons living with dementia demands a concerted multidisciplinary effort at establishing a Geriatric program in developing countries [36].

Interestingly, we have observed a rising trend in the burden of autoimmune demyelinating central nervous system disorders such as multiple sclerosis and neuromyelitis optica spectrum disorders. For instance, Nyame et al. in 1991 [11] did not report any case of Multiple sclerosis in Accra, the site of this present study. We believe the increasing availability of diagnostic tools such as MRI and CSF analysis for oligoclonal bands and recently IgG autoantibodies to Aquaporin 4 (anti-AQP4) has improved our capability of characterizing demyelinating diseases better [37,38]. Ghana was recently featured on the World Multiple sclerosis atlas using data from our clinic [39], Available

therapies including immune modulators and recently biologics have improved outcomes of our patients. Available currently in use are Azathioprine, Mycophenolate Mofetil, Mitoxantrone, Rituximab and recently Ocrelizumab [40].

4.1. Implications

The high and rising burden of neurological disorders encountered at our clinic suggest an urgent need to bolster training of neurologists and to build capacity of non-neurologists at primary level hospitals to provide care for patients with neurological disorders. Our center has organized several such training programs [41], outreach services and exploring the potential for tele-medicine as a promising avenue to support with patient care [42,43]. The dearth of Neurology manpower is also being addressed with outreach and training of medical officers and general practitioners across the country using various platforms from the International League Against Epilepsy (ILAE), Movement Disorders Society (MDS), World Federation of Neurology (WFN), Wessex Ghana Stroke project www.wgstroke.org, African Stroke Organization (ASO), and African Academy of Neurology (AFAN).

5. Conclusion

A wide spectrum of neurological disorders were encountered in this clinic, similar to previous reports from other centers in SSA. There is an urgent need to build local capacity to provide optimal care to meet the demand of the rising burden of neurological diseases in Ghana.

Conflicts

None to declare.

CRediT authorship contribution statement

Albert Akpalu: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Patrick Adjei:** Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – review & editing. **Kodwo Nkromah:** Data curation, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – review &editing. **Foster Osei Poku:** Data curation, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – review & editing. **Fred Stephen Sarfo:** Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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