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ORIGINAL ARTICLE

Diagnosis delay and duration of hospitalisation of patients with Buruli ulcer in Nigeria

Anthony O. Meka[a], Joseph N. Chukwu[a], Charles C. Nwafor[a], Daniel C. Oshi[a,1], Nelson O. Madichie[a], Ngozi Ekeke[a], Moses C. Anyim[a], Chukwuka Alphonsus[a], Obinna Mbah[a], Glory C. Uzoukwa[a], Martin Njoku[b], Kentigern Ntana[b] and Kingsley N. Ukwaja[c,*]

[a]Medical Department, German Leprosy and TB Relief Association, Enugu State, Nigeria; [b]St Benedict's Tuberculosis & Leprosy Rehabilitation Hospital, Ogoja, Cross River State, Nigeria; [c]Department of Medicine, Federal Teaching Hospital Abakaliki, Ebonyi State, Nigeria

[1]Department of Community Health and Psychiatry, University of West Indies (UWI), Mona, Kingston 7, Jamaica
*Corresponding author: Tel: +234 803 624 3196; E-mail: ukwajakingsley@yahoo.co.uk

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Background: Delayed diagnosis of Buruli ulcer can worsen clinical presentation of the disease, prolong duration of management, and impose avoidable additional costs on patients and health providers. We investigated the profile, delays in diagnosis, duration of hospitalisation, and associated factors among patients with Buruli ulcer in Nigeria.

Methods: This was a prospective cohort study of patients with Buruli ulcer who were identified from a community-based survey. Data on the patients' clinical profile, delays in diagnosis and duration of hospitalisation were prospectively collected.

Results: Of 145 patients notified, 125 (86.2%) were confirmed by one or more laboratory tests (81.4% by PCR). The median age of the patients was 20 years, 88 (60.7%) were >15years old and 85 (58.6%) were females. In addition, 137 (94.5%) were new cases, 119 (82.1%) presented with ulcers and 110 (75.9%) had lower limb lesions. The mean time delay to diagnosis was 50.6 (±101.9) weeks. The mean duration of hospitalisation was 108 (±60) days. Determinants of time delay to diagnosis were higher disease category (p=0.001) and laboratory confirmation of disease (p=0.02). Determinants of longer hospitalisation were; multiple lesions (p=0.035), and having functional limitation at diagnosis and undertaking surgery (p=0.003).

Conclusions: Patients with Buruli ulcer have very long time delays to diagnosis and long hospitalisation during treatment. This calls for early case-finding and improved access to Buruli ulcer services in Nigeria.

Keywords: Care-seeking, Delays, Diagnosis, *Mycobacterium ulcerans*, Nigeria, Treatment

Introduction

Mycobacterium ulcerans is the third most common mycobacteria infection globally after TB and leprosy.[1] The Uganda Buruli Group coined the name 'Buruli ulcer' (BU) for the disease because early cases were first detected in Buruli county, near lake Kyoga.[2] Worldwide, BU has been reported in 33 countries in Africa, the Americas, Asia and the Western Pacific.[1] With the exception of Australia, China and Japan, the majority of notified cases occur in tropical and subtropical settings.[1–4] In addition, a key feature of BU is its focal distributions even in highly endemic regions. Thus, estimating accurate population-based disease burden is challenging.[1] However, in highly endemic communities in West Africa, point prevalence has been estimated to range between 22/100 000 to 150.8/100 000 population.[5–9] The mode of transmission of *M. ulcerans* infection remains unclear. Substantial data points to the disease being acquired from an environmental source, possibly from exposure to contaminated soil or vegetation or by aerosol inhalation.[4] Recent evidence has implicated arthropods and aquatic organisms in disease transmission in endemic regions.[4]

Although situated between two countries (Benin and Cameroon) with regions of high BU endemicity, only very few cases of BU have been reported from Nigeria over the last four decades.[10,11] Most of these reports had limitations, such as the use of a purely descriptive approach (i.e., no measurement of

association), most of the diagnoses being retrospective or prospective but only based on clinical presentation.[10,11] It has been speculated that BU may be under-diagnosed and underreported in Nigeria. Recently, a large cohort of 127 PCR-confirmed BU patients coming from South-Western Nigeria between 2004 and 2013 were treated in Benin.[12] In 2012–2013, the German Leprosy and TB Relief Association, Nigeria, conducted a pilot advocacy, communication and social mobilisation and active case finding intervention regarding BU in the Ogoja district of Cross River State, Nigeria where a few clinical BU cases have been reported in the past.[11] The intervention notified 36 PCR-confirmed BU cases.[13] The high notification of BU in the district has resulted in the integration of BU control activities within the National TB and Leprosy Control Programme.[13,14] Subsequently, a phased systematic nation-wide response based on lessons learnt from the BU pilot project has been underway.[13]

Detailed information on the clinical profile, delays in diagnosis and hospitalisation of BU cases in Nigeria is lacking. Delayed diagnosis of BU can worsen the clinical presentation of the disease, increase the impoverishment of affected persons and their households, and may account for the rising incidence of BU in Nigeria. Studies about delays to diagnosis and duration of hospitalisation can therefore provide important information for programme managers and policy makers. The objective of this study was to investigate the clinical profile, delays to diagnosis, duration of hospitalisation and associated factors in a large cohort of patients with BU diagnosed and treated during the phase one scale-up of the BU case finding project in Nigeria.

Materials and methods

Study area

The study was carried-out in four States (Cross River, Anambra, Imo and Ogun) in Southern Nigeria. The States belong to the tropical rain forest belts characterised by several rivers and swamps. In each of the selected State, four local government areas (LGAs) (administrative districts) with a past or anecdotal report of clinical BU lesions were selected for the survey.[11,12]

Study design and population

This was a prospective cohort study within a community-based active case finding survey performed between May 2014 and September 2015. The details of the active case finding survey have been described elsewhere.[13] Briefly, it was carried out in two phases: a preparatory, and a case-finding and management phase. During the first few weeks of the project, advocacy visits were held with the community leaders and health authorities and their approval obtained. The clinicians and project staff in selected facilities as well as laboratory staff within each district were trained to evaluate patients with presumptive features of BU, and to undertake sample collection, preparation and transportation. Also, general health workers and doctors working in the peripheral health facilities within the study LGAs were trained on BU symptoms recognition and appropriate referral.

The case-finding and management phase involved intensive advocacy, communication and social mobilisation. In the selected States, state-wide mass media campaigns regarding BU were carried-out. In addition, in the selected LGAs, community sensitisation programmes were performed, following the sensitisation programme (community outreach) in the study communities. The opportunity was also used to inform the communities of free treatment at a designated hospital that offers BU services. As part of the advocacy, communication and social mobilisation activities, screening for BU disease was done on site and persons with suggestive lesions were referred to the nearest hospital offering BU control services for clinical evaluation, free laboratory investigation and treatment. In addition, traditional healers engaged in treating persons with long-standing ulcers in the study districts were trained to also refer such cases for evaluation at the nearest hospital offering BU control services. And, persons having presumptive BU lesions were interviewed regarding knowing other persons who had similar lesions/ulcers. Such cases were identified and evaluated. Patients suspected of having BU disease that were referred to or presented at the nearest hospital offering BU control services had their diagnosis clinically validated by trained physicians to ensure that they were consistent with the WHO clinical case definitions,[15,16] and subsequently, they had other management strategies initiated.

Persons with clinical BU lesions had their samples collected for laboratory evaluation. Laboratory confirmation of *M. ulcerans* infection involved taking swabs from ulcerative lesions and fine needle aspirates from pre-ulcerative (oedematous) lesions, followed by laboratory testing (microscopy and/or molecular biology) using WHO standards.[14,15] Both clinical and laboratory-confirmed BU disease were treated according to WHO recommendations.[14–16] Each patient was admitted to the hospital and received an 8-week drug treatment (chemotherapy) consisting of a standard regimen of rifampicin and streptomycin or rifampicin and clarithromycin. Wound care for persons with ulcers also formed part of the clinical management. In addition, some individuals required additional surgical interventions (debridement, skin grafting and/or amputation) as part of the ulcer management. Physiotherapy was provided for those who had contractures and limitation of movement. The clinical profile of the BU cases, duration of the disease before diagnosis and duration of hospital stay were collected.

Statistical analysis

The data were recorded on a standardised BU report forms, double-entered into a Microsoft Excel spreadsheet (Microsoft Corp., Redmond, WA, USA) and analysed with Epi-Info version 3.4.1 (CDC, Atlanta, GA, USA). The normality of time delay to diagnosis and duration of hospital stay data distribution were assessed using a visual inspection of graphs. These were found to be normally distributed. Continuous variables were summarised as means (±SD). Group means were compared using ANOVA. Multiple linear regression models were constructed with the time delay to diagnosis and duration of hospitalisation as outcome variables. Categorical variables were summarised as counts and percentages. The χ^2 test was used to compare categorical proportions. All p-values were bidirectional, and a p-value of less than 0.05 was set as statistically significant.

Results

Clinical profile of the patients surveyed

In all, 145 patients with BU were diagnosed and treated between 1 May 2014, and 30 September 2015 at the selected hospitals in Nigeria. Patient's samples were collected either using wound swabs or fine needle aspiration (for oedematous lesions). PCR results were positive in 118 (81.4%) that were tested, Ziehl-Neelsen staining was positive in 104/145 (71.7%) cases. Overall, 125/145 (86.2%) were confirmed by one or more laboratory tests.

The median age of the patients at diagnosis was 20 (IQR 10–35 years; mean 24.2±7.4 years), with 88 (60.7%) patients older than 15 years. There was a slight sex preponderance with females accounting for 85 (58.6%) of the cases (Table 1). Also, 137 (94.5%) were diagnosed as new cases, 119 (82.1%) and 13 (9.0%) of the patients presented with ulcers and oedema, respectively. In terms of localisation of the lesions, 110 (75.9%) of the patients had lesions at the lower limb, and 25 (17.2%) had upper limb lesions. In addition, there was an almost balanced distribution in the sizes of the lesions with 32.4%, 29.7% and 37.9% having category I (<5 cm), II (5–15 cm) and III (>15 cm) lesions, respectively. Also, 121 (83.4%) of the patients presented with a single lesion, and 72 (49.7%) had functional limitation at diagnosis (Table 1).

There was no distortion of sex ratio according to age groups (females accounted for 59.6% and 58.0% of patients 15 years or younger and those older than 15 years, respectively (p=0.84 Table 1). Age was significantly associated with the size and/or number of lesions, and the presence of functional limitation of movement at diagnosis (Table 1). Younger patients were more likely to present with multiple lesions compared to older patients (24.6% vs 11.4%; p=0.037). Compared with older patients (>15 years), younger patients had fewer category I lesions (21.1% vs 39.8%), but higher category III lesions (50.9% vs 29.5%; p=0.019). And, younger patients were more prone to having functional limitation of movement at diagnosis (59.6% vs 43.2%; p=0.05).

Table 1. Clinical and epidemiologic profile of patients with Buruli ulcer, Nigeria, 2014–2015

Characteristics	Overall n (%)	≤15 years n (%)	>15 years n (%)	p-value
All	145 (100)	57 (39.3)	88 (60.7)	
Sex				NS
Female	85 (58.6)	34 (59.6)	51 (58.0)	
Male	60 (41.4)	23 (40.4)	37 (42.0)	
Classification of cases				NS[a]
New case	137 (94.5)	56 (98.2)	81 (92.0)	
Recurrent	8 (5.5)	1 (1.8)	7 (8.0)	
Clinical form				NS[a]
Plaque	8 (5.5)	4 (7.0)	4 (4.5)	
Ulcer	119 (82.1)	42 (73.7)	77 (87.5)	
Oedema	13 (9.0)	7 (12.3)	6 (6.8)	
Nodule	5 (3.4)	4 (7.0)	1 (1.1)	
Site of lesion				NS[a]
Upper limb	25 (17.2)	13 (22.8)	12 (13.6)	
Lower limb	110 (75.9)	38 (66.7)	72 (81.8)	
Trunk/head	10 (6.9)	6 (10.5)	4 (4.6)	
Size of lesion				0.019
Category I	47 (32.4)	12 (21.1)	35 (39.8)	
Category II	43 (29.7)	16 (28.1)	27 (30.7)	
Category III	55 (37.9)	29 (50.9)	26 (29.5)	
Number of lesions				0.037
Single	121 (83.4)	43 (75.4)	78 (88.6)	
Multiple	24 (16.6)	14 (24.6)	10 (11.4)	
Laboratory confirmation				NS
Yes	125 (86.2)	48 (84.2)	77 (18.5)	
No	20 (13.8)	9 (15.8)	11 (12.5)	
Presence of limitation				0.05
Yes	72 (49.7)	34 (59.6)	38 (43.2)	
No	73 (50.3)	23 (40.4)	50 (56.8)	

BU: Buruli ulcer; NS: not significant (p>0.05).
[a] p-value based on Fisher's exact test.

Time delay to diagnosis

The time delay (in weeks) to BU diagnosis among the study patients are shown in Table 2. The overall mean time delay to diagnosis was 50.6 (±101.9) weeks (median (IQR); 16 (6 - 50) weeks. Females had a longer mean delay (58 vs 40 weeks), but the difference did not reach statistical significance (p=0.09). There were no differences in time delay to diagnosis according to patient classification, presence of ulcer, site of lesion or number of lesion (p>0.05; Table 2). However, the mean time delay to diagnosis for patients with category I, II, and III lesions was 26, 50 and 76 weeks, respectively (p<0.001). This relationship persisted for both children and adults with category I, II and III lesions, respectively (Table 2). Also, the time delay for patients whose diagnosis was confirmed by a laboratory test was 76 weeks compared to 39 weeks for those whose tests were not confirmed by a laboratory test (p=0.02).

Duration of hospital stay

The duration of hospital stay (days) among patients with BU managed during the study period are as shown in Table 3. The overall mean duration of hospital stay was 108 (±60) days (median [IQR]; 91 [69–123] days). The mean duration of hospital stay did not differ according to age or gender categories (p>0.05). Also, there were no differences in duration of hospital stay according to patient classification, presence of ulcer, site of lesion or number of lesions (p>0.05; Table 3). However, the mean duration of hospital stay for patients with category I, II and III lesions were 92, 128 and 104 days, respectively (p=0.004). This relationship persisted for both children and adults with category I, II and III lesions, respectively (Table 3). Patients whose disease was confirmed by a laboratory test had a longer duration of hospital admission (116 vs 90 days; p=0.02). Patients with functional limitation of movement at diagnosis had a longer duration of hospital stay (130 vs 91 days; p<0.001); and patients who had surgery also had longer duration of hospital stay (131 vs 84 days; p<0.001).

Factors associated with delayed diagnosis and prolonged hospitalisation

In multivariable linear regression analysis, determinants of time delay to diagnosis were higher disease category (p=0.001) and

Table 2. Time delay in diagnosis (weeks) and its relationships with the profile of patients with Buruli ulcer, Nigeria

Characteristics	Total		≤15 years		>15 years	
	mean (SD)	p-value	mean (SD)	p-value	mean (SD)	p-value
All	51 (102)		42 (61)		56 (119)	
Sex		NS		NS		NS
Female	58 (117)		49 (69)		64 (138)	
Male	40 (40)		33 (50)		45 (89)	
Classification of cases		NS		NS		NS
New case	51 (102)		42 (61)		57 (121)	
Recurrent	49 (106)		18 (12)		51 (109)	
Clinical form		NS		NS		NS
Non-ulcer	37 (52)		42 (65)		25 (33)	
Ulcer	54 (110)		42 (61)		32 (61)	
Site of lesion		NS		NS		NS
Upper limb	45 (88)		21 (21)		72 (122)	
Lower limb	51 (108)		49 (71)		62 (120)	
Trunk/Head	58 (72)		37 (35)		80 (112)	
Size of lesion		<0.001		0.001		<0.001
Category I	26 (57)		26 (60)		27 (58)	
Category II	50 (87)		20 (22)		65 (95)	
Category III	76 (90)		64 (72)		90 (106)	
Number of lesions		NS		NS		NS
Single	51 (108)		41 (64)		56 (124)	
Multiple	48 (56)		44 (46)		52 (66)	
Laboratory confirmation		0.02		NS		NS
No	39 (60)		36 (48)		41 (67)	
Yes	76 (126)		61 (90)		83 (127)	
Presence of limitation		NS		NS		NS
Yes	45 (66)		46 (68)		44 (66)	
No	55 (82)		37 (53)		63 (121)	

BU: Buruli ulcer; NS: not significant (p>0.05).

Table 3. Hospital stay (days) and its relationship with the profile of patients with Buruli ulcer, Nigeria

Characteristics	Total		≤15 years		>15 years	
	mean (SD)	p-value	mean (SD)	p-value	mean (SD)	p-value
All	108 (60)		120 (71)		101 (51)	
Sex		NS		NS		NS
Female	115 (66)		49 (69)		64 (118)	
Male	98 (49)		33 (50)		45 (89)	
Classification of cases		NS		NS		NS
New case	108 (58)		119 (71)		101 (80)	
Recurrent	110 (80)		180 (0)		104 (81)	
Clinical form		NS		NS		NS
Non-ulcer	112 (79)		122 (104)		102 (44)	
Ulcer	107 (55)		119 (58)		101 (52)	
Site of lesion		NS		NS		NS
Upper limb	127 (66)		143 (83)		110 (35)	
Lower limb	106 (60)		118 (71)		100 (54)	
Trunk/Head	91 (32)		88 (35)		97 (29)	
Size of lesion		0.004		0.03		0.02
Category I	92 (29)		108 (34)		86 (25)	
Category II	128 (71)		148 (70)		118 (70)	
Category III	104 (66)		107 (82)		101 (44)	
Number of lesions		0.05		NS		NS
Single	104 (58)		116 (73)		98 (48)	
Multiple	130 (66)		138 (63)		123 (70)	
Laboratory confirmation		0.02		NS		0.02
Yes	116 (66)		126 (78)		109 (56)	
No	90 (39)		102 (42)		86 (36)	
Presence of limitation		<0.001		0.002		<0.001
Yes	130 (63)		135 (60)		125 (67)	
No	91 (51)		101 (80)		87 (33)	
Had surgery		<0.001		<0.001		<0.001
Yes	131 (70)		147 (82)		120 (60)	
No	84 (32)		85 (31)		84 (33)	

BU: Buruli ulcer; NS: not significant (p>0.05).

laboratory confirmation of the disease (p=0.02; Table 4). Also, the determinants of longer duration of hospital stay during treatment were occurrence of multiple lesions (p=0.035), and patients with functional limitation in movement at diagnosis who had surgery (p=0.003).

Discussion

BU remains a major neglected tropical disease. Large national studies in West African countries viz, Ghana, Benin and Côte D'Ivoire have been described providing clues to the epidemiology of the disease in the region.[5–9] Recently, these countries have been reporting fewer cases of BU.[1] With our intervention and surveillance in four States in Nigeria, we report on the clinical profile of BU in another West African country. Several epidemiologic features of the disease consistently reported in previous studies were also observed viz, slight female sex preponderance, the predominance of single lesions and lesions on the lower limbs, ulcers as the commonest clinical presentation, presence of functional limitation of movement at diagnosis and balanced distribution of the lesions across disease categories. Furthermore, beyond the many additional findings reported in this study three are of major importance; the high burden of BU disease in Nigeria, time delay to diagnosis and its determinants, and duration of hospital stay and its determinants.

This report reinforces previous observation of probable underestimation of the burden of BU in Nigeria. The four States where these BU cases were found were previously reporting no cases.[13,17] The States were characterised by drainage basins to major rivers, location in the tropical rainforest belt, changeable topography with many small hills and fertile plains. Similar environments are encountered in other BU endemic areas of West Africa, for which patients are found around different drainage systems but always with broad fertile richly inundated

Table 4. Multivariable linear regression analysis of predictors of longer delays to diagnosis and longer duration of hospitalisation among patients with Buruli ulcer in Nigeria, 2014–2015

Variables	β	SE	F-test	p-value	R^2
Model 1. Predictors of longer delays before diagnosis among patients with Buruli ulcer in Nigeria, 2014–2015					
					0.12
Older age (years)	0.53	0.45	1.38	NS	
Female sex	18.4	15.4	1.40	NS	
Presentation as ulcer	20.4	20.5	0.99	NS	
Multiple lesions	−10.6	23.7	0.20	NS	
Higher disease category	33.8	10.3	10.80	0.001	
Laboratory confirmation of diagnosis	41.4	17.9	5.30	0.02	
Functional limitation	−10.1	17.8	0.32	NS	
Lesion at the trunk	13. 7	30.70	0.20	NS	
Upper limb lesion	−1.49	22.2	0.04	NS	
Recurrent disease	−21.2	28.2	0.57	NS	
Model 2. Predictors of longer hospitalisation during treatment among patients with Buruli ulcer in Nigeria, 2014–2015					
					0.28
Older age (years)	0.27	0.24	1.3	NS	
Female sex	10.1	8.2	1.51	NS	
Presentation as ulcer	4.40	10.9	0.16	NS	
Multiple lesions	23.6	12.6	3.5	0.035	
Laboratory confirmation of diagnosis	0.80	10.4	0.005	NS	
Higher disease category	0.70	5.6	0.014	NS	
Limitation at diagnosis	17.4	14.7	1.4	NS	
Lesion at the trunk	−15.8	16.4	0.93	NS	
Lesion at the upper limb	9.3	11.9	0.61	NS	
Recurrent disease	12.2	15.1	0.65	NS	
Had surgery	16.7	12.2	1.90	NS	
Limitation at diagnosis and had surgery	55.8	18.2	9.4	0.003	

β: coefficient; BU: Buruli ulcer; NS: not significant (p>0.05); R^2:correlation coefficient.

plains.[7,8,12] This report supports the sustenance of the ongoing expansion of BU surveillance system in Nigeria, and suggests a need for the expansion of BU treatment centres in Southern Nigeria. The age distribution of the cases was largely consistent with previous findings.[5,8,9,13,18] The median age of cases observed was comparable to what was reported in Ghana (25 years) and D. R. Congo (27 years) but higher than a median of 12 years in Benin and other regions.[5,8,9,18] Sex distribution was not consistent with the findings of other studies. We found slight female sex preponderance with an overall balanced ratio between children and adults. In most other studies in West Africa, that males and females were affected equally; male patients were more often affected in children (younger than 15 years) while females were more often affected in the older age groups.[5,6,8,9,18] Such sexual dimorphism is frequently recorded in human infectious diseases – particularly in human mycobacterial infection.[19–22] These sex differences have been suggested to be due to differences in exposure levels, differential host immune response, other biological differences or interplay of these factors and sex.[5,19,20]

The effect of time delay to diagnosis and treatment for BU is important for generating health policy solutions for BU control. In this study the overall mean time delay to diagnosis was 51 (102) weeks. This was far higher than the time delay of between 42 and 84 days reported in other West African countries[23,24]; and between 14 days (IQR 0–6 weeks) and 42 days (ranging from 2 and 270 days) reported in Australia.[25] However, it agrees with the time delay in Southern America where the time delay reported among Peruvian patients with BU was between 1 and 8 months.[26] We found that the site of the lesion, clinical form, number of lesions and clinical classification of the patients were not associated with time delay to diagnosis. Individuals with category I lesions had a shorter time delay to diagnosis compared with those with either categories II or III lesions. WHO recommends that as a measure of early detection, the proportion of category III lesions reported from any district or country should be below 25% – the proportion of category III lesions in our study (37.9%) exceeded this target.[1] They also recommend that the proportion of patients presenting with limitation of movement at diagnosis from any district or country should be below 15%[1]; in this study 49.7% had limitation of movement at diagnosis. Furthermore, another measure of early detection recommended by WHO is that the proportion of ulcerative lesions at diagnosis reported from any district or country should

be 60% or lower[1]; in this study, the proportion of ulcerative lesions was 82.1%. The long time delay to diagnosis observed in this study indicates the need for interventions to reduce it and improve early detection. This can be achieved through sustained community education, capacity building of health workers to recognise and diagnose BU, provision of treatment services, and engagement of informal providers to refer suspicious cases of BU for evaluation and treatment.

In this study, the mean hospitalisation period of the patient was consistent with previous reports.[27,28] This can be reduced by ensuring early and active case finding of the disease in order to detect the non-ulcerative forms of the disease which have been found to have reduced hospitalisation period – thus having much less impact on the socio-economic status of the patients and their households – since both the patients and their caretakers would spend fewer days away from their income-generating source of livelihoods.[27] A higher disease category was associated with longer delays to diagnosis. This agrees with the observation that a higher disease category e.g., a category III lesion, is a marker for late detection.[1] Furthermore, a patient whose BU lesion was laboratory-confirmed was a predictor of longer delay to diagnosis. It may be that these patients have more advanced lesions and are likely to have presented as ulcers. Patients whose lesions occurred as a plaque or nodule are more likely to be at an early stage of the disease and the lesion may have precluded sample collection for laboratory diagnosis. Such patients are more likely to be diagnosed early if they encounter health workers with training on BU care. The occurrence of multiple lesions, and patients with functional limitation in movement at diagnosis who also had surgery were independent predictors of prolonged hospital stay. Multiple lesions will probably require more wound care and other measures compared to single lesions. Thus, in addition to ensuring that patients present early through active case-finding strategies in order to detect early disease lesions; patients with BU admitted with these risk factors should be closely followed-up at diagnosis in order to limit complications that may predispose them to having longer hospitalisation period.

Our study findings have some limitations. First, it was conducted in a setting without a well-established National Buruli Ulcer Control Programme. Thus, our observations may not be generalisable to all BU endemic and non-endemic settings. This report will be used to advocate for more resources for BU control in Nigeria. Second, the duration of delay before diagnosis was based on patient recall – thus may be prone to recall bias. We tried to reduce this by helping the patients in their recall efforts using past events. Third, we did not evaluate patients' and health workers' knowledge of BU, and its effects on diagnosis delay. Good knowledge has been suggested to predict early detection.[29,30] We are currently investigating patients' and health workers' knowledge of BU in order to refine our educational interventions in the study setting.

Conclusions

We have reported on the clinical profile including sex and age differences of patients with BU in Nigeria. In addition, we confirmed the very long time delay to diagnosis of BU and its determinants, and demonstrated the duration of hospital stay and its determinants among patients with BU in Nigeria. The findings of this study are a wake-up call for the expansion of BU services especially the promotion of active case finding strategies, decentralisation of treatment services, capacity building for health workers in endemic settings and the evaluation of factors affecting treatment-seeking behaviour in order to ensure early detection and treatment of BU, and to sustain further comprehensive BU control strategies in Nigeria.

Authors' contributions: AOM, JNC, CCN, DCO, NOM, NE, MCA and CA conceived the study; AOM, JNC, and KNU designed the study protocol; all authors collected data, performed data entry and carried out the data analysis and interpretation; KNU, AOM, DCO, JNC, NE, NOM and CCN, drafted the manuscript. All authors critically revised the manuscript for intellectual content. All authors read and approved the final manuscript. JNC and KNU are guarantors of the paper.

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Competing interests: None declared.

Ethical approval: This study was approved by the Ethics and Research Advisory Board of the German Leprosy & TB Relief Association, Enugu State, Nigeria. Permission was also obtained from the management of the hospitals where BU services were offered. All patients or their legal guardians (for minors) gave a written informed consent for all diagnostic and treatment purposes. All BU cases found were treated at no financial costs to patients.

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