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ORIGINAL RESEARCH ARTICLE

Evaluating the Treatment Costs for Uncomplicated Malaria at a Public Healthcare Facility in Nigeria and the Implications

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Abstract

Background Accurate information on the facility costs of treatment is essential to enhance decision making and funding for malaria control.

Objective The objective of this study was to estimate the costs of providing treatment for uncomplicated malaria through a public health facility in Nigeria.

Methods Hospital costs were estimated from a provider perspective, applying a standard costing procedure. Capital and recurrent expenditures were estimated using an ingredient approach combined with step-down methodology. Costs attributable to malaria treatment were calculated based on the proportion of malaria cases to total outpatient visits. The costs were calculated in local currency [Naira (N)] and converted to US dollars at the 2013 exchange rate.

Results Total annual costs of N28.723 million (US$182,953.65) were spent by the facility on the treatment of uncomplicated malaria, at a rate of US$31.49 per case, representing approximately 25% of the hospital's total expenditure in the study year. Personnel accounted for over 82.5% of total expenditure, followed by antimalarial medicines at 6.6%. More than 45% of outpatients visits were for uncomplicated malaria. Changes in personnel costs, drug prices and malaria prevalence significantly impacted on the study results, indicating the need for improved efficiency in the use of hospital resources.

Conclusion Malaria treatment currently consumes a considerable amount of resources in the facility, driven mainly by personnel cost and a high proportion of malaria cases. There is scope for enhanced efficiency to prevent waste and reduce costs to the provider and ultimately the consumer.

Key Points for Decision Makers

Treatment of uncomplicated malaria consumed up to 25% of a public health facility's annual budget, with personnel accounting for a considerable proportion of the total expenditure for uncomplicated malaria alone.

Nearly half of outpatient visits to the facility were treated for uncomplicated malaria, necessitating attention regarding appropriate management for enhanced efficiency.

A high incidence of presumptive diagnosis and treatment contributed significantly to the high treatment costs in the facility.

Overall, there is scope for enhanced efficiency in the utilisation of the facility resources, especially as it relates to personnel.

The high cost estimates emphasize the considerable economic burden of malaria in Nigeria, underscoring the need for continued donor support for effective malaria control in the country.

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1 Background

The burden of malaria is highest among tropical regions of the world, including Nigeria [1]. The disease is a major public health concern in sub-Saharan Africa (SSA) as it is a leading cause of avoidable disability and death, especially among children [2]. This is particularly the case in Nigeria, which is said to account for a quarter of the burden of malaria in Africa [3, 4]. Ascertaining health system costs of treating malaria provides relevant information for soliciting appropriate funding for its control, from both government and non-government organisations, to reduce any out-of-pocket expenditure among patients. Healthcare facilities are central to the provision of malaria treatment and hence critical to the success of its management. The provider cost and quality of services in these facilities have implications on healthcare utilisation as poor services and high costs of care can deter utilisation, whether government funded or out-of-pocket, and promote the use of less effective care or practices [2, 5]. The success of malaria treatment depends significantly on the interaction of patients and households with health services and their costs [2, 5]. The high cost of care has been identified as a major barrier to access effective malaria treatment, driving patients to seek care from less effective sources [6–9]. This presents an equity issue since the poor, who are often the most affected [6], do not have access to effective treatments, especially with currently high out-of-pocket expenditures in Nigeria [10]. In the context of limited resources, weak health systems and the burden of communicable diseases, particularly in SSA [11], accurate information on the overall cost of treatment is essential to improve strategies for malaria control. Previous studies have reported the economic burden of malaria, particularly to households in SSA [9, 12–19]. Household costs represent both direct and indirect costs of treatment and care to patients and caregivers [18].

Whilst considerable attention has focused on household costs of malaria treatment [19], information regarding facility costs has not been adequately explored. Studies that focused on the cost of treating the disease in hospitals or health facilities are currently limited [20]. Moreover, such studies lack sufficient details to enhance decision making. A study in Nigeria by Onwujekwe et al. [18] recently estimated a recurrent provider cost per case of malaria treatment of between US$30.42 and US$48.02 for each outpatient and inpatient case, respectively, while non-recurrent provider costs per case were put at US$133.07 and US$1857.15 for outpatient and inpatient care, respectively. Similarly, Sicuri et al. [19] estimated the health system costs per case of paediatric inpatient and outpatient malaria treatment in three countries, Ghana, Tanzania and Kenya, to be US$2.8–123, US$1.75–48 and US$2.77–57, respectively. Previously in Burkina Faso in 2005, the average provider cost per patient of paediatric outpatient and inpatient malaria treatment was estimated at US$6.74 and US$61.08, respectively [20]. The study in Kenya by Ayieko et al. [16] estimated providers' cost of treating paediatric malaria in district hospitals to be between US$47 and US$75 per case, without distinction between mild and severe cases. These studies were mostly based on a simple 'snap-shot' cost analysis rather than a routine costing system on which future policy decisions could be based.

Detailed information on the hospital or health facility cost will provide a more effective tool for decision making for appropriate resource allocation decisions. This is particularly important in Nigeria given its high burden of malaria relative to other African countries and the lack of comprehensive costing analyses. Consequently, the objective of this study is to fill this gap and provide adequate knowledge of the health system costs of malaria treatment to enable managers to make informed decisions on resource allocation and efficiency in malaria treatment and control. This will be achieved by comprehensively evaluating the direct costs of treating uncomplicated malaria at a public health facility to generate relevant information for planning and effective implementation of malaria case management.

2 Methods

2.1 Study Site

The study was carried out at the Nnamdi Azikiwe University Medical Center (NAUMC), Awka, Nigeria, which provides primary and secondary healthcare services to the university community of over 50,000 people, mainly staff and students. The facility has a capacity of 10–15 beds, with 15 doctors, three pharmacists, 32 nurses and several other healthcare workers. The workers are appropriately trained to provide relevant services. There are both microscopy and rapid diagnostic test (RDT) tools for laboratory diagnosis and confirmation of malaria parasite. There are more than 10,000 outpatient visits to the facility per annum [21].

Health workers are adequately informed on malaria treatment guidelines and logistics management. Pre-package artemisinin-based combination therapies (ACTs) are available for the treatment of uncomplicated malaria. Other drugs available in the facility include sulphadoxine–pyrimethamine (SP) tablets, quinine and artemether injections for severe malaria and intermittent preventive treatment (IPT) for women and children. Histidine-rich protein-II

(HRP-II) RDTs are also available. Patient flow and treatment practices are in line with current treatment guidelines, as described in a previous study [21].

The supply of antimalarial drugs is carried out using a procurement guideline. Donors also provide support through donations of drugs such as the Affordable Medicine Facility—malaria (AMFm) drugs, though quantities are now relatively small.

Although the availability of antimalarial drugs in the facility is regular, there are occasions where there is a limited range of products available as a result of the purchasing procedures, which can affect the choices available to prescribers. Payments are made by all patients, including staff, students and community members who access services at the centre. Payments for students are deducted from fees paid in advance.

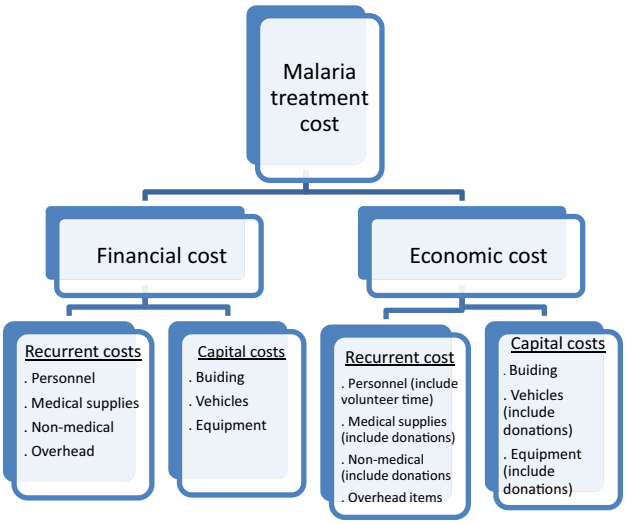

Fig. 1 Components of the health facility cost of malaria treatment

2.2 Framework and Study Design

A cross-sectional cost-of-illness approach, based on a standard costing procedure, was employed in this study to estimate the facility cost of malaria treatment. The costs were broadly divided into financial and economic costs. Financial costs represent direct expenditures on resource procurement, while economic costs are the financial costs in addition to the opportunity costs of resource utilisation. These include the costs of donated items, volunteer services and the adjustment of financial costs through annualisation of capital items, as well as quantification and valuation of all resource inputs (including donated items) utilised in the intervention.

The costs were subsequently categorised into recurrent and capital expenditures. Capital costs include those items whose useful life is considered to be longer than 1 year. Recurrent costs are those costs that lasted for less than 1 year or if payments for them were made more than once a year, such as the cost of training. The framework is illustrated graphically in Fig. 1. Since the medical centre operates mainly as a primary healthcare facility (services are basically outpatient), the costing approach involved a full costing activity for estimating outpatient costs. The approach uses detailed cost and healthcare utilisation data, so the costs of all activities in the facility were estimated, divided into capital and recurrent items.

2.3 Cost Data Identification and Collection

Cost resources were collected and analysed from the perspective of the healthcare provider. Consequently, only direct medical and non-medical costs of malaria treatment were collected, and not indirect costs such as loss of productivity. This is in line with previous costing studies for the treatment of malaria [18–20], as well as budget impact analyses [22] and key criteria typically used by health authorities to value and fund medicines [23].

An ingredient approach was used to identify and collect all resources used up in the delivery of malaria treatment, collecting actual line item expenditure and activity data wherever possible. Top-down calculations were performed to allocate capital resources where detailed information was not possible or available.

The baseline data on hospital resource use for malaria treatment were collected from medical records and pharmacy departments for patients treated for uncomplicated malaria between the months of January and June 2013. A pharmacy research assistance was engaged and trained to collect and document all patient-related encounters at the facility's dispensing units, using a prepared notebook for collecting and documenting relevant variables per patient including the date, age, sex, diagnosis for malaria and comorbidity as well as the costs of all medications and supplies dispensed. Patient records were comprehensively reviewed to obtain information on the level of resource use per patient. Resource use data included the overall costs of medication (including the type, frequency, amount, duration and route of administration of medications), supplies and laboratory tests. Pharmacy prices were based on current published prices at the time [24]. We have previously used comprehensive patient records to assess adherence to current treatment guidelines [21].

Other resource items included the costs of staff/personnel, building, equipment, utilities and other sundry expenses. Utilities and overheads include administrative costs, office maintenance, water and electricity bills, telephone, fax and postage. Supplies comprised office stationery and other consumables. Vehicle maintenance and transport are included in the fuel/maintenance costs. A

Table 1 Cost items and sources of collection

Item	Source
Capital items	
Building/space	Maintenance
Vehicles	Stores
Furniture/equipment	Stores
Medical devices (e.g. stethoscopes, surgical instruments)	Departments
Non-medical devices (e.g. furniture, televisions and air conditioners)	Departments/stores
Recurrent costs	
Drugs procurement costs	Pharmacy
Personnel	Administration
Training/capacity building	Administration
Utilities/overhead	Administration
Fuel/maintenance	Maintenance
Supplies/office costs	Stores

detailed list of items collected and measured, and their source, is shown in Table 1.

Expenditure data were collected from the bursary/accounts and stores/maintenance departments. Budget data were also used to estimate expenditure where other sources were not available. In-depth interviews were held with the chief medical director, chief nursing officer, chief pharmacist and other heads of departments in the facility to identify the type and number of staff and equipment that are used in malaria treatment. Non-hospital costs, such as patients' costs/contributions in terms of payment for medicines supplied and travel, were not collected as we concentrated on facility costs only.

Data collected were then double entered into a Microsoft Excel® (Microsoft Corp., Redmond, WA, USA) spreadsheet and checked for consistency. Discrepancies were identified and resolved while referencing the original data forms. The costs data were analysed at the 2013 price level.

2.4 Cost Calculations

All costs were measured at their market values in local Nigerian currency [Naira (N)] and converted to US dollars at the 2013 exchange rate (N157 = $US1). This rate reflected the period of study. Any update to current values may not reflect the true costs given the current challenges of the Nigerian economy, unstable prices and unrealistic exchange rates, which will affect the analysis. Consequently, we have kept to the 2013 exchange rate.

Capital costs were measured and valued by first annuitising the initial market price of the capital items over their expected useful life and then adding them to the annual recurrent estimated costs. This reflects the value-in-use of the capital assets. Vehicles and equipment costs were annualised over a 10-year period and discounted at 3% in line with previous publications [25, 26]. Capital items were divided into building (30% annualisation) and equipment, such as cabinets, furniture, stethoscopes, thermometers, motor vehicles (ambulances), and discounted [9, 26, 27].

The effect of variation of discount rates was examined in the sensitivity analysis. Building costs were estimated from office floor spaces, measured and valued on the basis of a standard cost per square meter land valuation measurement, and annualised over a useful 30-year period at a 3% discount rate [28]. Allocation of shared costs in joint offices was based on the proportion of malaria treatment.

Personnel costs were valued according to existing annual staff gross salary scales, including benefits and allowances. Time spent by each staff category in malaria treatment or on a suspected malaria case is multiplied by the pro rata earnings for each category. Given the variation of staff time per patient, which presents challenges when estimated on patient-specific basis, the time item was included in the outpatient visit cost.

Direct medical and non-medical costs of supplies and consumables were calculated by summing their used quantities within the period, multiplied by their individual or replacement costs. Actual purchase prices for resources were used for estimating unit costs. This included the pharmacy purchase price for medicines. For items whose prices were not available, replacement costs were used. The costs of shared supplies and utilities were valued using a step-down approach and allocated on the basis of facility utilisation of malaria patients [28]. However, for resources unique to malaria treatment, such as laboratory diagnosis, full allocations were made based on the actual malaria service utilisation. Medication costs per patient were calculated by multiplying the quantities of drugs prescribed/dispensed by the prices obtained from the pharmacy department [24].

Generally, while medicines and laboratory examinations were treated as recurrent, other costs were regarded as overheads. Their costs were obtained by direct attribution based on the proportion of treated malaria cases. This was calculated by multiplying the cost of the overheads with the proportion of malaria cases treated at the outpatient department (OPD) in the facility within the study period. Finally, the total recurrent and capital costs were summed to estimate the total annual cost associated with malaria treatment. The malaria treatment cost per patient was obtained by dividing the facility's total annual cost of malaria treatment by the total number of malaria cases over the study period.

This study estimated the costs of outpatient treatment for uncomplicated malaria, where 'uncomplicated malaria' is defined as including all malaria cases where no hospitalisation is required.

2.5 Assumptions

A number of assumptions were made to inform the cost calculations. These are shown in Table 2.

2.6 Sensitivity Analysis

A sensitivity analysis was performed to test the robustness of the estimated costs. The following parameters were varied:

- Discount rate: 3–5%
- Staff salaries: reduced by 50%
- Malaria prevalence: 0.47–0.27
- Change in drug costs from actual purchase prices.

Personnel/staff salary was chosen as a key parameter for the sensitivity analysis as this is a major cost driver. Salary staff costs are known to be lower in primary healthcare centres in Nigeria, where malaria is mostly treated [18]; hence, the sensitivity analysis included a 50% reduction. The choice of 0.27 prevalence was used to reflect the rate obtained in a larger two-facility-based study previously reported [21], as well as a measure of accuracy given the prevalence of presumptive treatment in the health facility as 43% of the treated cases do not actually have malaria. Similarly, drug prices are also a known variable parameter.

2.7 Data Analysis

The data were analysed for financial and economic costs. Further analysis was carried out for costs without co-medication (using only antimalarial drugs) and with co-medication. Data were managed and analysed using Microsoft Excel® (version 2007) as well as Statistical Package for Social Sciences (SPSS®) version 16 (SPSS Inc., Chicago, IL, USA) and GraphPad Prism 5 (GraphPad Software, La Jolla, CA, USA). The costs data were calculated and presented as means and medians.

2.8 Ethics Approval and Consent to Participate

Although this study did not involve patients' participation, ethical approval was sought and obtained from the Nnamdi Azikiwe University Teaching Hospital Ethical Review Committee as part of a larger study on the cost-effectiveness analysis of antimalarial drugs in south east Nigeria (Reference NAUTH/CS/66/62).

3 Results

3.1 Financial and Economic Cost Estimates

Distribution of the financial and economic costs of malaria treatment at the facility during the study period is shown in Table 3.

Table 3 shows a total annual financial cost of N33,533,217.86 (US$213,587.37) for treating patients with malaria in this facility. The total annual economic cost was estimated at N28,723,723.15 (US$182,953.65), comprising 98.2% recurrent and 1.8% capital items.

Major cost drivers included personnel at 82.5% of total costs, followed by antimalarial medicines at 6.6% (Table 3). Overhead costs (represented by the costs of administration and utilities) contributed N1,040,357, representing 3.6% of the total cost of malaria treatment. Based on the number of malaria cases treated during the study period, this translated into an average of N4,943.84 (US$31.49) per outpatient episode of uncomplicated malaria without co-medication. With co-medication, the average unit cost increased to N5522.29 (US$35.63) per

Table 2 Assumptions used in the cost calculations

Parameter	Assumption	Source
Discount rate	3%	Central Bank of Nigeria (CBN) interest rate
Personnel costs	Staff gross earnings	Finance/audit department
Exchange rate	N157 = US$1	Nigerian foreign exchange rate—2013
Malaria prevalence	0.47 (sensitivity analysis 0.27)	Hospital records (university-wide data)

N Nigerian Naira

Table 3 Annual financial and economic costs of malaria treatment (2013 prices)

Items	Type of resource	Financial cost (N)	Cost profile (%)	Economic cost (N)	Unit cost (N)	Unit cost (US$)	Cost profile (%)
Capital items	Buildings/space	2,113,277	6.3	137,475.76	23.66	0.15	0.5
	Vehicle	3,209,894	9.6	376,200.56	64.75	0.41	1.3
	Medical devices	0.00	0.0	0.00	0.00	0.00	0.0
	Non-medical devices	0.00	0.0	0.00	0.00	0.00	0.0
	Subtotal	5,323,171.04	15.9	513,676.32	88.41	0.56	1.8
Recurrent items	Personnel	23,684,380	70.6	23,684,380	4076.49	25.96	82.5
	Utilities	1,040,357	3.1	1,040,357	179.06	1.14	3.6
	Drugs	1,906,197	5.7	1,906,197	328.09	2.09	6.6
	Medical supplies and consumables	1,188,980	3.5	1,188,980	204.64	1.30	4.1
	Laboratory	390,134	1.2	390,134	67.15	0.43	1.4
	Subtotal	28,210,047	84.1	28,210,047	4855.43	30.93	98.2
	Total cost	33,533,218	100	28,723,723	4943.84	31.49	100

Currency conversion rate: US$1.00 = N157

N Nigerian Naira

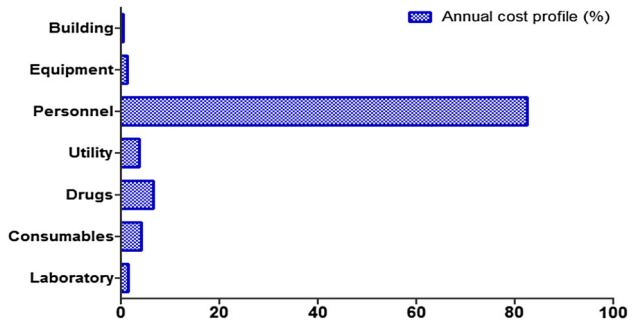

Fig. 2 Composition of the facility annual economic costs of malaria treatment

uncomplicated malaria episode. Figure 2 shows the relative composition of the annual economic costs of treatment for uncomplicated malaria in the facility.

3.2 Drug Treatment Costs

Antimalarial drug treatment amounted to a total economic cost of N1,906,197 (US$12,141.38) per annum at N328 (US$2.08) per case, representing 6.6% of the total cost (Table 3). When the cost of co-medication is included, the total increased to N5,266,968 per annum at N906 (US$5.77) per case, representing 16.4% of the total cost.

3.3 Sensitivity Analysis

The results of sensitivity analyses are presented in Table 4. The unit cost of treatment changed by 37% when a malaria prevalence rate of 0.27 was used in place of the hospital rate of 0.47. This reflects the measure of accuracy, assuming that 43% of the treated cases do not actually have malaria. As mentioned, the revised rate was used to reflect the value obtained in a previous study [21] and as a measure of accuracy given the high rate of presumptive treatment in the facility. Reducing the personnel cost by 25% and 50%, respectively (to compare with other non-university health facilities), showed a significant drop in the total and unit values by 21 and 41%, respectively. Changes in the discount rate and drug prices did not significantly impact on the treatment costs.

4 Discussion

The findings suggest that the medical centre generated a total annual economic cost of N28,723,723.15 (US$182,954) for the treatment of uncomplicated malaria during the study period (Table 3), comprising both recurrent and capital expenditures. Personnel accounted for a considerable proportion at 82.5% of total costs, followed by antimalarial drugs at 6.6%. This translates to an average provider cost of N4943 (US$31.49) for treating one episode of uncomplicated malaria in the OPD, with antimalarial drugs. When the cost of co-medication is included, the average value of treatment increased to N5522.29 (US$35.23) per case. This represents approximately 25% of total hospital expenditure, indicating a substantial proportion of the facility's annual budget.

The unit cost estimates in this study fall within the findings of similar studies reported in a systematic review by White et al. [17], for both financial and economic costs of treating uncomplicated malaria from a provider

Table 4 Sensitivity analysis of uncertain parameters on the study results

Parameter	Percentage change in parameter	Effect on treatment costs	Comments/justification
Malaria prevalence	43% reduction in the rate used from 0.47 to 0.27	Total and average costs significantly reduced by 37%	Indicates the significant impact of accuracy of diagnosis on the cost of treatment Change in rate to reflect the lower prevalence in a previous larger study as well as capture the impact of presumptive treatment
Personnel salaries	25% reduction in personnel cost	Treatment costs (total and average) reduced by 21%	High cost of personnel indicates significant contribution to the high costs of treatment
	50% reduction in personnel cost	Treatment costs reduced by 41%	
Discount rate	3–5%	No significant change in treatment costs	Discount rate shows no impact on treatment costs Reflects standard practice in economic evaluations [26]
	3–10%	No significant change in treatment costs	
Drug costs	Increased by 25%	Total and average cost per case increased minimally at 2%	Drug prices do not significantly impact on the total cost of treatment
	Decreased by 25%	Total and cost per case reduced minimally at 3.3%	

perspective. The economic cost ranged between US$9.14 and US$37.99 per episode of uncomplicated malaria at a median cost US$22.48. The study in Nigeria by Onwujekwe et al. [18], undertaken in selected public primary health facilities in a rural setting, estimated a provider cost of US$30 per outpatient malaria treatment. However, this estimate represents only the recurrent component and did not include the cost of capital items, reported to be US$133 per case. The unit cost estimates are also comparable with those of a previous study in South Africa [29], which estimated a hospital cost of outpatient malaria treatment at between US$28.55 (baseline) and US$37.99 (post-intervention with ACT) per case. Similarly, a study in India by Gogtay et al. [27] estimated a hospital treatment cost of between US$15.64 and US31.87 per outpatient malaria treatment. Similar to our study, these were hospital-level cost studies.

Similar provider cost estimates in other African countries suggest a range of US$3–6 per case of uncomplicated malaria [19], indicating considerable differences to this study. However, these studies did not report comprehensive analysis of the provider cost of malaria treatment, making comparisons difficult. These reports also typically represented a 'snap shot' analysis of provider cost data [20]. Consequently, from a more comprehensive approach, our study results suggest appreciably higher unit and total cost estimates for uncomplicated malaria treatment, with a higher rate of malaria prevalence, than in previous studies.

Other studies have been conducted in health centres, which typically represent lower-level health facilities and therefore have less expensive services than hospital-level facilities in which health workers receive higher salaries. As mentioned, hospital services are expected to cost more than twice those of health centres, mainly due to higher personnel and capital unit costs [29]. In this study, personnel cost averaged US$26 per case of uncomplicated malaria. This is considerably higher than the unit cost of US$3.98 reported by Wiseman et al. [9] in Tanzania, but close to the value of US$24.00 documented in the study by Onwujekwe et al. [18], which was carried out in health centres in Nigeria.

In this study, a baseline malaria prevalence rate of 0.47 was used for the analysis, based on the proportion of malaria treatment in the facility. This is significantly higher than values used in previous studies, which ranged between 0.15 and 0.23 [25, 28]. These studies assumed malaria prevalence rates in the study settings rather than the facility rate as used in this study. The high proportion of malaria treatment in this study may reflect the malaria prevalence and high transmission rate in this area in Nigeria. However, the high incidence of presumptive malaria treatment reported in the centre [21], increases the incidence of malaria treatment, thereby overstating malaria prevalence. This suggests overtreatment and wastage, significantly contributing to the increased cost of care. When the prevalence rate was reduced by 43% to 0.27 in the sensitivity analysis, the unit cost estimate significantly dropped by 37% to approximately US$19.84 per case (Table 4). Consequently, to reduce costs and prevent waste, there is a clear need to improve the accuracy of treatment through effective laboratory confirmation of malaria cases, using microscopy or RDT. Laboratory diagnosis has been demonstrated to be cost effective [30, 31]. The limited use laboratory diagnosis in this study is reflected in the low proportion of laboratory costs to the total cost of treatment (Table 3).

Furthermore, the high unit cost of this study may also suggest low capacity or under-utilisation of available resources, based on the number of patient visits, or alternatively due to disproportionate use of personnel resources. Either way, this indicates inefficiency of resource utilisation. Strengthening the healthcare system through efficient utilisation of resources will make it function more effectively and reduce overall costs to the provider and patients [18].

Medicines were the other significant contributors to treatment cost (Table 3). The current use of ACT, which is considerably more expensive than monotherapy, would have contributed to the increased cost of care [32, 33]. The comparatively high cost of treatment could be reduced through a more efficient approach to malaria treatment. This could include reducing the extent of presumptive diagnoses with associated treatment to increase the accuracy of diagnosis and associated treatment, thereby reducing waste.

This provider cost of treatment has implications on the burden of malaria treatment to the patient or households through cost transfers as professional fees. When viewed against the need to recover costs, especially from private health facilities, this cost is transferred to the patient in the form of hospital charges and/or professional fees, thereby increasing patients' out-of-pocket expenses. Added to the indirect cost of productivity loss, the overall cost would increase beyond the capacity of many low-income patients, considering that majority of the population in Nigeria live below the poverty line [34]. This should be avoided where possible.

Onwujekwe et al. [18] reported household expenditures/cost of US$12.57 and US$23.20 for outpatients and inpatients, respectively. A high facility cost of treatment contributes to making patients seek alternative sources of care for malaria treatment [6, 7], with implications for the subsequent quality of care. When viewed against similar costs and the economic status of the population, this cost represents a significant proportion of gross domestic product (GDP) in low-income settings. However, unlike in the private health facilities where there is expected to be full cost recovery, health services are highly subsidised in public health facilities in Nigeria, leading to limited cost recovery measures [34] benefitting patients. This may explain why an increasing proportion of patients seek care in public facilities.

Further recognition of the burden of malaria in low-income settings such as those that can occur in settings in Nigeria has made many regions in Nigeria operate free maternal and child health (FMCH) services for a package of services including malaria treatments [18, 24]. This implies that the provider bears a significant proportion of malaria treatment [18]. This high cost of malaria treatment underscores the need for donor support in the provision of malaria treatment services to improve patient care, and it is hoped this will continue. Robust information regarding current costs of treatment can benefit such groups in their deliberations as well as payers of healthcare in general [22, 35].

Generally, the cost of malaria treatment (comprising household and/or health system costs) is high in Nigeria (Table 3) and other low-income settings where malaria is prevalent. The proportion of who pays for the treatment varies between the health system and the household, depending on the context. This can be catastrophic to some households. However, this is not the case in health systems where providers bear most of the cost of treatment. Even though Nigeria has recently launched the national health insurance scheme to provide the necessary buffer to health expenditure [10], the effect is yet to be felt as the majority of the citizens still pay out of pocket. The provision of FMCH services in many regions in Nigeria is commendable but there needs to be improvement for long-term sustainability. On the whole, improved efficiency in the utilisation of resources will enhance the effectiveness of the healthcare system and reduce the overall cost to the provider and consumer. We hope this type of analysis paves the way for more thorough economic evaluations in Nigeria to improve the quality, efficiency and sustainability of the healthcare system in the country. This builds on recent guidance regarding budget impact analyses [22, 35].

4.1 Study Limitations

We are aware that the study was carried out in one centre, which may affect generalisability of the estimates. This was due to the challenges in the availability of reliable data and in getting permission to collect similar data from other sites. Consequently, the costs may be overestimates compared with costs in more routine ambulatory care settings. However, this was allowed for in the sensitivity analysis. In addition, the findings share many characteristics of similar studies, which enhance their reliability and generalisability. We similarly performed sensitivity analyses of key resource items in order to reflect the potential variability in key parameters in different settings and facilities in order to assess their impact on the cost estimates. We acknowledge that scaling up the study would strengthen the findings, and this will be the subject of future research projects.

We are aware that we used patient records to help calculate resource use. However, this is a standard source of patient data within health economic studies. In addition, this hospital is a university healthcare facility with better record-keeping practices than other general facilities. Consequently, we believe patient records to be an acceptable method to collect reliable data for this study. We have already used part of the data when reviewing treatment practices against current guidelines and found it to be reliable [21].

We also accept that data on patients' and household costs were not included; however, these are not part of provider costs. Overall, we believe the findings from our study are robust and provide useful baseline information for designing future scale-up measures.

Finally, this study used a costing method that evaluated the cost of treating episodes of uncomplicated malaria through an outpatient clinic. This suggests the need to exercise care when comparing the estimates from other studies due to differences in costing objectives and methodologies.

5 Conclusion

The study shows that the costs associated with malaria treatment in this health facility are significant, constituting a considerable proportion of overall hospital expenditure. This suggests that the health system in Nigeria currently bears a significant proportion of malaria treatment costs. The findings have implications for effective malaria treatment in view of the transferred cost to the patients, who are already burdened by the high indirect cost of productivity loss and out-of-pocket expenses as well as a healthcare system that is already burdened by the challenges of limited resources. Our results emphasise the considerable economic burden of malaria infection in the country, underscoring the need for continued government and donor agency support to effectively manage malaria in Nigeria.

To enhance efficiency in malaria treatment and control, there is an appreciable need to strengthen the healthcare system to make it function more effectively and reduce the overall burden of care on the provider and consumer. The findings of this study may help provide information to guide further studies as well as to solicit appropriate funding allocation for effective malaria control in Nigeria and other similar settings.

Author Contributions CCE conceived and designed the study, collected and analysed data, and wrote the initial draft. DRF and BBG contributed to the write-up of the paper and critiqued successive drafts, including the re-submission. All authors read and approved the final manuscript.

Compliance with Ethical Standards

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