



ORIGINAL RESEARCH

Drug Utilization and Cost Minimization Analysis of Antimalarial Therapies in a Tertiary Healthcare Institution in North-Central Nigeria

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ABSTRACT

Background: Malaria remains a leading cause of morbidity and mortality in Nigeria, particularly among children under five and pregnant women. The associated economic burden underscores the need for a cost minimization analysis (CMA).

Objective: To conduct a CMA of identified treatment options used in the management of malaria among patients at the family medicine clinic of University of Ilorin Teaching Hospital North-central Nigeria.

Methods: A cross-sectional study involving 290 participants was conducted. Data were collected using questionnaires and structured data collection forms and descriptive and inferential analysis was carried out. Ethical approval was obtained prior to commencement of the study.

Results: About 177 (61.04%) of the participants were female and most represented age group was 35-44 years (20.69%). Four main drug combinations were identified: Artemether + Lumefantrine, Dihydroartemisinin + Piperaquine, Artemisinin + Piperaquine and Artesunate + Amodiaquine. CMA revealed one branded product (Coartem) and three generic equivalents (Amatem Softgel, Lokmal, and Lonart DS). Lokmal, the most prescribed (45.51%) was also the cheapest at N266.67 (0.17 USD). Despite being the most expensive at N1000 (0.66 USD), Coartem, was the second most prescribed at 22.85%. In the Dihydroartemisinin + Piperaquine category, the branded drug P-Alaxin (N500.00; 0.31 USD) was prescribed at the same frequency (33.33%) as its generic counterparts Malact (N216.67; 0.14 USD) and Arthelad (N273.30; 0.17 USD), despite being twice as costly.

Conclusion: Cost considerations may not significantly influence prescribing behaviour, underscoring the need for enhanced prescriber awareness and policy interventions to encourage the use of cost-effective, therapeutically equivalent generics.

Keywords: Malaria; Antimalarials; Drug Utilization Studies; Branded products; Cost Minimization Analysis (CMA); Generic equivalents

INTRODUCTION

Cost minimization analysis (CMA) is a technique of analysis in pharmacoeconomics that is used to compare cost and outcomes of pharmaceutical products and services¹. It is applicable when the treatment alternatives under consideration are therapeutically equivalent, meaning they produce identical clinical outcomes². In such cases, the analysis primarily focuses on comparing direct costs, including drug acquisition and administration frequency. Like other comprehensive pharmacoeconomic techniques, CMA supports the selection of the most cost-effective option, thereby promoting optimal resource utilization, improved treatment outcomes, and reduced financial burden on individuals, healthcare systems and society³.

Malaria continues to represent one of the most critical public health challenges in Nigeria, contributing substantially to the country's morbidity and mortality rates. Despite sustained national and international interventions aimed at malaria control and elimination, Nigeria remains the most heavily affected country worldwide. Current estimates indicate that Nigeria accounts for approximately 27% of global malaria cases and 23% of malaria-related deaths^{4, 5}.

The high prevalence of malaria in Nigeria is driven by a complex interplay of socioeconomic, infrastructural, and environmental factors. Widespread poverty, insufficient healthcare infrastructure, and poor sanitation significantly compromise malaria prevention and treatment efforts. Moreover, limited access to effective preventive interventions—such as insecticide-treated nets (ITNs) and indoor residual spraying (IRS)—further exacerbates the burden of the disease. The emergence and spread of drug-resistant strains of *Plasmodium* parasites present an additional challenge to malaria control. In rural and underserved communities, low levels of health literacy and persistent cultural misconceptions about the aetiology and transmission of malaria continue to impede effective prevention and timely treatment⁶.

Malaria disproportionately affects vulnerable populations, including children under the age of five, pregnant women, and individuals residing in remote or hard-to-reach communities. These groups face heightened risks of severe illness and complications due to limited access to timely and effective healthcare. Beyond its direct health consequences, malaria contributes to school and workplace absenteeism, diminishes individual and societal productivity, and imposes a substantial economic burden on households as well as the national healthcare system⁷.

By understanding and implementing cost-effective strategies to minimize the impact of malaria, healthcare resources can be allocated more efficiently. This ensures that limited resources are utilized optimally to treat malaria cases, benefiting a larger number of affected individuals⁸.

Malaria has a substantial economic burden on affected countries and communities. It affects productivity, leads to increased healthcare costs, and can hinder economic development. By running this technique of analysis, policymakers can identify interventions that provide the best value for money, thereby reducing the economic burden of malaria and fostering sustainable economic growth⁹. Similar studies have shown that for the Nigerian healthcare system, cost of branded medicines was significantly higher than that of their generic counterparts¹⁸. Findings from studies in Nigeria, have also consistently shown lower rates of generic prescribing, with branded drugs dominating prescription patterns²⁰.

This study aims to conduct a utilization analysis to identify available treatment options, followed by a cost minimization analysis (CMA) of the identified therapeutic alternatives.

Cost minimization analysis of antimalarial therapies in adult patients at the University of Ilorin Teaching Hospital will help in Optimizing Resource Allocation for Enhanced Economic Development and improved clinical, and humanistic outcomes.

METHODS

Study setting

The study was carried out at the University of Ilorin Teaching Hospital (UITH), situated in Ilorin, the capital city of Kwara State, Nigeria. The hospital was Founded in 1970. It is 650 bedded with 21 clinical service department, including the General Out-Patient also called Family Medicine Department. The Family medicine department runs daily clinic attending to over 200 patients both adult and paediatric patients, with various disease conditions including Malaria fever.

Study Population

The study population were patients with malaria fever registered at UITH

Eligibility Criteria

Inclusion Criteria

Patients 18 years and older with confirmed malaria diagnosis

Exclusion Criteria

Patients with inpatient status.

Pregnant and lactating patients

Sample size

Population size greater than 10,000 was the reference point and for this Fischer's formula was used¹⁰.

$$n = \frac{Z^2 P (1-P)}{d^2}$$

Z = the standard normal deviate corresponding to the level of confidence (95%)=1.96

p = prevalence = 22%^{4,5}

d=desired degree of accuracy/precision set at 0.05

$$n = \frac{1.96^2 * 0.22(1-0.22)}{0.05^2} = 263.68$$

Calculating for non-response rate at 10%

$$n = 264 * 10\%$$

$$n = 26.4$$

$$n = 264 + 26.4$$

$$n = 290.4$$

Study Design, Sampling Technique and Data Collection Tools

The study adopted a cross-sectional design. A standardized questionnaire was used to collect

socio-demographic information, while structured data collection forms were employed for a retrospective review of 290 case notes, selected using a sampling interval of five. The same therapeutic outcome was assumed for both generic and branded products of each drug. Standard accounting procedures and time and motion studies were strictly adhered to.

Data Collection Procedure

The prescribed and dispensed drugs, precisely antimalarial, were recorded for the period between January and August 2023. Information retrieved includes, name and strength of the drug, defined daily dosing, cost per defined daily dose. The folders were marked/coded and the patients owning the folders were administered the standardized structured questionnaires for socio demographic information ,on clinic days.

Cost and perspective of analysis

The cost was evaluated from the individual's perspective, as patients in the Family Medicine unit paid for the drugs out-of-pocket. Only cost of medications were examined. Other cost components, such as direct non-medical costs, loss of productivity, and intangible costs, were assumed to be the same for the purpose of this study. Discounting and adjustments were not applied, as the study period was less than one year.

Sensitivity analysis

Sensitivity analysis was performed to test whether the decision changes when specific variables are altered within reasonable range in favour of less cost options. The cost per Defined Daily Dose (DDD) of the generics was increased by 25% and 50%, respectively, and then compared with the cost of the branded alternatives. Similarly, the cost of the branded products was reduced by the same percentages and compared with the generics.

Data Analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences

(SPSS) (version 21). Descriptive analysis, including means, and frequencies, was used to summarize the socio-demographic characteristics of patients. Inferential statistics were employed to compare the mean cost per Defined Daily Dose (DDD) of the various antimalarials and determine whether the differences were statistically significant."

Ethical Approval

Ethical approval was sought and obtained from the Ethics and Research Committee of the Institution Approval Number: UITH/CAT/189/VOL.21B/502.

RESULTS

Demographic Information

The socio-demographic data of patients sampled for cost minimization analysis are presented in Table 1. Out of a total of 290 patients, 61.84% (177) were female, most had tertiary education 234 (80.41%) within the age range of 25-34 years 75 (25.86%). Most of the patients were employed 212 (72.85%) with average rated income level 212 (72.85%).

Table 1 Sociodemographic data

Items	Frequency	Percentage (%)
Gender		
Female	177	61.04
Male	113	38.96
Education Level		
No formal education	23	7.90
Secondary	33	11.34
Tertiary	234	80.41
Age group		
18-24	41	14.14
25-34	75	25.86
35-44	60	20.69
45-54	55	18.97
55-64	33	11.38
65-70	26	8.96
Employment status		
Employed	212	72.85
Self-employed	51	17.52
Unemployed	27	9.30
Income level		
Average	212	72.85
High	63	21.64
Low	15	5.15

Key: – Low=<₦ 30.0000(\$18), Average= ₦ 30.0000–₦200, 000(18-125\$) High=>₦200, 000(\$125). Note: At the time of this study 1USD=1590.75 NGN

Drug Utilization Studies

Table 2 shows that the four main drugs used in the treatment of uncomplicated malaria were Artemether + Lumefantrine, Dihydroartemisinin + Piperaquine, Artemisinin + Piperaquine, and Artesunate + Amodiaquine. None of the identified drugs

were used for treatment of complicated malaria. The available brands and generic equivalents are shown in the table. The brand Lokmal recorded the highest number of prescriptions, accounting for 79 prescriptions (27.24%), followed by Artequick with 63 prescriptions (21.76%).

CMA - Artemether + Lumefantrine Regimens

The result shows that Lokmal, a generic form of Artemether + Lumefantrine which was the cheapest at N266.67 (0.17USD) based on Cost/DDD was the most prescribed during this period with a prescription frequency of 45.51%. Contrastingly though, Coartem

(branded product), despite being the most expensive at N1000 (0.66USD), came next with a frequency of 22.85%. Another generic equivalent, Lonart DS was prescribed almost as many times as the branded type standing at 21.14 % of all prescriptions in this category (Table 3).

Table 2: Drug Utilization studies

Brand	Antimalarial drug	Number of prescriptions	Percentage (%) of total antimalarial prescription
Coartem	Artemether + Lumefantrine	40	13.8
Camosunate	Artesunate + Amodiaquine	16	5.5
Amatem Softgel	Artemether + Lumefantrine	19	6.6
Lokmal	Artemether + Lumefantrine	79	27.24
Lonart DS	Artemether+ Lumefantrine	37	12.8
P-alaxin	Dihydroartemisinin + Piperaquine	12	4.1
Malact	Dihydroartemisinin + Piperaquine	12	4.1
Arthelad	Dihydroartemisinin + Piperaquine	12	4.1
Artequick	Artemisinin + Piperaquine	63	21.76
Total		290	100

Table 3: Mean cost/DDD of Artemether + Lumefantrine Regimens for Cost Minimization Analysis (CMA)

Items	Branded Coartem	Generic equivalent Amatem Softgel	Lokmal	Lonart DS
Defined Daily Dose (DDD)	80 mg/480mg bid	80 mg/480mg bid	80 mg/480mg bid	80 mg/480mg bid
Cost/DDD (₦)	1000	600	266.67	833.3
Cost/DDD(USD)	0.66	0.38	0.17	0.52
Frequency of prescription (%)	40 (22.88%)	19 (10.87%)	79 (45.51%)	37 (21.14%)
t-value	1246.9	9126.3	5074.3	754.68
p-value*	<0.001	<0.001	<0.001	<0.001

Key: bid = twice daily; *p-values were obtained from the comparison of mean cost/DDD of each generic type with the branded type. Note: At the time of this study 1USD=1590.75 NGN

CMA - Dihydroartemisinin + Piperaquine Regimen

The mean cost/DDD of selected Dihydroartemisinin + Piperaquine brands for cost minimization analysis (CMA) are shown in Table 4. Two Dihydroartemisinin + Piperaquine drugs (Malact and Arthelad) were

compared with one branded product, P-alaxin. In this category, equal frequency of prescription (12, 33.33%) was recorded irrespective of mean cost/DDD (N500.00, 0.31 USD and N216.67, 0.14 USD; N273.30; 0.17 USD respectively).

Table 4: Mean cost per Defined Daily Dose (DDD) of Dihydroartemisinin + Piperaquine Regimens for Cost Minimization Analysis (CMA)

Items	Branded P-alaxin	Generic equivalent Malact	Arthelad
Defined Daily Dose (DDD)	120mg/960mg od	120mg/960mg od	120mg/960mg od
Cost/DDD (₦)	500	216.67	273.3
Cost/DDD(USD)	0.31	0.14	0.17
Frequency of prescription (%)	12 (33.33)	12 (33.33)	12 (33.33)
t-value	27491.41	36578.8	27491.4
p-value	<0.001	<0.001	<0.001

Key: od = once daily; **p*-values were obtained from the comparison of mean cost/DDD of each generic type with the branded type. Note: At the time of this study 1USD=1590.75 NGN

CMA - Artesunate + Amodiaquine Regimens

In the Artesunate +Amodiaquine category Camosunate was the only prescribed brand as shown on table 5 below.

Sensitivity Analysis

For Artemether-lumefantrine regimens, the cost of the branded product (Coartem) was NGN 1,000. All iterations of the base case

values resulted in costs that did not exceed NGN 1,000. The only exception was the cost of Lonart DS, which exceeded NGN 1,000 For regimens containing Dihydroartemisinin and piperaquine, all iterations yielded cost estimates that did not exceed NGN 500, which corresponds to the cost of the branded formulation, P-Alaxin, as shown in Figure 1 below

Table 5: Mean cost per Defined Daily Dose(DDD) of Artesunate + Amodiaquine Regimens for Cost Minimization Analysis (CMA)

Items/Brand	Camosunate
Defined Daily Dose (DDD)	100mg/300mg
Cost/DDD (₦)	400
Cost/DDD(USD)	0.25
Frequency of prescription(%)	1 (100%)

Key: Note: At the time of this study 1USD=1590.75 NGN

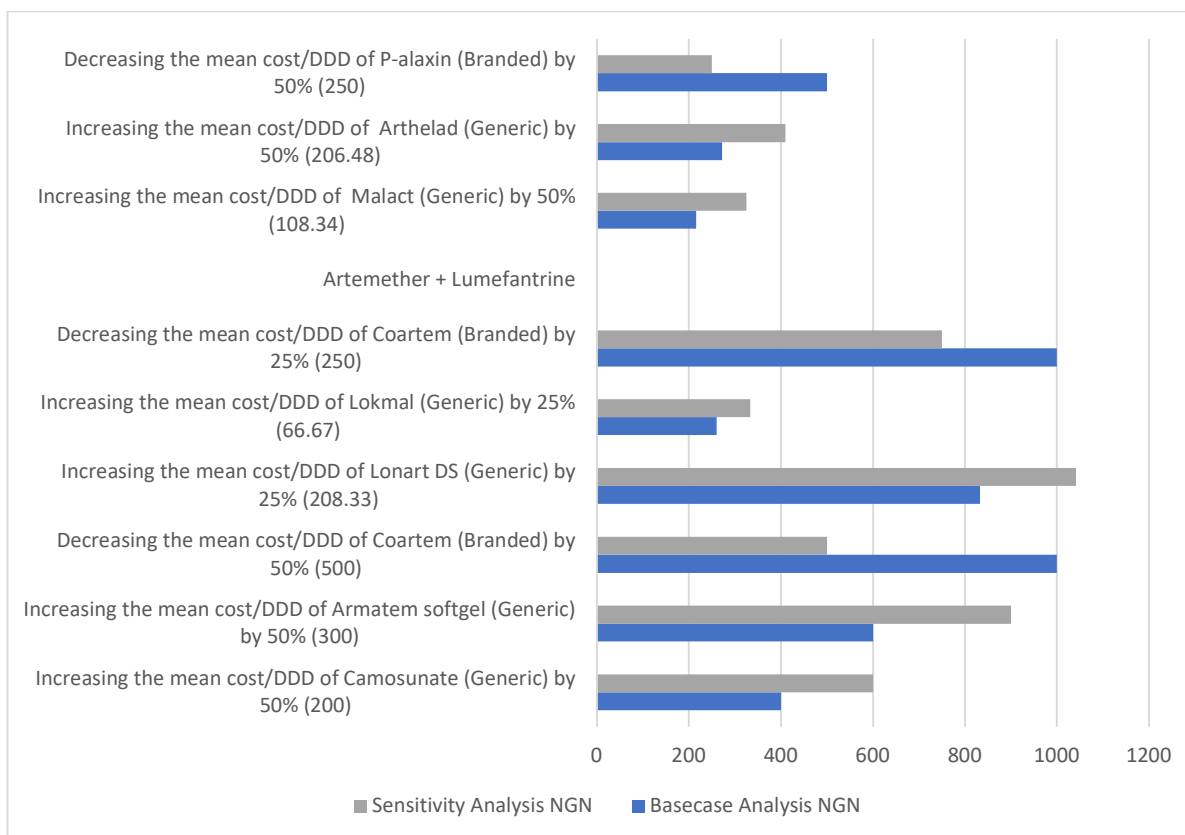


Figure 1: Sensitivity analysis for Cost-Minimization Analysis of antimalarial agents

Note: At the time of this study 1USD=1590.75 NGN

DISCUSSION

The results showed a widespread tendency to prescribe more expensive branded drugs, even when significantly cheaper generic alternatives were readily available. The mean cost per defined daily dose of Branded and Generic equivalent were significantly different for all antimalarial analyzed for the cost minimization analysis. This aligns with findings from a previous study¹⁸, which compared the prices of branded and generic drugs and demonstrated that the cost of branded medicines was significantly higher than that of their generic counterparts.

For the Coartem brand of Artemether + Lumefantrine, the cost of treating one patient with a branded medication could cover the treatment of three patients using the cheapest generic alternative, Lokmal. This is consistent with the findings of a study conducted across

23 pharmacies and the University of Benin Teaching Hospital, which reported that branded artemether-lumefantrine (AL) products consistently cost significantly more than their generic counterparts¹⁹. The fact that Coartem is the second most prescribed drug in the Artemether + lumefantrine category is in tandem to studies²⁰ that have reported that Coartem (the branded artemether-lumefantrine) remains the most frequently prescribed antimalarial in both hospital and retail settings in Nigeria, despite its significantly higher cost compared to generic alternatives.

In comparison to P-alaxin (branded), both generic variants exhibited considerably different mean costs/DDD ($p < 0.001$). The fact that the frequency of prescription of the branded and the generics in this case was same for all contrasts with findings from another study in Nigeria, which showed lower generic

prescribing rate²⁰. P-Alaxin, the branded antimalarial, which was found to be approximately twice as expensive as the two generics used in this study Malact and Arthelad, implies that for the cost of treating one patient with P-Alaxin, two patients could be treated with a generic alternative.

Results showed that even when far less expensive generic alternatives (Lokmal) were available, branded medications that were more expensive in case of Coartem were still second most prescribed. A cost minimization analysis of antimalarial therapies in adult patients attending UITH revealed that branded medications were still prescribed even when generic alternatives were available. Despite the fact that branded products were substantially more expensive, this was widespread.

The widespread prescription of branded drug despite their relatively higher cost was one of the findings of this study, this observation was found to be robust to sensitivity analysis, because despite iterations on the base-case values, the decision remained unchanged: more expensive drugs were prescribed more frequently than cheaper alternatives, indicating irrational prescribing patterns. When a generic alternative is available and its efficacy is guaranteed, there is no rationale for using branded medications. A contributing factor to the unreliable efficacy/effectiveness of some generic medications may be Nigeria's unstructured medicine distribution system, which makes it easier to produce fake and counterfeit goods¹². The primary advantage of using generic antimalarials is cost savings. These medications offer a cost-effective alternative, allowing healthcare systems to treat more patients within limited budgets. Regulatory authorities should ensure that generic antimalarials meet the same stringent quality and safety standards as their branded counterparts. While some patients may have a preference for branded drugs due to familiarity or perceived quality, many are willing to prioritize cost savings, especially in regions with limited financial resources¹³. The use of generic antimalarials aligns with global health initiatives aimed at improving access to

essential medicines in low- and middle-income countries. Choosing generic antimalarials can contribute to reducing health disparities by ensuring that cost is not a barrier to treatment for marginalized populations. More logical prescribing can result from a method for cost comparison like CMA. The use of extremely costly medications that are unaffordable owing to poverty or cost has had a negative impact on treatment outcome¹⁶. Due to the high cost of healthcare, people may be sick or in need of medical treatments but lack the funds to pay for them. A new drug's inclusion in the formulary should be decided with the help of pharmacoeconomic analysis, which is based on the idea that a drug shouldn't cost more if it isn't any better than a comparable product. Any additional investment may be considered "value for money" if it offers superior outcomes compared to existing therapies, even at a higher cost, provided sufficient funding is available¹⁷.

CONCLUSION

The management of uncomplicated malaria in the study setting relied primarily on four antimalarial drug combinations: Artemether + Lumefantrine, Dihydroartemisinin + Piperaquine, Artemisinin + Piperaquine and Artesunate + Amodiaquine with no drugs identified for the treatment of complicated malaria. Prescription patterns revealed a preference for branded (propriety) medications despite the availability of more cost-effective generic alternatives. Notably, Lokmal (a brand of Artemether + Lumefantrine) was the most frequently prescribed, and Coartem was widely used despite its higher cost. These findings suggest that cost may not be a primary consideration in prescribing practices of antimalarial at UITH. Highlighting the need for increased awareness and policy guidance to promote the use of equally effective but more affordable generic options.

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The authors declare they have no conflicts of interest to disclose

AUTHOR CONTRIBUTIONS

HBG - Research conceptualization, research/protocol design, editing content to meet journal specifications and approving the final version to be published.

AMO - Data collection, manuscript writing and approving the final version to be published.

OMJ - Sensitivity analysis and approving the final version to be published.

OMA - Draft editing and approving the final version to be published.

OIE – Literature review/search, editing and approving the final version to be published.

AA - Data analysis and approving the final version to be published.

AG - Tool development, supervision, editing and approving the final version to be published.

FASG - Data analysis, editing and approving the final version to be published

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