

Evaluation of antibiotic prescriptions and use in under-five children in Ibadan, SouthWestern Nigeria

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Abstract

Background: Irrational antibiotic prescriptions for children is a global concern requiring periodic evaluation and monitoring.

Objectives: To assess appropriateness of antibiotic prescribing for under-five children, as well as evaluating mothers' usage of antibiotics for their under-five and reason(s) for use.

Method: Cross-sectional review of out-patient case-notes of under-five using principles of antibiotic prescribing and a questionnaire-guided interaction with under-five mothers.

Results: Nearly all (445;98.9%) antibiotic prescriptions were based on signs and symptoms indicative of bacterial infection. Only 3(0.7%) had the initial antibiotic regimen modified. Nine (2.0%) had documented evidence of sensitivity test requested before antibiotic prescribing. Presence of infection or need for antibiotic therapy was established in 190(42.2%). Majority (324;72.0%) of mothers had administered antibiotics to their under-five. Of these, 157(48.5%) were prescribed by physicians and 79(24.4%) were self-recommended. Educational status of mothers significantly influenced antibiotic usage.

Conclusion: Antibiotic prescriptions for under-fives was largely based on symptoms indicative of bacterial infections, thereby corroborating the widespread empirical antibiotic prescribing. Considerable number of mothers engaged in self-recommendation of antibiotics for their under-fives. Thus, there is a need for continuous enlightenment of prescribers and mothers on rational use of antibiotics, while microbiological confirmation of clinical diagnosis is encouraged for evidence-based antibiotic prescribing.

Keywords: Antibiotic prescription, under-five children, mothers/caregivers.

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Introduction

Antibiotic prescriptions for children is a cause for concern in both developed and developing countries, especially for its excessive use in non-established infections or in infections with viral etiology¹⁻⁴. In Nigeria, children below the age of 14 years constituted more than 40% of the population^{5,6}, while children aged five years and

below constitute the bulk of patients attending the paediatric out-patient clinics⁷. These age groups are particularly vulnerable to many communicable and infectious diseases, with mortality among them usually very high^{6,7}. The United Nation Children Endowment Fund (UNICEF) reported in 2013 that about 2300 under-five children in Nigeria die every day⁸.

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Although antibiotics play a crucial role in reducing child morbidity and mortality⁹, its irrational use directly increases antibiotic resistance by promoting the emergence of resistant bacteria leading to increased rates of treatment failures and more severe illness episodes with higher costs and mortality rates¹⁰⁻¹³. Hence, the need for special attention towards paediatrics who are largely at different developmental stages^{6,12}. Rational prescribing implies using the right drug for the right patient at the right time in the right dose and manner of administration at affordable

cost with the right information. Thus, rational antibiotic prescription has to be tailor-made for individual patient taking into account the diagnosis, age, sex, weight, micro-organism susceptibility, vital organ functions, drug and food interactions, as well as socioeconomic background of patient^{14,15}.

In many low- and medium-income countries, indiscriminate and excessive use of antibiotics without medical guidance is largely facilitated by inadequate regulation of distribution and sale of prescription drugs^{16,17}. Studies have documented that a large number of mothers/caregivers do not consult the physician when their children/wards fall sick, instead they either visit the nearby pharmacies or patent medicine vendors to make complaints and medicine will be recommended¹⁸⁻²⁰. Some of them also considered self-medication of antibiotics for their wards/children, or consult a neighbour who may be having some left-over drugs²¹ from previous use. Such irrational use of antibiotics causes avoidable drug-related adverse effects^{22,23} as well as contributes to antibiotic resistance^{24,25} and unnecessary medical costs.

In addition, a number of physician-related factors contributing to inappropriate or irrational prescribing has been identified to include workloads and time pressure, inadequate drug knowledge and experience, diagnostic uncertainty, incomplete patient information, prescriber's perceived demand and expectation, as well as consideration about susceptibility among others²⁶⁻³¹. Therefore, there is a need for continuous medical education and training for prescribers on rational antibiotic prescribing, as well as enlightenment of the general public on proper use of antibiotics in order to reduce the menace of antibiotic resistance. Among the numerous interventions proposed by the World Health Organization to tackle irrational antibiotic prescribing is the necessity for prescribers to adopt and use protocols or guidelines based on strong evidence for the use of antibiotics³². Adopting these guidelines will standardize treatments, minimize dosage mistakes, avoid individual decisions, as well as ensure prioritization of decision based on clinical evidence³³.

Studies have been carried out to evaluate antibiotic use in public health facilities especially among adults³⁴⁻³⁸, and many of these studies suggest the need for periodic audits of antibiotic prescriptions and use with a view to ensure sustained interventions to minimize negative consequences arising from inappropriate use of anti-

otics. In Nigeria and many other developing countries, research assessing appropriateness of antibiotic prescriptions and usage in accordance with principles of antibiotic prescribing is scarce. This study therefore aimed at evaluating appropriateness of antibiotic prescriptions for under-five children in selected secondary and tertiary healthcare facilities in Ibadan, Oyo state, SouthWestern Nigeria, using antibiotic prescribing evaluation criteria developed by Adorka et al³⁹. Profile of antibiotics used by mothers for their under-five children and reasons for use were explored, while relationship between mother's educational status and some specific response on antibiotics used was subsequently investigated.

Method

Study site

This study was carried out in three healthcare facilities in Ibadan Metropolis namely Adeoyo Maternity Teaching Hospital, Yemetu; Oni and Son Children Hospital, Ring Road; and the University Health Service (UHS), Jaja, University of Ibadan, Ibadan, all in Oyo state, SouthWestern Nigeria. Adeoyo Maternity Teaching Hospital is a tertiary facility that caters for the healthcare needs of several categories of ambulatory and institutionalised patients, and it is a well-known hospital for maternity services and children care. Oni and Son Children Hospital is majorly for children-related treatment and care. The University Health Service is a secondary healthcare facility which provides medical services for students and members of the university community, and it is one of the major routine immunisation centres in Ibadan Metropolis.

Study design

A cross-sectional retrospective review of out-patient case notes of under-five children in selected hospitals between July and December, 2015 using principles of antibiotic prescribing adapted from Adorka et al³⁹. A questionnaire-guided prospective interaction with mothers of under-five children who attended the immunisation clinic of selected hospitals was subsequently carried-out for four consecutive weeks. Ethical approval was obtained from the University of Ibadan/University College Hospital Institution Review Board with the approval number NHREC/05/01/2008a

Study population

Out-patient case notes of under-five children in the medical record unit of Adeoyo Maternity Teaching Hospital

and Oni and Son Children Hospital, as well as mothers of under-five children who visited Adeoyo Maternity Teaching Hospital and UHS for routine immunisation of their children within the period of study.

Sample size determination

Based on estimated record of a total of 22,200 out-patient case notes for under-five children from Oni and Son Children Hospital and Adeoyo Maternity Teaching Hospitals between July and December, 2015, a representative target sample size of 450 case notes was determined using Yamane (1967) sample size formula⁴⁰. Also, a total of 3700 under-five children who were regularly been treated in Adeoyo Maternity Teaching Hospital and UHS on a monthly basis was obtained from the medical record unit of the hospitals. Based on the estimated population and allowing for attrition rate, a target sample size of 450 was also calculated to guide enrollment of under-five mothers for the prospective interaction.

Inclusion criteria/Exclusion criteria

The most recent prescription contact in selected case notes of under-five children, containing at least one antibiotic was included for review. Prescriptions with no antibiotics and those with incomplete information such as patient's age were excluded. Also, mothers/caregivers who brought their under-five children to the hospitals for routine immunisation, and who consented to participate in the study were enrolled. Mothers of children older than five years and those who declined participation were excluded.

Sampling and recruitment procedures

All the under-five out-patient case notes that met the inclusion criteria from selected hospitals within the study period were chronologically arranged, with every other case note subsequently selected for review. For the prospective phase, mothers of under-five children were approached for participation in the study while waiting for their children's turn of routine immunisation schedule. Details of objectives and procedure of the study were explained to individual participant, after which voluntary informed consent was obtained from every participant to signify their intention for participation. Confidentiality of responses and anonymity were assured, while they were informed that participation is voluntary. Only consented mothers of under-five children were consecutively enrolled and administered the questionnaire.

Instrument for data collection

The retrospective review of case notes was guided by Adorka et al³⁹ antibiotic evaluation criteria based on principles of antibiotic prescribing. The evaluation tool was designed with a 'Yes' or 'No' response option, and was largely based on (a) principles of establishing the presence of bacterial infections before administration of antibiotics⁴¹⁻⁴³ (b) principles of establishing potential sources of infections or co-morbid conditions predisposing patients to certain infections prior to prescribing antibiotics for prophylactic purposes⁴³ and (c) principles of making appropriate antibiotic selection for empiric or definitive treatment of infections including the need for and ensuring the effectiveness of prescribed antibiotics^{41,42,44}.

Prospective interaction with mothers of under-five children was guided by pre-tested and validated structured questionnaire comprising three sections: Section A gathered socio-demographic data of mothers of under-five children including age, educational status and occupation. Section B assessed opinion of mothers on antibiotics used for their under-five children at one time or the other. Section C evaluated data on mothers' perceived effectiveness of antibiotics used for their under-five children among other questions.

Pre-test and validation of instrument

The instruments were assessed for content validity by two academic scholars in the department of Clinical Pharmacy and Pharmacy Administration, University of Ibadan. Face validity was done among five mothers of under-five children from Oni and Son Children Hospital to ascertain appropriateness of sampling procedure vis-a-vis the study design. Ten case notes from the UHS were used to pre-test the antibiotic prescribing evaluation criteria. Necessary modifications were made thereafter to ensure clarity and comprehension of the questions before the final version of the questionnaire was administered to participants.

Data analysis and management

Data obtained were sorted, coded and entered into Predictive Analytic Software (PASW) Version 20.0 for data analysis and management. Descriptive statistics including frequency and percentages was used to summarise data. Chi-square test was used to evaluate the relationship between educational status of mothers/caregivers and some specific response on antibiotics used for their under-five at $p < 0.05$ considered significant.

Results

There were 243 (54.0%) case notes reviewed from Oni and Son Children Hospital and 207 (46.0%) from Adeoyo Maternity Teaching Hospital. The mean age of under-five children whose case notes were reviewed was 17.5 ± 15.6 months. Majority, 431 (95.8%) had age ≤ 24 months, 14 (3.0%) were within the ages of $> 24 - \leq 48$ months, and 5 (1.1%) were in the age range of $> 48 - \leq 60$ months. Out of a total of 1742 medicines reviewed from 450 prescription contacts, 521 (29.9%) were antibiotics. Almost all, 445 (98.9%) prescriptions had the anti-

biotics prescribed based on signs and symptoms indicative of bacterial infections. A substantial proportion, 445 (98.9%) of antibiotics prescribed were broad-spectrum agents for all possible pathogens associated with the site of infection. Only 3 (0.7%) prescriptions had the initial antibiotic regimen modified by addition of other antibiotics. Nine (2.0%) had documented evidence of culture and sensitivity test results requested before initiation of antibiotic therapy. Details of retrospective assessment of under-five antibiotic prescriptions using individual criteria are shown in Table 1.

Table 1: Retrospective assessment of antibiotic prescriptions for under-five using Adorka et al individual criteria

Variable (n = 450)	Frequency	
	Yes	No
Antibiotic prescription based on		
Signs and symptoms indicative of bacterial infections present	445 (98.9)	5 (1.1)
Presenting signs and symptoms absolute for bacterial infections present	154(34.2)	296 (65.8)
Possible site for infection identified	380 (84.4)	70 (15.6)
Potential source of infection identified	2 (0.4)	448 (99.6)
Presence of infections established by objective data	134 (29.8)	316 (70.2)
Presence of infections inferred by symptoms only	310 (69.9)	140 (31.1)
Antibiotics prescribed alone	30 (6.7)	420 (93.3)
Initial antibiotics treatment modified by the addition of other antibiotics	3 (0.7)	447 (99.3)
Initial antibiotics treatment modified by the substitution of other antibiotics	10 (2.2)	440 (97.8)
Prescribed doses of antibiotics correct (Using BNF standard dosage regimen)	400 (88.9)	51 (11.1)
Prescribed antibiotics were broad-spectrum agents for all possible pathogens associated with the site of infection	445 (98.9)	5 (1.1)
Bacterial morphology and gram stain performed before therapy initiation	4 (0.9)	446 (99.1)
Culture sensitivity test performed before antibiotic therapy initiation	4 (0.9)	446 (99.1)
Culture and sensitivity test requested before initiation of antibiotic therapy	9 (2.0)	441 (98.0)
Culture sensitivity test performed in the course of antibiotic therapy	3 (0.7)	447 (99.3)
Antibiotic choice based on culture sensitivity test results	6 (1.3)	444 (98.7)

n = number, BNF = British National Formulary for children (2014 edition)

The criteria combination for prescription assessment showed that 190 (42.2%) antibiotic prescriptions were established based on the presence of infection or the

need for antibiotic use. A total of 185 (41.1%) antibiotic prescriptions were based on the presence of suspected bacterial infection, without evidence of laboratory test confirmation (Table 2).

Table 2: Retrospective assessment of antibiotic prescriptions for under-five based on criteria combination

Variable (n = 450)	Frequency (%)
Presence of infection or need for antibiotic use for treatment established	190 (42.2)
Bacterial infection may be present, though not confirmed	185 (41.1)
Presence of infection or need for antibiotic use or treatment not Established	7 (1.6)
Need for prophylactic use of antibiotics not established	1 (0.2)
Medication error in antibiotic prescription	3 (0.7)
Presence of infection or need for antibiotic use for treatment established, but medication error in antibiotic prescribing was present	14 (3.1)
Presence of infection or need for antibiotic use for treatment established, but principles of empiric prescribing of multiple antibiotics for treatment was not followed	5 (1.1)
Presence of infection or need for antibiotic use for treatment was established, and principles of antibiotic prescribing based on CST results was followed	10 (2.2)
Bacterial infection may be present though not confirmed and medication error in antibiotic prescribing was also present	25 (5.6)
Bacterial infection may be present though not confirmed and empiric prescribing of multiple antibiotics for treatment was not followed	3 (0.7)
Bacterial infection may be present though not confirmed, but principles of empiric prescribing of single antibiotic for treatment was followed	6 (1.3)
Presence of infection or need for antibiotic use or treatment was established and medication error in antibiotic prescribing was present	1 (0.2)

CST = culture and sensitivity test, n = number

Category definition for appropriateness of antibiotic prescribing showed that almost all the antibiotic prescrip-

tions (438; 97.3%) were empirically prescribed for the treatment of infection without adherence to the principles of antibiotic prescribing (Table 3).

Table 3: Category definition for appropriateness of antibiotics prescribed for under-five

Variable (n = 450)	Frequency (%)
Antibiotics empirically prescribed for the treatment of infection without adherence to the principles of antibiotic prescribing	438 (97.3)
Antibiotics empirically prescribed without adherence to principles of antibiotic prescribing and in conditions for which antibiotics were not justified	5 (1.1)
Antibiotics prescribed based on culture and sensitivity test results	4 (0.9)
Antibiotics empirically prescribed in accordance with principles of antibiotic prescribing for the treatment of possible infections	2 (0.4)
Antibiotics empirically prescribed in accordance with principles of antibiotic prescribing for the treatment of infections	1 (0.2)

n = number

More than one-half, 263 (58.4%) of the prescriptions reviewed from the case notes contained cephalosporins, with cefuroxime 158 (35.1%) as the most commonly prescribed antibiotic. Penicillins constituted 108 (24.0%),

with amoxicillin-clavulanic acid (94; 20.9%) being the most commonly prescribed. Profile of antibiotics prescribed for under-five children in the case notes is shown in Table 4.

Table 4: Profile of prescribed antibiotics for under-five in the case notes

Variable (n = 450)	Frequency (%)
Cephalosporins	
Cefuroxime	158 (35.1)
Cefixime	56 (12.4)
Cefpodoxime	41 (9.1)
Cephalexin	4 (0.9)
Ceftriaxone	2 (0.4)
Cefotaxime	1 (0.2)
Ceftazidime	1 (0.2)
Penicillins	
Amoxicillin-Clavulanic acid	94 (20.9)
Amoxicillin	14 (3.1)
Aminoglycosides	
Gentamycin	2 (0.4)
Macrolides	
Erythromycin	2 (0.4)
Quinolones	
Ciprofloxacin	2 (0.4)
Other antimicrobials	
Metronidazole	2 (0.4)
Chloramphenicol	2 (0.4)
Sulphamethoxazole + Trimethoprim	1 (0.2)
Combination antibiotics	
Cefuroxime + Gentamycin	21 (4.7)
Amoxicillin-clavulanic acid + Gentamycin	14 (3.1)
Ceftazidime + Amikacin	6 (1.3)
Ceftriaxone + Gentamycin	6 (1.3)
Cefuroxime + Amikacin	4 (0.9)
Amoxicillin-clavulanic acid + Amikacin	4 (0.9)
Amoxicillin- clavulanic acid + Chloramphenicol	3 (0.7)
Ceftriaxone + Amikacin	3 (0.7)
Cefotaxime + Amikacin	2 (0.4)
Amoxicillin-clavulanic acid + 3-in-one cream	2 (0.4)
Cefixime + Chloramphenicol	1 (0.2)
Cefuroxime + Chloramphenicol	1 (0.2)
Cefixime + Metronidazole	1 (0.2)

n = number

A total of 328 (73.0%) under-five mothers participated from Adeoyo Maternity Teaching Hospital and 122 (27.0%) from UHS. The response rate was 100.0%. Of these, 222 (49.3%) had tertiary education, 205 (45.6%) had secondary education, while 17 (3.9%) and 6 (1.3%) had primary and no formal education, respectively. Majority (300; 66.7%) of the under-five mothers were self-employed, 105 (23.3%) were government-employed, while 45 (10.0%) were unemployed.

About two-thirds, 324 (72.0%) had administered antibiotics to their under-five children at one time or the other. Of these, a large number (197; 60.8%) used the antibiotics within one to three months prior to the study period. A sizeable number, 157 (48.5%) administered the antibiotics based on doctor's prescription, while 79 (24.4%) self-recommended the antibiotics because of previous experience of use. Penicillins (234; 72.2%) were the most commonly administered antibiotics to under-five with ampicillin-cloxacillin drop (165; 50.9%) constituting the highest proportion (Table 5).

Table 5: Profile and reasons for previously administered antibiotics by mothers to under-five

Variable	Frequency (%)
Period of antibiotics administration to under-five children (n = 324)	
Within the week of study	5 (1.5)
One week prior to the study period	24 (7.4)
One to three months	197 (60.8)
Over three months	63 (19.4)
Over a year	18 (5.6)
Do not remember	17 (5.2)
Profile of administered antibiotics to under-five (n = 324)	
Penicillins	
Ampicillin-cloxacillin drop	165 (50.9)
Suspension amoxicillin	45 (13.9)
Suspension amoxicillin-clavulanic acid	18 (5.6)
Suspension ampicillin	6 (1.9)
Cephalosporins	
Suspension cefuroxime	21 (6.5)
Suspension cefixime	7 (2.2)
Suspension cephalixin	4 (1.2)
Suspension ceftazidime	1 (0.3)
Other antimicrobials	
Suspension sulphamethoxazole-trimethoprim	18 (5.6)
Syrup metronidazole	14 (4.3)
Suspension erythromycin	8 (2.5)
Three-in-one cream	7 (2.2)
Syrup chloramphenicol	2 (0.6)
Do not remember the name of antibiotics used	8 (2.5)
Mothers' reasons for recent administration of antibiotics (n = 324)	
Prescribed by a physician	157 (48.5)
Self-recommendation because of previous experience of use	79 (24.4)
Recommended by a relative/friend	41 (12.7)
Recommended by a pharmacist	23 (7.1)
Recommended by a nurse	17 (5.3)
Recommended by a patent medicine vendor	7 (2.2)

n = number

More than one-half (218; 67.3%) of mothers claimed to recall the dosage of the antibiotics administered to their under-five. Of these, 41 (18.8%) mothers appropriately described the dosing regimen of antibiotics reported to have been used for their under-five, while 177 (81.2%) inappropriately described the antibiotic regimen vis-à-vis dose, dosing interval and duration of use (Table 6). Educational background of mothers had significant influence on usage of antibiotics for their under-five. Details of

relationship between educational status of mothers and specific response on antibiotics used for under-five are shown in Table 6. Measures taken by mothers/caregivers on left-over antibiotics include discard/throw away the remaining antibiotics (264; 81.5%), kept the remaining antibiotics for future use (35; 10.8%), always finish/complete the whole antibiotic prescribed regardless of the number of days recommended (22; 6.8%), while 3 (0.9%) mothers/caregivers reported using the remaining antibiotics for the older children when needed.

Table 6: Relationship between educational status of mothers and specific response on administered antibiotics for the under-five

	Specific response on administered antibiotics for the under-five		Chi-square	p-value
	Yes, n (%)	No, n (%)		
Mothers' educational status	Appropriateness of dosage of antibiotics administered (n = 218)			
No formal education/Primary	2 (11.8)	15 (88.2)	4.807	0.090
Secondary	27 (24.5)	83 (75.5)		
Tertiary	12 (13.2)	79 (86.8)		
	Appropriateness of antibiotics used for suspected symptoms of infections (n = 324)			
No formal education/Primary	6 (28.6)	15 (71.4)	6.819	0.033*
Secondary	64 (44.8)	79 (55.2)		
Tertiary	88 (55.0)	72 (45.0)		
	Appropriateness of source of information for the antibiotics (n = 324)			
No formal education/Primary	12 (60.0)	8 (40.0)	7.164	0.028*
Secondary	78 (54.2)	66 (45.8)		
Tertiary	110 (68.8)	50 (31.2)		
	Self-medication of under-five with antibiotics (n = 324)			
No formal education/Primary	8 (42.1)	11 (57.9)	6.763	0.034*
Secondary	89 (60.1)	59 (39.9)		
Tertiary	73 (44.6)	87 (55.4)		

*Significant difference with Chi-square test for relationship between mothers educational status and some specific response on the antibiotics used, n = Number, British National Formulary for children (2014 edition) is used as a guide to ascertain dosage regimen appropriateness. Self-medication is considered as antibiotic usage without prescription from a physician. Appropriate source of antibiotics information is considered as information received from the primary care physician.

Discussion

Although antibiotics play a crucial role in reducing child morbidity and mortality^{9,10}, their inappropriate use may directly increase antibiotic resistance by promoting the emergence of resistance strain of bacteria^{10,11}. World Health Organisation has stated that antimicrobial resistance is one of the world's most serious public health problem and is largely caused by inappropriate prescribing and use^{32,45}. Thus, periodic evaluation and monitoring of antibiotic use especially in vulnerable population such as under-five children is essential. From the present study, nearly all the antibiotics prescribed (98.9%) were based on signs and symptoms indicative of bacterial infections, and > 98% were broad-spectrum agents for all possible pathogens associated with the site of infection. This largely indicates that most of the antibiotics prescribed for the under-five children were empirically prescribed, thereby further corroborating the widespread empirical nature of antibiotic prescribing in many developed and developing countries^{36,46-49}.

In contrast, the principles of antibiotic prescribing emphasize the need for evidence-based prescribing of antibiotics based on laboratory confirmation of implicated

organism(s) before the initiation of antibiotic regimen^{41,43}. However, in this study, the microbial, culture and sensitivity, a gold standard test for confirmation of bacterial infection was requested before initiation of antibiotic therapy in only few cases (2.0%). Although, microbiological diagnosis is important for obtaining accurate diagnosis of bacterial infection, its utility in routine clinical practice is limited by a number of factors^{41,50} including time constraints or delay in obtaining laboratory results - usually 24 -72 hours in most cases, expertise required for appropriate specimen collection and processing, as well as costs of laboratory investigations among others. Thus, the clinical manifestations presented by a patient may help in making decision for empirical antibiotic therapy especially for acute infections in under-five children where prompt clinical diagnosis and treatment are desired to avert fatal consequence(s)^{46,48,51}. In such situation, the initial antibiotic selection for empirical therapy should rely on broad-spectrum agents until culture and sensitivity data are available to determine the implicated organism(s). Once there is a laboratory evidence confirming the susceptible organism(s), a prompt switch to a cost-effective antibiotics with the narrowest possible spectrum

of activity is desirable for continuation of therapy^{46,48,51}. In general, appropriate use of antimicrobial agents involve obtaining an accurate diagnosis to determine the need for and timing of antimicrobial therapy, understanding how dosing affects the antimicrobial activities of different agents, tailoring treatment to host characteristics using narrow-spectrum agents and shortest duration of therapy^{41,50}. Therefore, there is a need for continuous medical education and training for prescribers on rational antibiotic prescribing, while ensuring improved access to microbiological-based laboratory facilities. This will guarantee better therapeutic outcomes with reduced incidence of antibiotic resistance.

Cephalosporins, most especially cefuroxime were the commonly prescribed antibiotics for under-five in the facilities studied. This is followed by penicillins, specifically amoxicillin-clavulanic acid. Previous studies have also reported cephalosporins and penicillins as the most commonly prescribed antibiotics for treatment of different infections in under-five children^{6,9,52}. Cephalosporins are broad-spectrum bactericidal agents that have similar mechanism of action with penicillins, but are less susceptible to beta-lactamases^{53,54}. Although, many of the antibiotics used by mothers/caregivers for under-five children at one time or the other were prescribed by physician, a substantial number of mothers also self-recommended the administered antibiotics for different kinds of symptom suggestive of infections. Many of the mothers/caregivers claimed to administer the antibiotics largely because of previous experience of effectiveness of use to their older children. Nevertheless, self-medication with antibiotics for prevention of future illness or active treatment of infections should be largely discouraged. Antibiotics should only be used when prescribed by a physician and this must be evidence-based in line with the principles of antibiotic prescribing⁴¹⁻⁴³. Hence, the need for education and consistent enlightenment of mothers/caregivers on appropriate use of antibiotics for their under-five children. Rational use of antibiotics will help to stem the tides of continual antibiotic resistance since there are limited range of antibiotics available for the treatment of most infections^{41,55}. The practice of self-medication with antibiotics by mothers of under-five may perhaps be linked to unregulated distribution of prescription drugs in many low- and middle income countries^{14,15,56-58} including Ni-

geria. In many resource-poor countries, prescription-only medicine and over-the-counter drugs can be purchased in most pharmacies and patent medicine stores without prescription^{14,15,56-58}. However, continued exposure of individual to antibacterial or antimicrobial agents is a major precursor to antibiotic resistance by promoting emergence of resistance bacteria strain⁵⁸⁻⁶⁰.

Interestingly, educational background of mothers significantly influenced decision for antibiotic usage for the under-five children. Higher level of education significantly impacted on mothers' choice of appropriate antibiotics for suspected symptoms of infections, as well as favors mothers' tendency to engage in antibiotic self-medication practices. This is consistent with previous studies^{16,18} which reported education of mothers as an influential factor on knowledge of use of antibiotics in cases of upper respiratory tract infections. Mothers/caregivers who are better educated are more likely to understand basic information on health education, as well as be able to recognise basic signs and symptoms of common childhood infections. Prescribers therefore need to intensify efforts at ensuring proper clarification of antibiotics information for mothers/caregivers of under-five, especially those with no formal education or those who possess minimal level of literacy. Furthermore, education on measures to properly handle left-over antibiotics by mothers should be appropriately reinforced during patient provider encounters. This becomes necessary on account of the fact that substantial proportion of mothers in this study mentioned methods for handling unfinished antibiotics to include discard/throw away the remaining antibiotics, as well as keeping the antibiotics for future use. These irrational disposal methods for unused antibiotics should be essentially discouraged, while mothers should be educated and enlightened on the need to always ensure completion of the recommended course of antibiotic regimen.

Despite the useful information from the present study, its limitations include the likelihood of memory or recall bias among mothers/caregivers with respect to use and dosage regimen of antibiotics administered to their under-five children. Also, opinions of under-five mothers who participated in this study may not be entirely representative of all mothers in the country, although, the proportion of participants who were engaged in this study is largely a representative sample size for the study sites.

Another limitation of this study is the fact that only the case notes of ambulatory under-five children were reviewed, while specific disease condition(s) or illness of under-five for which an antibiotics was prescribed was not distinctly explored. Future study may therefore need to take these gaps into consideration in order to ensure a far reaching conclusions on the appropriateness of antibiotic prescribing practice. Nevertheless, the strength of the present study may be linked to ability of the evaluation criteria to allow for a detailed description and assessment of antibiotic prescribing trends based on principles of antibiotic prescribing. Many of the previous studies³⁴⁻³⁸ that evaluate drug use in public health facilities focus largely on prescription reviews using World Health Organization prescribing indicators which does not include detailed account of antibiotic prescribing trends.

Conclusion

Antibiotic prescriptions for under-five children in the facilities studied was largely based on signs and symptoms indicative of bacterial infections, thereby further corroborating the widespread empirical antibiotic prescribing. Cephalosporins and penicillins classes of antibiotics were mostly prescribed for treatment of infections in the under-five, with considerable number of mothers who had engaged in self-recommendation of antibiotics at one time or the other. Thus, there is a need for consistent enlightenment of mothers on proper use of antibiotics. Also, continuing medical education and training for prescribers on rational antibiotic prescribing should be reinforced, while microbiological confirmation of clinical diagnosis is encouraged to ensure evidence-based antibiotic prescribing.

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Conflict of interest statement

None to declared by the authors.

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