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ORIGINAL RESEARCH

Impact of Antimicrobial Stewardship Intervention on Antibiotic Prescribing Practices in the Paediatric Unit of a Tertiary Hospital: Using Global-Point Prevalence Survey as a Tool

Ola-Bello Olafoyekemi I*[1], Osuagwu Chioma S[2], Versporten Ann[3], Ines Pauwels[3], Goossens Herman[3], Akintan Patricia E[4], Fajolu Iretiola B[4], Oshun Philip O[2], Roberts Alero A[5], Temiye Edamisan O[4], Ajudua Sharon C[4], Oduyebo Oyinlola O[2]

[1]Department of Microbial Pathology, University of Medical Sciences, Ondo, Ondo State
[2]Department of Medical Microbiology, University of Lagos/Lagos University Teaching Hospital, Lagos.
[3]Laboratory of Medical Microbiology, Vaccine & Infectious Disease Institute (VAXINFECTIO), Faculty of Medicine and Health Science, University of Antwerp, Antwerp, Belgium
[4]Department of Paediatrics, University of Lagos/Lagos University Teaching Hospital, Lagos
[5]Department of Community Medicine, University of Lagos/Lagos University Teaching Hospital, Lagos

*Correspondence: Dr OI Ola-Bello, Department of Microbial Pathology, University of Medical Sciences, Ondo, Ondo State. E-mail: oladbello@yahoo.com ; ORCID – https://orcid.org/0000-0002-8146-8013.

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Abstract

Background: Antimicrobial Stewardship programs help to promote the appropriate use of antibiotics, thereby reducing the emergence of resistance, decreasing healthcare costs, and preventing drug-related adverse events while improving patients' clinical outcomes.
Objectives: To determine the antimicrobial stewardship programme's impact using a prospective audit with feedback on antimicrobial prescribing practices in a Paediatrics department.
Methods: A baseline Point prevalence survey and post-intervention Point prevalence survey (PPS) were conducted in April 2019 and November 2019, respectively, in the Department of Paediatrics of the Lagos University Teaching Hospital (LUTH) using the global point prevalence survey (Global-PPS) of antimicrobial consumption and resistance as a tool. We compared the results from the two surveys to determine their impact on antibiotic prescribing practices in the department.
Results: At baseline PPS, 90 of 114 children (78.9%) were treated with 164 antibiotics. At post-intervention PPS, 46 out of 62 children (74.2%) were on 81 antibiotics. The antimicrobial consumption rate decreased from 79% to 74% pre- and post-intervention. The reason for antibiotic therapy documentation increased from 99.5% to 100% post-intervention.

Guideline compliance increased from 43.1% to 76.5%. Stop/review date documentation increased from 42.5% to 81.5% post-intervention. Targeted therapy moved from 7.9% to 25.9%. Treatment based on biomarkers improved from 4.27% to 60.5%. ASP significantly enhanced the quality indicators {χ^2:13.998; P=0.01}.
Conclusion: Antimicrobial Stewardship Programmes optimised antibiotic use through coordinated interventions. Point Prevalence Surveys (PPS) identify areas for improvement, and the Global PPS has proven to be an effective tool in detecting opportunities for enhancement.

Keywords: Antibiotics, Antimicrobial Resistance, Antimicrobial Stewardship Program, Biomarkers, Paediatrics, Global-PPS, Quality indicators.

Introduction

Antimicrobial resistance (AMR) has been a significant health concern globally.[1,2] The indiscriminate use of antimicrobials in healthcare settings and their increasing consumption, particularly in poor resource countries, are key factors fuelling this growing public health threat.[1-3] The World Health Organization (WHO) has recommended active interventions and programs to reduce the burden of AMR in all healthcare settings.[1,3] An antimicrobial stewardship program (ASP) is an intervention to reduce excessive utilisation of antimicrobials in our healthcare institutions, which deals with the challenges of antimicrobial resistance.[1] However, in Nigeria, there is little information on stewardship.[2] Only 24% of the tertiary institutions have structured ASP committees. [1-4] Antimicrobial stewardship involves various interventions to reduce inappropriate antimicrobial consumption.

The goals of ASP focus on improving patients' outcomes by improving infection cure rates, reducing hospital-acquired infection, length of admission, morbidity and mortality rates, as well as minimise consequences following the use of antimicrobials such as drug toxicity with greater interest in reducing healthcare costs and preventing antimicrobial resistance, using antimicrobial guidelines.[1–3, 5–8]. Areas of interest include antimicrobial guidelines,[7] appropriate dosing, duration of therapy, set of quality indicators (reason for prescribing antimicrobials; stop/review date), and prescription based on microbiology data to improve patient's clinical outcomes and prevent the development of resistant organisms.[9]

The Antimicrobial Stewardship Program is authorised through a multidisciplinary work team with core membership of an infectious diseases physician, a clinical microbiologist and a clinical pharmacist with expertise in infection.[7,10] The Stewardship program uses different strategic interventions classified as Structural, Persuasive, Enabling, or Restrictive.[11–13]These strategies lead to direct control over antimicrobial use at an institution and educational opportunities for prescribers when a request is made.
The need for an Antimicrobial Stewardship programme has been recognised in the Lagos University Teaching Hospital (LUTHd. A point prevalence survey was carried out in LUTH in 2015[14] and 2017[15] to determine the rate and characteristics of antibiotic prescription. The prevalence of antibiotic prescribing in the hospital was high in all disciplines, including Paediatrics, with only about 50% of prescriptions based on clear therapeutic indications. Less than 1% of the prescriptions were based on the use of biomarkers, and the antibiotics guideline was not accessible. There was clear evidence that the hospital needed a cohesive antimicrobial stewardship program.[15] In 2018, as part of the hospital antibiotic policy and through the effort of the antimicrobial stewardship committee, the Department of Paediatrics produced a guideline

to optimise antibiotic use and improve patient treatment and outcomes.

The Point Prevalence Survey (PPS) is a core method to identify specific areas to improve the quality of antibiotic prescribing in various healthcare settings.[10] This tool identifies inappropriate use of specific antimicrobial agents and resistance, proposes quality indicators of antimicrobial prescribing practices, and identifies targets to improve antimicrobial prescribing and use.[16] This study assessed the impact of antimicrobial stewardship on the antibiotic prescribing practices of the paediatrics department of the Lagos University Teaching Hospital (LUTH) using the Global PPS protocol. The Global-PPS employs standardised quality indicators to assess the efficacy of interventions, establish benchmarks for improvement, and evaluate the impact of implemented measures. The tool identifies current hospital practices, revealing significant variations and deficiencies in antibiotic prophylaxis and treatment. PPS data informed the development of quality indicators and performance targets for enhancing hospital antibiotic prescribing practices.

Methods

Study design and setting

This was a cross-sectional study using the Point Prevalence Survey (PPS) conducted in April 2019 as a baseline assessment of the antimicrobial prescribing practices in the paediatric wards of the Lagos University Teaching Hospital. The Department of Paediatrics comprises 150 beds, two neonatal units, and three older children wards. It has an annual admission range from 2500-4000. The PPS baseline assessment preceded a prospective audit with intervention and feedback [17] carried out using the departmental antibiotic treatment guideline as part of the AMS intervention. After six months, a post-intervention PPS was conducted in November 2019 to assess the impact of the AMS intervention in these wards using a global point prevalence survey for antimicrobial consumption and resistance protocol designed by the University of Antwerp (www.global-pps.com). Global PPS tools help identify targets to improve the quality of antimicrobial prescribing, improve healthcare quality, and assess effective interventions through repeated PPS. Global-PPS uses standardised quality indicators to evaluate interventions set, targets for improvement, and measure the impact of interventions.

Study population and eligibility criteria

All patients on the wards except in haemato-oncology within the paediatrics department of LUTH were the study population. All patients on the wards who were on antibiotics at a.m. on survey day were included. Patients who had already been discharged before 8 o'clock and/or admitted after that time were excluded. Antimicrobial agents for systemic use were included for PPS as follows: Antibacterial and antifungals for systemic use (including griseofulvin and Terbinafine); drugs for the treatment of tuberculosis; Antivirals and Antimalarial, while Antimicrobials for topical use were excluded from the survey.

Sample size/ Sampling methodology

In the Ward Form, the number of patients admitted was determined during a single visit made at 8 a.m. on the day of the Global-PPS. The total number of available beds attributed to inpatients of the ward surveyed at 8 a.m. was determined. This means the number of total inpatient beds at the time of the survey (Number of beds equals the total beds in the ward, both occupied and empty). This was the denominator of the Global-PPS. After that, the number of patients on antimicrobial therapy was determined, and ongoing therapy was over a few days. Still, each eligible ward was visited only once during the stipulated time. This formed the numerator for the Global-PPS. Types of indications for prescribed antibiotics were also noted.

Data collection and tools

Data were collected using standardised paper forms (wards and patients forms) for both the baseline point prevalence survey and a post-intervention point prevalence survey, and the quality indicators were compared using the Global-PPS for antimicrobial consumption and resistance. The Global-PPS web-based application was used for data entry, verification, validation, and reporting as designed by the University of Antwerp (URL: http://app.globalpps.uantwerpen.be/globalpps_webpps/)

Variables: Information collected using the standardised forms included the age of the child, particular ward, antimicrobial therapy/ regimen, indication for antibiotics, route of administration, documentation of stop/review dates, reason for prescription in note, treatment decision supported by microbiology data and/ or biomarker to assess quality indicators for antimicrobial prescribing.

Quality Assurance

The percentage of patients with reasons for antibiotic use in notes and stop/review date was documented. The reason in notes and stop/review date were documented for each antibiotic level over the total scores for this indicator. The percentage of guideline compliance was counted at each patient level per antimicrobial therapy over total scores for this indicator. For combination therapy with more than one antibiotic: If one antibiotic by diagnosis is not compliant, then this combination therapy for this diagnosis was counted as non-compliant.

Data analysis

Descriptive statistics were applied for all antibiotics administered to the patients during PPS and those being reviewed for prospective audit recommendations and compliance, as well as for positive culture, susceptibility and resistance traits. Results were presented using frequencies and proportions, contingency tables and charts. A chi-square test assessed trends and relationships in the guideline's compliance over the study period. This was done using SPSS version 22. (IBM, Corp, Armonk, NY, USA).

Ethical considerations

Ethical approval for this study was obtained from the Health Research Ethics Committee of the College of Medicine, University of Lagos, Nigeria, with an assigned number, ADM/DCST/HREC/APP/2671. Participants were not required to sign an informed consent form since this represents a quality improvement project undertaken within the hospital rather than an experimental study; however, information obtained from the participants' folders was treated as confidential.

Results

One hundred and fourteen patients were admitted during the baseline point prevalence survey; 90 (78.9%) were on 164 antimicrobials, while 46 (74.2%) of 62 eligible children were on 81 antimicrobials at the post-intervention level. The antimicrobial consumption rate decreased from 79% to 74% pre- and post-intervention. Antimicrobial use prevalence rates ranged from 66% to 92% across the four wards (Figure 1), and 66(59.4%) were on multiple antimicrobial therapies. At the antibiotic level, antibiotics were prescribed empirically; 145(88.4%); 60 (74.1%) and based on microbiology data, 13 and 21 antibiotics treatments were targeted therapies (7.9%; 25.9%), pre-and post-intervention, respectively.

Treatment based on biomarkers improved from 4.27% to 60.5%. The indications for the antimicrobial prescriptions include community-acquired infections (60%, 65.4%), prophylaxis

(36%, 29.6%), and hospital-acquired infections (4%, 5%), pre-and post-intervention (Table I).

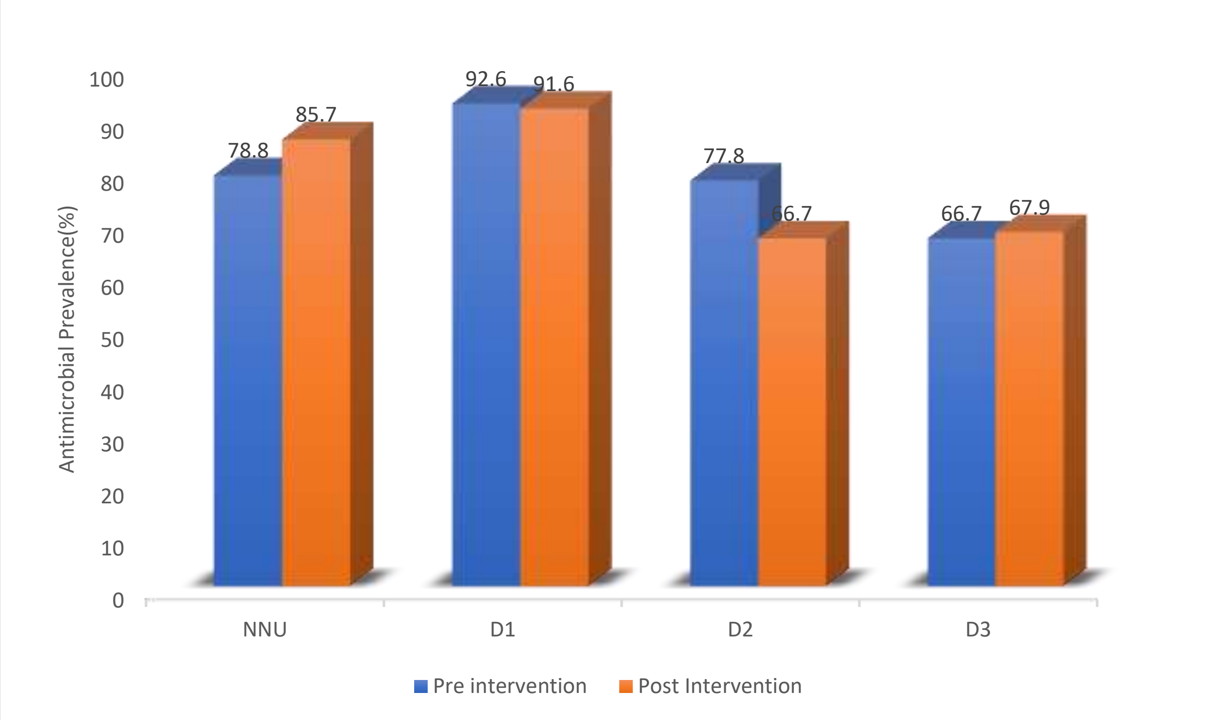

Figure 1: Antimicrobial Prevalence Rates in the Paediatric Wards
NNU - Neonatal inborn unit; D1 - Neonatal Outborn Unit; D2 - Paediatric Medical Ward; D3 - Paediatric Medical Ward

Table I: Indications for antibiotic prescription

Indications	*Pre-Intervention*		*Post -Intervention*	
	N	*Total (%)*	*n*	*Total (%)*
Therapeutic				
CAI	98	60	53	65.4
HAI	7	4	4	5.0
Prophylaxis	59	36	24	29.6
Total	***164***	***100***	***81***	***100***

CAI- Community-acquired Infection, HAI- Hospital-acquired Infection. This was calculated for each antibiotic therapy

Analysis at the patient level revealed the key prescribing patterns: 66 (59.4%) were multiple antibiotic patients, defined as patients who received more than one antibiotic, and 100 (90.1%) on intravenous therapies. Intravenous therapy was 100% in the neonatal wards; it ranged from 71.4% to 88.9% in the older children's ward. The number of patients on IV increased from 91.1% to 100%, pre- and post-intervention. Antibiotic quality indicators by activity for all patients were counted at antibacterial level; documentation of stop/review date was 42.5%; 81.5%, Guideline compliance was 43.1%; 76.5% while reason in notes was 99.5%; 100% - pre- and post-intervention (Table II). The impact of ASP on quality indicators was statistically significant {χ^2:13.998; P=0.01}. The most frequently used antimicrobials were amikacin (31%; 21%), cefotaxime (28%; 19%), and ceftriaxone (12%;

17%) pre- and post-intervention, for both therapeutic and prophylactic uses (Figure 2). The top diagnoses treated with antimicrobials were sepsis 24 (30.7%), pneumonia 11 (14.1%) and nervous system infections (12.8%).

Table I: Quality indicators for antibiotic prescribing

Quality indicator/ Wards	*Pre-intervention n (%)* NNU	D1	D2	D3	Total	*Post-intervention n (%)* NNU	D1	D2	D3	Total
Number of antibiotic therapies	52	55	25	32	202	14	21	18	28	81
Reason in notes (%)	52 (100)	54 (98.1)	25 (100)	32 (100)	201 (99.5)	14 (100.0)	21 (100.0)	18 (100.0)	28 (100.0)	81 (100.0)
Guidelines compliant (%)	24 (46.1)	32 (58.6)	11 (44)	12 (37.5)	87 (43.1)	10 (71)	19 (91)	10 (56)	23 (82)	62 (76.5)
Stop/Review date (%)	28 (53.8)	29 (52.7)	5 (20)	20 (62.5)	86 (42.5)	12 (86)	21 (100)	13 (72)	20 (71)	66 (81.5)
Prevalence of Intravenous Therapy										
	Pre-intervention PPS					*Post-intervention PPS*				
No of patients on admission	33	27	27	27	114	7	12	15	28	62
Treated patients on antibiotics (N)	26	25	21	18	90	6	11	10	19	46
Prevalence of IV therapy	26 (100)	25 (100)	16 (88.9)	15 (71.4)	82 (91.1)	6 (100)	11 (100)	10 (100)	19 (100)	46 (100)

This was calculated for each antibiotic therapy, except for intravenous therapy, which was calculated based on the number of treated patients. Guideline compliance for combination therapy with >1 antibiotic: if one antibiotic by diagnosis is not compliant, this combination therapy for this diagnosis will be counted as non−compliant. Effect of ASP on quality indicators was statistically significant {χ^2 = 13.998; P = 0.01} NNU - Neonatal Inborn Unit; D1 - Neonatal Out-born Unit; D2 - Paediatric Medical ward; D3 - Paediatrics Medical ward.

Discussion

In Nigeria, few point prevalence studies have been conducted to assess the impact of antimicrobial stewardship programmes explicitly tailored to the paediatric population. The present study evaluated antimicrobial prescription patterns using quality indicators, revealing that nearly 79% of children were initially prescribed antibiotics. This rate of antibiotic prescription in this study aligns with findings from previous studies from some parts of Nigeria (68.3-78.2%) [14-16] and other parts of the world. [18,19] On the other hand, the rate differs from reports from some parts of western Nigeria (59.6%) [20] and other African countries (30-57%).[10] Comparable studies reported similarly high rates (82.9-84.6%). [15,16,21] The widespread use of antibiotics in this vulnerable population, including neonates and young children, is a pressing concern that necessitates immediate attention to combat antimicrobial resistance globally. Intensified stewardship efforts in all our healthcare settings can help improve appropriate antibiotic use and curb excessive consumption in these vulnerable age groups. The survey findings indicate a notable decline in the antimicrobial prevalence rate following the intervention. To sustain this progress, continuous education and policy implementation are essential.

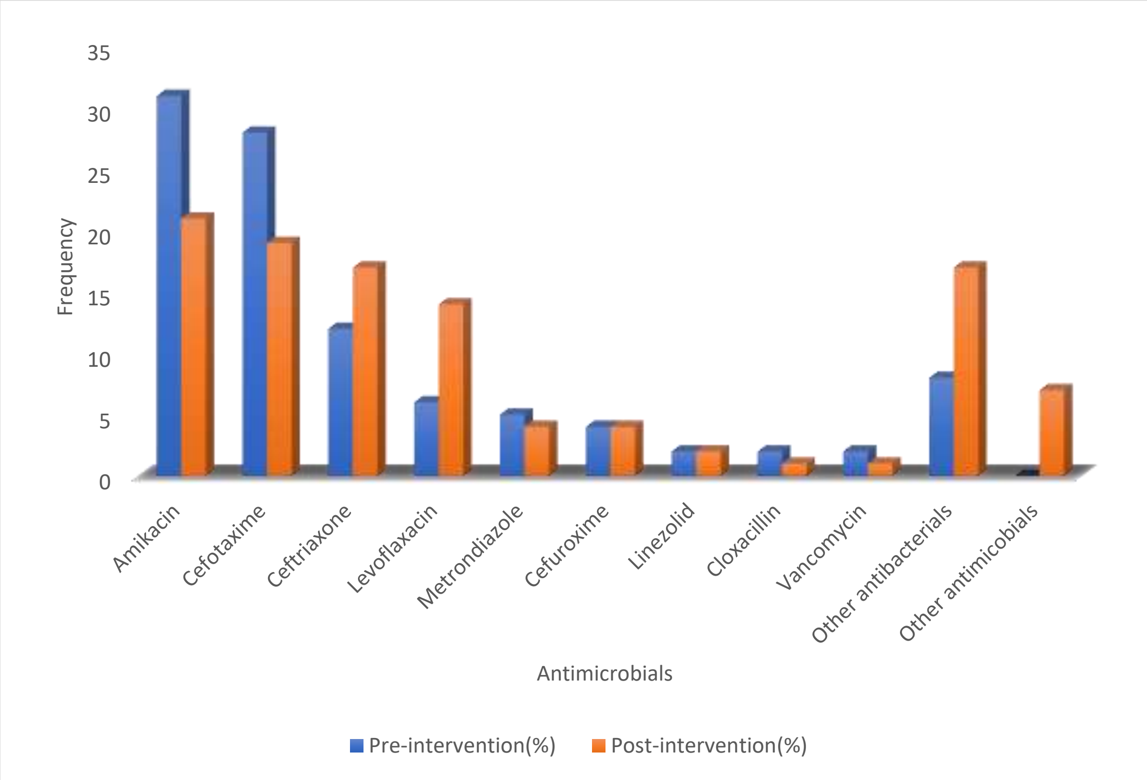

Figure 2: Most frequently used antimicrobials

The antimicrobial prescription rates in this study were 79% pre-intervention and 74% post-intervention. In contrast, a study in Thailand reported significantly lower rates, with 44.3% pre-intervention and 41.7% post-intervention.[18] Similarly, a PPS in the UK reported a rate of 40.9%.[22] These comparisons suggest that with prolonged implementation of antimicrobial stewardship programs, it is possible to achieve even better outcomes.

A notable example of successful antimicrobial stewardship is an outpatient surveillance interventional study, which reported a significant reduction in broad-spectrum antimicrobial prescriptions from 26.8% to 14.3%.[23] This improvement surpasses the findings of the present study. The interventions employed in this study included a continuous one-hour educational session, quarterly audits, and regular feedback, which collectively enhanced adherence to prescribing guidelines.[23]

Consistent with these findings, numerous studies have demonstrated that implementing antimicrobial stewardship programs (ASPs) leads to an overall decrease in antimicrobial consumption rates.[17,18,25-27]

This institution's high antimicrobial prescription rates can be primarily attributed to the prevalent practice of empirical therapy (88.4%) and the underutilisation of the Medical Microbiology Laboratory for diagnosing infections and conducting antimicrobial susceptibility testing.[28] This is in contrast to a Swiss tertiary hospital, where antimicrobial administration was more evenly distributed among empirical (37.8%), targeted (30.8%), and prophylactic treatments (30.3%). [25] The pre-intervention study revealed a remarkably low rate of targeted therapy (7.9%), consistent with findings from western Nigeria (3.8%), [20] eastern Nigeria, [16] and other African countries. [10] This highlights a persistent challenge in optimising antimicrobial use in these regions. The underutilisation of the microbiology laboratory likely contributed to this finding, suggesting that clinicians favour empirical treatment over laboratory-guided therapy.[28] This emphasises the need for targeted strategies to enhance awareness, accessibility, and optimal use of microbiology laboratory services. This pattern may contribute to the high antimicrobial prevalence rates in the cited studies. [28]

A significant proportion of children in the present study (59.4%) received multiple antimicrobial therapies, consistent with previous surveys conducted at this centre between 2015 and 2018 (55%-69.9%). [14] This alarming trend necessitates urgent attention, as it can contribute to antimicrobial resistance and adverse drug reactions. [29] The indiscriminate administration of antimicrobial agents for paediatric conditions has become a standard practice, significantly contributing to developing antimicrobial resistance among pathogens. Moreover, children, especially in developing regions, are disproportionately exposed to antimicrobial agents compared to adults.[4] Empirical evidence suggests that 20% and 50% of antibiotic prescriptions are unwarranted or inappropriate.[29] This study's findings align with previous research, highlighting the disproportionate exposure of neonates, particularly in outborn and inborn wards, to antibiotics. This demography constitutes the highest-consuming group within the paediatrics department, underscoring the need for targeted interventions to optimise antimicrobial use.[8]

The analysis of antimicrobial prescriptions revealed that the primary indication was for community-acquired infections (CAI), accounting for 60% of prescriptions. Prophylaxis was the second most common indication, comprising 36% of prescriptions, while hospital-acquired infections accounted for a relatively small proportion (4.0%). These findings are consistent with previous studies [4,10,20], including the longitudinal reports of Point Prevalence Surveys (PPS) conducted in Nigeria in 2015, 2017, and 2018, [30] which reported similar patterns of antimicrobial use. [1-3] Similarly, a PPS in eastern Nigeria found that therapeutic purposes accounted for 51% of antimicrobial prescriptions.[4] A Swiss study also reported a significant proportion of antimicrobial prescriptions for prophylaxis (30%).[5] These findings differ from a multicentre PPS in Turkey, which reported a more even distribution of antimicrobial prescriptions between prophylactic and therapeutic purposes.[6] This discrepancy may be attributed to variations in clinical practices, guidelines, and healthcare settings between regions. The dominance of community-acquired infections as the primary indication for antimicrobial prescriptions highlights the need for targeted interventions to optimise antimicrobial use in healthcare settings. Furthermore, the relatively high proportion of prescriptions for prophylaxis warrants careful evaluation to ensure that these prescriptions are justified and in line with evidence-based guidelines.

The study revealed that approximately 90.1% of patients received intravenous therapy, surpassing rates reported in Swiss (56%)[7] and West Nepal (48.9%)[8] studies. This trend is consistent with findings from various investigations conducted across Nigeria, Ethiopia, and Iran, which reported rates ranging from 70% to 100%.[14-16, 20, 21, 30-32] The high frequency of intravenous therapy may be attributed to the widespread use of amikacin and cefotaxime, which are exclusively available in intravenous formulations and are essential for treating sepsis and pneumonia, particularly in children. Neonates, being high-risk patients due to their immunocompromised or critical condition, were more frequently subjected to antibiotic use. However, it is essential to reserve parenteral routes for patients who cannot tolerate oral antibiotics when oral administration is deemed unreliable in severe infections or when specific antimicrobial agents are exclusively available intravenously.[33] Excessive reliance on intravenous therapy can lead to prolonged hospital stays.[33] To address this issue, healthcare providers should receive comprehensive education on the benefits of transitioning from intravenous to oral therapy as soon as feasible.[33] This approach can help optimise antimicrobial use, reduce hospital stays, and promote more efficient patient care.

Guideline compliance was initially observed at 43.1% across all paediatric wards, surpassing rates reported in a Sudanese study (22%-30%), [34] conducted in a similarly resource-constrained environment. This marked improvement exceeds the outcomes of other Nigerian studies. [1,14-16,30] In contrast, a Turkish paediatrics teaching hospital demonstrated a significantly higher antimicrobial compliance rate of 89%, approximately double that of the pre-intervention PPS (43%) in this study.[35] The Turkish hospital's 89% compliance rate is noteworthy. Our post-intervention PPS results showed a significant improvement in guideline compliance, highlighting the importance of sustained antimicrobial stewardship (AMS) efforts, robust infection prevention and control measures, and hospital personnel's effective adoption of these strategies. This study demonstrated enhanced adherence to antimicrobial guidelines, particularly following interventions, reaching an impressive 81.5% compliance rate compared to previous studies.[14-16,30]

Notably, this study observed a significant increase in the documentation of stop/review dates, surpassing rates reported in some Nigerian studies (21%, 27%). [1,3,15,20,30] However, it contrasts with a study conducted in eastern Nigeria, which achieved a remarkably high rate of 97%. [16] The accurate documentation of stop/review dates is crucial for guiding antibiotic stewardship, enabling prescribers to adjust therapy as needed. The omission of this critical information can compromise treatment outcomes and contribute to antibiotic misuse. Furthermore, this study demonstrated a high rate of recorded reasons for antibiotic prescriptions, ranging from 99% to 100% pre-and post-intervention. While this surpasses the generally lower rates observed in other studies,[14,15,21,30] it aligns with findings from some Nigerian investigations.[16,20]

The antimicrobial usage pattern observed in this study closely resembles that reported in a previous US study, with beta-lactams, particularly cephalosporins, being frequently prescribed alongside rising resistance rates.[35] Numerous African studies, including Nigeria and Europe mirror this trend. [14-16,20,21,23,26,29,31,32,35,36] Cephalosporins should be classified as "Watch" antibiotics due to their widespread efficacy, affordability, and accessibility. However, a survey undertaken in six tertiary healthcare facilities across Nigeria and India revealed a predominance of fluoroquinolones (74%) and third-generation cephalosporin (72.1%) prescriptions. [12] In contrast, a Swiss tertiary hospital reported a higher prevalence of penicillin-beta-lactamase inhibitors (30%).[25] This discrepancy may be attributed to Switzerland's enhanced access to microbiology investigations and antimicrobial guidelines.

Conclusion

This study demonstrates the effectiveness of Antimicrobial Stewardship Programmes (ASPs) in promoting optimal antibiotic use and improving prescribing practices. Point Prevalence Surveys (PPS) are a quality improvement tool that identifies targeted areas for enhancement, resulting in reduced antimicrobial consumption. The significant improvements in quality indicators and biomarker-guided treatments observed in this study highlight the positive impact of ASPs on clinical practice. The Global PPS quality indicators have proven to be a valuable tool for evaluating the success of antimicrobial stewardship initiatives and informing future quality improvement strategies.

To strengthen antimicrobial stewardship in Nigeria, the following strategies are recommended: a multidisciplinary collaboration, national antimicrobial guidelines, and surveillance systems should be established, continuous education and training programs should be implemented for healthcare professionals, hospitals should implement antimicrobial stewardship programs and promote patient and community education. Others include the need for further studies to explore innovative methods for measuring antimicrobial prescriptions and the use of incentives for healthcare professionals who adhere to antimicrobial guidelines and also hold them accountable for inappropriate antimicrobial prescribing practices.

Acronyms

AMS- Antimicrobial Stewardship
ASP- Antimicrobial Stewardship Program
IV- Intravenous
LUTH- Lagos University Teaching Hospital
GPPS- Global Point Prevalence Survey
PPS- Point Prevalence Survey

Authors' Contributions: O-BOI, OCS, APE, FBI, and OOO conceived the study while OB-OI, VA, IP, GH, APE, and OOO designed the study. O-BOI, OCS, IP, GH, FIB, and OOO did the literature review while O-BOI, OCS, APE, FBI, and OOO did data collection. All the authors analysed and interpreted the data. O-BOI, OCS, APE, and OOO drafted the manuscript. All the authors revised the draft for sound intellectual content and approved the final version of the manuscript.

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