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A multicentre Point Prevalence Study of Antibiotics Utilization in Hospitalised Patients in an Urban Secondary and a Tertiary Healthcare Facilities in Nigeria: Findings and Implications

*Olayinka O. Ogunleye[1.2], Modupe R. Oyawole[3], Patricia T. Odunuga[3], Folasade Kalejaye[3], Adesola F. Yinka-Ogunleye[4,5], Adesola Olalekan[6,7], Sunday O. Ogundele[1,2], Bernard E. Ebruke[8], Atinuke Kalada Richard[9], Bene D Anand Paramadhas[10], Amanj Kurdi[11,12.13], Jacqueline Sneddon[14], Andrew Seaton[14,15,16], Brian Godman[11,13,17]

[1]Department of Pharmacology, Therapeutics and Toxicology, Lagos State University College of Medicine, Ikeja, Lagos, Nigeria.

[2]Department of Medicine, Lagos State University Teaching Hospital, Ikeja, Lagos, Nigeria.

[3]Department of Pharmacy, Lagos State University Teaching Hospital, Ikeja, Lagos, Nigeria.

[4]Nigerian Centre for Disease Control, Federal Capital Territory, Abuja, Nigeria.

[5]Institute of Global Health, University College, London

[6]Department of Medical Laboratory Science, University of Lagos, Idiaraba, Lagos, Nigeria. Email: adesolaolalekan@gmail.com

[7]Centre for Genomics of Non-Communicable Diseases and Personalized Healthcare (CGNPH), University of Lagos, Akoka, Lagos, Nigeria

[8]International Foundation Against Infectious Diseases In Nigeria (IFAIN), Abuja, Nigeria

[9]Department of Medicine, General Hospital, Lagos, Nigeria

[10]Department of Pharmacy, Nyangabgwe Hospital, Francistown, Botswana.

[11]Strathclyde Institute of Pharmacy and Biomedical Sciences, Strathclyde University, Glasgow, UK.

[12]Department of Pharmacology, College of Pharmacy, Hawler Medical University, Erbil, Iraq

[13]School of Pharmacy, Sefako Makgatho Health Sciences University, Ga-Rankuwa, Pretoria, South Africa

[14]Healthcare Improvement Scotland, Delta House, 50 West Nile Street, Glasgow G1 2NP, UK

[15]Queen Elizabeth University Hospital, Glasgow, United Kingdom,

[16]University of Glasgow, Glasgow, United Kingdom

[17]School of Pharmaceutical Sciences, Universiti Sains Malaysia, Penang, Malaysia

***Corresponding Author:**

Dr Olayinka O. Ogunleye

Department of Pharmacology, Therapeutics and Toxicology, Lagos State University College of Medicine, Ikeja, Lagos, Nigeria.

E mails: olayinka.ogunleye@lasucom.edu.ng, yinkabode@yahoo.com

Tel: +234 805 335 7057

Abstract

Background

The understanding of antimicrobial utilization patterns is pertinent to successful implementation of the National Action Plans on Antimicrobial Resistance (AMR). There is however limited information on antibiotics utilization in Nigeria. This study was undertaken to build on existing information and provide direction for appropriate interventions including Antibiotics Stewardship Programs (ASP).

Method

A Point Prevalence Study (PPS) was conducted in two public urban health facilities in Lagos, Nigeria using a design adapted from the European Centre for Disease Prevention and Control (ECDC) and Global-PPS surveys.

Results

The prevalence of antibiotics use was 80.6% administered mostly parenterally (83.1% of total prescriptions) with concerns with extended surgical antibiotics prophylaxis. The mostly used antibiotics in the secondary hospital were parenteral metronidazole (32.4%), ceftriaxone (27.5%) and amoxicillin + clavulanate (8.2%) while the mostly used in the tertiary hospital were ceftriaxone (25.3%), parenteral metronidazole (19.1%) and Amoxicillin +Clavulanate (9.3%). There was an appreciable lack of specific functional capacities, policies and processes to promote appropriate antimicrobial use in both hospitals.

Conclusion

There is high rate of antibiotics utilization in these facilities with lack of institutional frameworks and processes for ensuring appropriate antibiotic use. The study provides the information needed to improve future antimicrobial use in hospitals and reduce AMR.

1. Introduction

Antimicrobial Resistance (AMR) is a critical challenge to healthcare systems globally increasing morbidity, mortality and costs [1–3]. With reports showing involvement of all regions of the world and across all age groups, AMR is a true global emergency requiring urgent action in all

nations[4,5]. AMR is widely attributable to unnecessary prescribing and dispensing of antibiotics including ''misuse'' in prophylaxis for surgical site infections (SSIs) as well as use in animals for growth promotion and the prevention of infections[6–9].

In low- and middle-income countries (LMICs), there is a high burden of infectious diseases reflected by considerably increased utilisation of antimicrobials in recent years, and unrestricted access to antibiotics is a particular challenge[5,10–13]. The causes of AMR in these settings are compounded by concerns with the healthcare professionals practices, inadequate patient education, weak health systems, limited diagnostic facilities, inadequate drug regulatory mechanisms with defective supply chains and inappropriate sales of antibiotics [14–16]. The high burden of infectious diseases in the continent of Africa has been associated with a tripling of antibiotic consumption in recent years [5,13]. There is also high use of antibiotic in Nigeria, consistent with the trend in the rest of Africa [10,17–20]. In a recent survey 97% of the doctors in a Nigerian urban tertiary hospital prescribed antibiotics based on their clinical judgements and experience with no institutional antibiotics guidelines in place and laboratory reports rarely available [21].

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In order to address the global problem of AMR, the World Health Assembly adopted a Global Action Plan on Antimicrobial Resistance in May 2015 mandating member states to evolve their respective multi-sectoral National Action Plans (NAP)[22]. The Nigerian NAP on Antimicrobial Resistance was developed in 2017 with the 'One Health' approach and the country has also enrolled into the Global Antimicrobial Resistance Surveillance System [23]. Antimicrobial Stewardship Programs (ASP), which constitutes part of the focus areas of Nigerian NAP on AMR, promotes the rational use of antibiotics improving clinical outcomes. [24–26].The establishment and functionality of ASPs however remain a challenge especially within LMICs including Nigeria due to issues including lack of personnel and funding [10,27]. A recent survey among tertiary hospitals in Nigeria demonstrated considerable concerns with only 35% of the facilities surveyed having a formal organisational structure responsible for ASPs, which were largely found to be sub-optimal [28], with facility-specific treatment recommendations based on local antimicrobial susceptibility only present in 23.5% of the facilities surveyed [28].

The understanding of antimicrobial utilization patterns in hospitals is pertinent to successful implementation of the National Action Plans on AMR and in particular for ASPs [29,30]. However, to date, there are limited number of studies documenting current antimicrobial use patterns in Nigeria in either hospital or ambulatory settings. These include point prevalence surveys (PPS) of antibiotics utilization conducted in four tertiary hospitals in Nigeria in 2015[31], a PPS of

antibiotics utilization in a tertiary hospital in South-Eastern Nigeria in 2017 [32] and more recently in 2019, a PPS of antibiotic utilization in one tertiary hospital and two secondary hospitals in Northern Nigeria [33]. These studies revealed a high prevalence of antibiotic use among hospitalised patients, mainly parenterally, with the third generation cephalosporins (mainly ceftriaxone), the imidazole group (mainly metronidazole) and the quinolones (mostly ciprofloxacin) most commonly prescribed. Targets for improving the quality of antibiotic utilization included addressing limited use of local antibiotic guidelines and high rates of empirical use, addressing extended period of surgical prophylaxis, and increasing rates of intravenous to oral switches. Taken together, these studies highlight the need for urgent interventions to improve the quality of antibiotic utilization within hospitals in Nigeria.

The first step in establishing a functional ASP is understanding current antibiotic utilization patterns. Consequently, we undertook an antibiotic PPS and ASP infrastructure survey in two urban hospitals in Nigeria (one tertiary and one secondary hospital) to add to the evidence base. These activities were designed to support the development of a local ASP strategy and to promote antibiotic surveillance in this and other healthcare facilities in Lagos state as well as Nigeria as a whole.

2. **Methodology**

2.1 Study Design

A prospective PPS of antimicrobial use within the two hospitals was undertaken over a two days period in November 2019 (one day per hospital) using a structured data collection tool adapted from the European Centre for Disease Prevention and Control (ECDC) and Global-PPS survey designs [29,34], which had previously been refined and tested to include confounders for Africa since 2017 [35–37].These includes documenting the extent of Human Immunodeficiency Virus(HIV), tuberculosis (TB), malaria infections and malnutrition among in-patients [38]. The survey also included a structured questionnaire that assessed the infrastructural capacities in the two hospitals for promoting rational antibiotic use. These includes access to a laboratory and a microbiologist, availability of materials and commodities for a functional laboratory service and the existence of Drugs and Therapeutics Committees (DTCs) and ASPs, and built on previous PPS studies[19,21,28,35]

2.2 Study Sites

The study was undertaken in two public healthcare facilities in Nigeria: one tertiary and one secondary hospitals in Lagos, the economic capital of Nigeria with over 20 million population. The two hospitals were:

i. Lagos State University Teaching Hospital (LASUTH), Ikeja, Lagos, Nigeria
   A 774-bed capacity tertiary health institution and one of three tertiary health institutions within the Lagos Metropolis. It has approximately 600 doctors (150 Specialists, 370 Resident doctors, 80 House officers), 900 nurses, 80 Pharmacists and 40 Laboratory Scientists and other non -clinical support and administrative staff.

ii. The General Hospital (GHL), Odan, Lagos, Nigeria
   Foremost secondary healthcare facility in the central business district of Lagos metropolis. Multi-speciality secondary healthcare facility with about 250 bed capacity, 164 doctors, 219 nurses, 19 pharmacists and 20 laboratory scientists and full complement of non-clinical staff.

We chose these two hospitals to be able to compare and contrast the findings within the economic capital and most populous city of Nigeria. These two hospitals enjoy a high patronage by the population within Lagos. Consequently, can provide a good basis for developing future ASPs within Lagos and other parts of Nigeria.

2.3 Inclusion and Exclusion Criteria

Inclusion Criteria

In-patients admitted at least one day before, were present in the ward at 7am on the survey day and had consented to accessing information from their medical records.

Exclusion Criteria

Short stay patients under observation who did not stay overnight, day-case patients such as those receiving chemotherapy or day-case surgery, discharged patients lodging overnight waiting to settle hospital bills or for transportation to their homes and patients who did not give consent for access to their medical records.

2.4 Data Collection

Patient - level data were collected in the two hospitals by trained volunteers including 20 pharmacy interns, 2 final year medical students and 8 medical interns. Data collectors were

trained on the subject of research ethics, the PPS methodology with the structured data collection tools similar to other PPS studies [35–37]. The study tool was in hard copy comprising separate forms for the hospital, ward and patient-level data, and a coding sheet for ensuring anonymity. Use of the data collection tools was practiced with the instructions and sample sheets for data entry to allow data collectors to ask questions and have any queries clarified prior to the commencement of the data collection.

Data were collected from the hospital records of patients who consented. Consent was sought for children and critically ill patients from their parents, next of kin or the treating clinician.

The lead investigator (OO) oversaw the data collection and liaised with data collectors to resolve queries as they arose.

Hospital based staff were also approached to provide information required to assess the existing institutional capacity for promoting appropriate antibiotic use including infrastructure, policy and practice and monitoring and feedback resources. Details of specific information and results are as presented in Appendix 3 of Supplementary materials.

2.5 Study Variables

Ward type, specialty and hospital were recorded. The total number of patients present on the ward on the day of the survey, the number receiving an antimicrobial and the total number giving consent was also recorded. Patient-specific data included age and employment status (collected if consent was given), risk factors for infection and antibiotics use namely catheter use, intubations, readmission (defined as a repeat admission for the same condition or a related complication arising from the previous admission), HIV status (if known), TB, malaria and malnutrition, previous hospital admission and past antibiotic use in the preceding 90 days using the Anatomical Therapeutic Chemical (ATC) classification codes[39].

The primary diagnoses of the surveyed patients were categorized into Non -Infectious Conditions (NIC) comprising non-communicable diseases while the Infectious Conditions were further categorized as Community Acquired Infections (CAI): occurring within 48 hours of admission, Healthcare Associated Infections: occurring after 48 hours of admission and Home Base Care Infection (HBCI): infections associated with home care [19,29,35] .

Antibiotic prescribing data included designation of the prescriber, indication and duration for antibiotic (treatment or prophylaxis), for prophylaxis, whether surgical or medical, route of administration (Intravenous (I/V) or Oral(P/O)), IV to PO switch, changed to sensitive antibiotics or not and recorded on drug chart or not. The indication was recorded using the same coding methodology used in the Global PPS tool [29,40] and as per anatomical site of infection.

2.6 Data Analysis

Collected data were subsequently transcribed into SPSS software tool (version 20.0) for analysis. Data cleansing was undertaken prior to analysis by exploring the entered data to identify typographical errors, incomplete entries, missing data and incoherent responses which were appropriately corrected. This was undertaken by the lead author (OO) and discussed with the data collectors in the post-PPS meeting. The data collectors subsequently went back to the patients' records to try and resolve the key issues, facilitated by the fact that the data collectors were medical and pharmacy staff. In addition, extreme values and outliers were also discussed at the post PPS meeting to further distinguish valid data from errors. The data was analysed and summarized as frequencies and percentages with means (standard deviations).

2.7 Ethical Considerations

Ethical approval for the study was granted by The Health Research Ethics Committee of The Lagos State University Teaching Hospital (LASUTH) and the Medical Director of The General Hospital, Lagos also gave his consent in writing to the approval. Informed consent was sought from all survey patients or their next of kin prior to any data collection.

3 Results

3.1 Participants Demography and Consent

A total of 494 patients were in-patients in the two hospitals (occupancy rate = 48.2%) on the days of the study out of which 491 (99%) gave consent to participate in the study and had their hospital records accessed. Two hundred and sixty (52.6%) were males and 234 (47.4%) females. Most (82%) were adults (age >18 years) and 216 (43.7%) were unemployed. Table 1 shows the sex and age distribution of the surveyed patients. Figure 1 shows the statistics of admission of the surveyed patients in the two hospitals with the most admissions in the adult surgical wards (30.2%), adult medical wards (23.3%), obstetrics & gynaecology wards (10.5%) and surgical emergency (9.1%).

Add in Table 1 and Figure 1

3.2 Antibiotics Use during Admission

A total of 398 patients out of 494 surveyed patients in the two hospitals were prescribed antibiotics on the day of the survey giving a total prevalence of antibiotics use of 80.6%. In the secondary hospital (GH, Lagos), 117 patients out of 150 were currently being prescribed antibiotics (78.0%) while 281 out of 344 patients (81.6%) were currently being prescribed antibiotics in the tertiary hospital (LASUTH). There were 774 total antibiotics prescriptions among the 398 patients that were being prescribed antibiotics giving an average of 1.94 antibiotics per patient with 83.1% of the total administered parenterally.

Table 2 shows the pattern and prevalence of antibiotics use among patients surveyed at the two hospitals. The secondary care hospital (GH, Lagos) had parenteral metronidazole as the most prescribed antibiotic (32.4%) followed by ceftriaxone (27.5%), amoxicillin + clavulanate (8.2%) and ceftriaxone combinations (6.6%) and others as shown.

In the tertiary hospital (Lagos State University Teaching Hospital) the most prescribed antibiotics were ceftriaxone (25.3%), followed by parenteral metronidazole (19.1%), amoxicillin + clavulanate (9.3%) and oral metronidazole (6%) and the others as shown.

Add in Table 2

The prescribed antibiotics during admission by antibiotics classes showed four most prescribed classes were cephalosporins (43.5%), the nitroimidazoles (28.8%), the penicillins (11.0%) and the quinolones (5.8%) with this summarized in Supplemental material 1.

50.3% of surveyed patients were prescribed a combination of two antibiotics followed by 29.6% prescribed single antibiotics and 13.8% prescribed three antibiotics while the remaining 6.3% were prescribed four or more antibiotics combinations.

The most commonly used two antibiotics combinations were ceftriaxone and metronidazole (40.5%), amoxicillin +clavulanate and metronidazole combination (6%) and each of cefotaxime and amikacin and ceftriaxone combinations and metronidazole in 5%.

3.3 Previous Antibiotic use and possible factors associated with an antibiotic prescription

Overall, a total of 220 (44.5%) patients of the 494 surveyed have had previous antibiotics use in the 90 days preceding their hospital admission. Out of the 398 patients prescribed antibiotics, a total of 186 patients (46.7%) have had previous antibiotics use within the previous 90 days of

admission. The majority of patients who had previous antibiotics use 136 (61.8%) received them from previous hospitalisation.

There were a total of 484 prescriptions of previous antibiotics uses with the most used antibiotics being ceftriaxone and parenteral metronidazole in the two hospitals (secondary and tertiary levels). Overall ceftriaxone use had a frequency of 134(27.7%), followed by parenteral metronidazole with a frequency of 108 (22.3%). Details of the previous antibiotics use in the two hospitals are as shown in Supplemental materials 2 and 3.

A total of 186 patients (37.7%) were previously hospitalized for similar complaints while 26.5% were transferred into the surveyed hospitals from other healthcare facilities and 16.4% re-admitted. Transfers, readmissions and prior antibiotic use was higher in the tertiary referral hospital. It is noteworthy that 34.2% of the patients were catheterised (mainly urinary) and 1.4% were intubated at the time of the survey. Proportions with malnutrition, malaria, HIV/AIDS, TB and those on HAART are as shown in Table 3 as possible risk factors for high use of antibiotics in these two hospitals.

Add in Table 3

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3.4 Classification of Primary Diagnosis of Surveyed Patients on Admission

The most common category of primary diagnosis was Non -Infectious Conditions (NIC) constituting 52.2% while Community Acquired Infections (CAI) constituted 41.5%, Healthcare Associated Infections (HAI) 5.7% and Home Base Care Infection (HBCI) 0.6%. Figure 2 shows details of the types of diagnosis of patients on admission in the two hospitals.

Add in Figure 2

3.5 Indications for Antibiotic Use

The commonest indications for antibiotics were sepsis/suspected bloodstream infection (34.4%), septic arthritis/ osteomyelitis (including prosthetic joint infection) (10.5%) and Soft tissue infections (cellulitis, wound, and deep soft tissue) (10.3%). Other indications and their respective frequencies are as shown in Table 4.

Add in Table 4

The indications most commonly treated with two antibiotics combinations were sepsis/suspected bloodstream infection (17.5%), soft tissue infections (17.0%) and Obstetrics and Gynaecology infections (11.0%) while three antibiotics combinations were mostly prescribed for both sepsis/suspected bloodstream infection (20.0%) and soft tissue infection (20%).

3.6 Surgical Prophylaxis and Microbiological Tests

A total of 63 patients in the two hospitals had surgical antibiotics prophylaxis with a duration of 24 hours in 15 patients (23.8%) and over 24 hours in 48 patients (76.2%).

Out of a total of 398 patients in the two hospitals who were prescribed antibiotics, microbiological culture and sensitivity test was ordered in only 67 (16.8%) of patients (56/281(19.9%) in the tertiary hospital and 11/117 (9.4%) in the secondary hospital. Results were available in only 28 at the time of the survey (41.8% of those tested). Only 18 (64.3%) of those who obtained results had their antibiotics changed to the sensitive ones with intravenous to oral switch implemented in a total of 12 (3.0%) patients.

3.7 Institutional Capacities to Promote Appropriate Antimicrobial Use

Assessments of both institutional infrastructural and functional capacity to promote appropriate antimicrobial use revealed that the two hospitals appeared to have in place at least the basic infrastructure and regular supplies of materials for microbiological studies. However, there was a considerable lack of specific functional capacities, policies and processes to promote appropriate antimicrobial use in both hospitals. For example, there was typically unavailability of national or local antimicrobial guidelines on the wards in the two hospitals, only the tertiary hospital had a functional Infection Prevention and Control (IPC) activities, and there was no functional Drugs and Therapeutic Committee (DTC) in either hospitals. In addition, the Nigerian or Local Essential Medicine Lists (EML) were not available in the wards of either hospitals and there were no facility specific treatment recommendations based on local Culture and Sensitivity Tests (CSTs) and currently no national or local antimicrobial guidelines used for empiric decision making. In addition, there was no functional ASP in either hospital, and no educational programs as well as monitoring and feedback mechanisms to improve future antimicrobial use in either hospital. Details of the findings are as shown in Supplemental material 4.

4 *Discussion*

A total of 494 patients who had been in hospital for at least 24 hours and satisfied other inclusion and exclusion criteria were surveyed in the two hospitals amounting to 48% of the total bed capacities of these hospitals (44% in LASUTH and 60% in GH, Lagos). The surveyed patients were mostly adults above 18 years (83%), and most admissions were in the adult surgical wards (30.2%), adult medical wards (23.3%) and obstetrics and gynaecology wards (10.5%) which is similar to the findings of the PPS study in Botswana [35] .

A concern is the high proportion of patients (80.6%) on antibiotics, higher in the tertiary hospital which also had higher rates of previous antibiotic prescribing. These rates are also higher than those recorded in other studies across Africa with 54.7% in Kenya, 51.4% in Ghana and 31% to 37.7% among public tertiary hospitals in South Africa [36,41–43] . Our results are also higher than the overall prevalence of antibiotics prescribing of 34.4% from 12 hospitals among the five African countries in the Global PPS and higher than a consolidated 62.7% (37.7 – 70.6) among African countries in a recent systematic review [19]. We are not sure of the reasons for these differences; however, an earlier study had established infectious diseases as the most common cause of illness and death in Nigeria, accounting for about 66% of total mortality in 2015 [44]. Consequently, potentially enhancing inappropriate use because of concerns. In addition, the high rate is also potentially a reflection of possible risk factors for potential antibiotics use recorded amongst these patients (Table 3). The presence of high rates of these risk factors and associated high antibiotic prescribing rates are consistent with the findings of a study in Botswana, where high prescribing rates were also seen (70.6% of patients) [35]. Other potential risk factors for antibiotic use among the patients in this study are malnutrition in 3.6%, malaria in 3.0%, HIV in 2.6% and HAART (Use of Highly Active Anti-retroviral Therapy) in 1.8% where known and co-existing Tuberculosis (TB)) with 1.6% of patients on anti-TB drugs.. Of note however are the lower prevalence of HAART/HIV, co-existing TB and malnutrition in our study population compared to the population studied in Botswana with 40.04% of in-patients having HIV, 25.4% co-existing TB and 5% malnutrition respectively [35].

However, the prevalence of CAI of 41.5% in our study is consistent with the findings of 40.1% in the study of Labi et al (2018) in Ghana [42] but lower than the overall findings of 57.4% on average among 12 African hospitals in the Global-PPS study as well as 61.7% from Botswana [29,35]. On the other hand, our findings revealed an HAI rate of 5.7%, which is lower than the finding in Botswana of 8.44% and considerably lower than the findings of 21.1% in a study in Ghana [35,42].

The possible reason for this recorded lower rate of HAIs in our study is unclear but may be attributable to the Infection Prevention and Control (IPC) committee present in one of the studied hospitals (the tertiary hospital, LASUTH) even through the activities of this committee was judged sub-optimal. This though may not be the full reason given the high rates of antimicrobial use documented as well as concerns with prescribing patterns seen including those to prevent SSIs. We will be exploring this further in future studies.

While the findings of the most prevalent indications for antibiotics use in the two hospitals are similar to the findings of similar studies from other parts of Africa and the Global PPS, worthy of note in our study was that the most common indication for prescribing antibiotics was clinical sepsis without laboratory confirmation in over a third (34.4%) of the surveyed patients. We are not sure why there was a greater prevalence of clinical sepsis in our patients than seen for instance in the Global PPS and systematic reviews [19,29]. However, this may reflect the fact that we only included leading secondary and tertiary hospitals in this study in contrast to others that also included community hospitals where respiratory tract and other infections including urinary tract infections may be more common.

The patterns and prevalence of antibiotics prescribed in the two hospitals studies have both similarities and differences with findings in previous PPS studies in Nigeria and in other countries. Oduyebo et al in a 2015 PPS of antibiotics in four Nigerian tertiary hospitals found ceftriaxone was the most prescribed antibiotics (18.9%) followed by metronidazole (18.0%) and the quinolones (14.1%)[31]. This is similar to the findings of Umeokonkwo et al in a 2017 PPS of antibiotics in a tertiary hospital in South-Eastern Nigeria with ceftriaxone (25.1%), metronidazole (24.6%) and second-generation quinolones (ciprofloxacin, 9.7%) the most prescribed antibiotics [32]. While the findings of these two previous Nigerian studies are consistent with our current findings of ceftriaxone and metronidazole as the two most prescribed antibiotics, our study found amoxycillin +enzyme Inhibitor as the third most utilized antibiotics rather than the quinolones in previous studies. The finding of metronidazole as the most prescribed antibiotics followed by ceftriaxone within the secondary hospital (GH, Lagos) in our study is also consistent with the findings of Abubakar et al in a 2019 PPS of antibiotics use in three hospitals (one tertiary) and two secondary) in Northern Nigeria where the most prescribed classes of antibiotic were nitroimidazoles (28.5%), third generation cephalosporins (18.9%), fluoroquinolones (13.6%) and combinations of penicillins and beta-lactamase inhibitors (10.5%) [33].

Furthermore, the pattern of antibiotic prescriptions in our current study is consistent with the pattern recorded in Kenya where the most prescribed antibiotics were the third generation

cephalosporins, the imidazole derivatives, broad spectrum penicillins and the aminoglycosides, and also in Botswana with the third generation cephalosporin ,though cefotaxime instead of ceftriaxone, being the most prescribed antibiotic followed by metronidazole and then the penicillins including the penicillins and beta-lactamase inhibitors [35,41]. In the contrary, the most frequently prescribed antibiotics in the Global PPS study were the penicillins with a ßlactamase inhibitor, followed by the fluoroquinolones, carbapenems and glycopeptides and also in a Ghanaian study where penicillins followed by the nitroimidazoles, cephalosporins (3rd and 2nd generations) and aminoglycosides were mostly prescribed [29,42]. Overall, the most prescribed antibiotics groups in our study included the cephalosporins (43.5%), the nitroimidazoles (28.8%), the penicillins (11.0%) and the quinolones (5.8%), which are consistent with the findings of the Global PPS.

The finding of surgical antibiotics prophylaxis given for longer than 24 hours duration in 76.2% of patients in our study is consistent with findings in Botswana where extended surgical antibiotics prophylaxis ranged from 66.67% to 100%, the Global PPS study that recorded a global average of 86.3%, and generally among LMICs [29,35,45] .These prescribing practices are of great concern as evidence does not support a prolonged duration of prophylaxis antibiotics and potentially this increases the risk of resistance, side effects and costs [46,47]. Another area of concern was the low number of culture and sensitivity tests (CST) ordered, i.e., in only 16.8%, with results available in 7% and only 4.5% of patients having their antibiotics changed to sensitive one. In addition, a low number of intravenous to oral switch in only 3% of the patients. These findings align with the findings of a previous study in the tertiary hospital surveyed that revealed 97% of doctors prescribe antibiotics based on their clinical judgements and laboratory support is rarely available [21]. Both hospitals have in place at least the basic infrastructure and regular supplies for a microbiology service but lack functional capacity, policies and processes to support appropriate antimicrobial use. These are opportunities for the future with functioning IPCs, ASP groups and DTCs identifying key areas for quality improvement programmes. Potential key areas include improving awareness of antibiotic resistance, monitoring and surveillance of antibiotic use, availability and use of good quality and low-cost generic medicines, improved laboratory services, development and maintenance of antibiotics guidelines and the appropriate use of antibiotics in patients to prevent SSIs, with the recent review by Mwita et al (2021) and Eneyi et al (2020) providing guidance in LMICs including Nigeria [45,48]. We have also seen in Namibia that the availability of robust, well organised and easy to use guidelines results in high adherence rates in practice, providing examples to Nigeria and other African countries [49,50] With the identification of areas for quality improvements in this survey, authors plan to follow

up with the establishment of functional ASPs in these two hospitals in the first instance focusing on key areas including development of prescribing guidelines for common infections identified as major indications for antibiotics use in this study, increasing IV to oral switching, addressing concerns with prophylaxis for SSIs and increasing requests for CSTs We will be following these up in future research projects to monitor the impacts of these interventions. The findings from this study and lesions to be learnt from planned interventions will guide the cascading of similar activities in other healthcare institutions across Nigeria. This can potentially be facilitated by the development of an APP as applied recently in South Africa to improve data collection and timely analysis of PPS studies[51,52]. However, there needs to be political will among hospitals in Nigeria as part of the Nigerian NAP to drive forward future initiatives to improve antimicrobial utilisation rates in the country.

5 Conclusion

Our study revealed high rates of antibiotics prescribing mostly parenterally with extended surgical prophylaxis coupled with a lack of institutional capacities for appropriate antibiotics use. These findings are indicative of an urgent need for interventions and forms the basis for the establishment of functional ASPs as well as development of institutional based antibiotics guidelines to improve future antibiotic prescribing in hospitals. Such interventions should be implemented locally as well as nationally.

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Table 1: Sex and Age Distribution of Patients in the two Hospitals

Variable	**Categories**	**Health Facility**		**Total and % of Total Patients f (%)**
		LASUTH (TERTIARY) f (%)	**GH, LAGOS (SECONDARY) f (%)**	
Sex	Male	**163 (47,4)**	**97(64.7)**	260(52.6)
	Female	181(52.6)	53(35.3)	234(47.4)
Age Group	0-29 days	29 (8.4)	0(0.0)	29(5.9)
	1 – 11 months	15(4.4)	3(2.0)	18(3.6)
	1 – 9 years	46(13.4)	2(1.3)	48(9.7)
	10 -19 years	18(5.2)	6(4.0)	24(4.9)
	20 – 29 years	46(13.4)	18(12.0)	64(13.0)
	30 – 39 years	47(13.7)	23(15.3)	70(14.2)
	40 -49 years	49(14.2)	32(21.3)	81(16.4)
	50 – 59 years	40(11.6)	24(16.0)	64(13.0)
	60 – 69 years	33(9.6)	23(15.3)	56(11.3)
	70 and Above	21(6.1)	19(12.7)	40(8.1)
	Total	344(100.0)	150(100.0)	494(100.0)

Table 2: Antibiotics Use during Admission by Patients Surveyed at LASUTH (Tertiary Hospital) and General Hospital, Lagos (Secondary Hospital)

ATC CODE	**ANTIBIOTICS**	**Tertiary Hospital (f/%)**	Secondary Hospital (f/%)	Total Frequency/%
J01DD04	Ceftriaxone	134 (25.3)	**67 (27.5)**	201 (26.0)
J01XD01	Metronidazole parenteral	101 (19.1)	**79 (32.4)**	180 (23.3)
J01CR02	Amoxicillin +Enzyme Inhibitor	49 (9.3)	**20(8.2)**	69 (8.9)
P01AB01	Metronidazole oral	32 (6.0)	**11(4.5)**	43 (5.6)
J01DC02	Cefuroxime	31 (5.8)	**11(4.5)**	42 (5.4)
J01GB06	Amikacin	22 (4.2)	**0 (0.0)**	22 (2.8)
J01DD01	Cefotaxime	21 (4.0)	**0 (0.0)**	21 (2.7)
J01MA12	Levofloxacin	18 (3.4)	**9 (3.7)**	27 (3.5)
J01DD02	Ceftazidime	14 (2.6)	**2 (0.8)**	16 (2.1)
J01DD08	Cefixime	14 (2.6)	**1 (0.4)**	15 (1.9)
J01DH02	Meropenem	13 (2.5)	**4 (1.6)**	17 (2.2)
J01GB03	Gentamicin	11 (2.1)	**0 (0.0)**	11 (1.4)
J01DD54	Ceftriaxone Combinations	11 (2.1)	**16 (6.6)**	27(3.5))
J01DD13	Cefpodoxime	9 (1.7)	**1 (0.)**	10 (1.3)
J01MA02	Ciprofloxacin	9 (1.7)	**5 (2.0)**	14 (1.8)
J01FA09	Clarithromycin	8 (1.5)	**0 (0.0)**	8 (1.0)
J01CA51	Ampicillin Combinations	3 (0.6)	**0 (0.0)**	3 (0.4)
J01XA01	Vancomycin	3 (0.6)	**0 (0.0)**	3 (0.4)
J01DH51	Imipenem	3 (0.6)	**0 (0.0)**	3 (0.4)
J01BA01	Chloramphenicol	2 (0.4)	**0 (0.0)**	**2 (0.3)**
J01DA01	Cefalexin	2 (0.4)	**0 (0.0)**	**2 (0.3)**
J01FA10	Azithromycin	2 (0.4)	**5 (2.0)**	**7 (0.9)**
J01FA01	Erythromycin	2 (0.4)	**0(0.0)**	**2(0.3)**

J01CA04	Amoxicillin	2 (0.4)	**4 (1.6)**	**6 (0.8)**
J01CR05	Piperacillin and beta lactamase inhibitor	2 (0.4)	**0 (0.0)**	**2 (0.3)**
J01MA07	Lomefloxacin	1 (0.2)	**0 (0.0)**	**1 (0.1)**
J01AA12	Tetracycline	1 (0.2)	**0 (0.0)**	**1 (0.1)**
A07AA05	Polymyxin B	1 (0.2)	**0 (0.0)**	**1 (0.1)**
J01MA06	Norfloxacin	1 (0.2)	**0 (0.0)**	**1 (0.1)**
J01MA14	Moxifloxacin	1 (0.2)	**0 (0.0)**	**1 (0.1)**
J01DD09	Cefodizime	1 (0.2)	**0 (0.0)**	**1 (0.1)**
J01MA01	Ofloxacin	1 (0.2)	**0 (0.0)**	**1 (0.1)**
J01GB02	Spectinomycin	1 (0.2)	**0 (0.0)**	**1 (0.1)**
J01FF01	Clindamycin	1 (0.2)	**0 (0.0)**	**1 (0.1)**
J01CA01	Ampicillin	1 (0.2)	**0 (0.0)**	**1 (0.1)**
J01CR03	Ticarcillin and Enzyme Inhibitor	1 (0.2)	**0 (0.0)**	**1 (0.1)**
J01DD07	Ceftizoxime	1 (0.2)	**0 (0.0)**	**1 (0.1)**
J01EE03	Sulfametrole and Trimethoprim	0 (0.0)	**3 (1.2)**	**3 (0.4)**
J01CG02	Tazobactam	0 (0.0)	**2 (0.8)**	**2 (0.3)**
J01CR50	Sultamicilin	0 (0.0)	**1 (0.4)**	**1 (0.1)**
J01DD14	Ceftibuten	0 (0.0)	**1 (0.4)**	**1 (0.1)**
J01EE07	Sulfamerazine and Trimethoprim	0 (0.0)	**1 (0.4)**	**1 (0.1)**
J01EE01	Sulfamethoxazole and Trimethoprim	0 (0.0)	**1 (0.4)**	**1 (0.1)**
	TOTAL	244 (100.0)	**530 (100.0)**	**744 (100.0)**

Table 3: Risks factors for Potential Antibiotic Use

	GH, LAGOS (SECONDARY)		LASUTH (TERTIARY)		TOTAL	
Risk Factors	**Frequency**	**% in GH, Lagos**	**Frequency**	**% in LASUTH**	**Total Frequency**	**% of Total Patients**
Previous Antibiotics	42	28	178	51.7	220	44.5
Previous Hospitalization	26	17.3	160	46.5	186	37.7
Transferred	14	9.3	117	34.0	131	26.5
Re-admission	18	12.0	63	18.3	81	16.4
HAART	5	3.3	4	1.2	9	1.8
TB	3	2.0	5	1.5	8	1.6
HIV/AIDS	8	5.3	5	1.5	13	2.6
Malnutrition	1	0.7	17	4.9	18	3.6
Malaria	2	1.3	13	3.8	15	3.0
Intubation	0	0.0	7.0	2.0	7..0	1.4
Catheterization	37	24.7	132	38.4	169	34.2

Previous Antibiotics = Previous Antibiotic Use in last 90 days, Previous Hospitalization: Previous Hospitalization in last 90 days, Transferred = Transferred in from another hospital, HART= On Highly Active Antiretroviral Therapy, TB = Diagnosis of Tuberculosis co-infection, HIV = Diagnosis of Human Immunodeficiency Virus and Acquired Immunodeficiency Syndrome

Table 4: Indications for Antibiotics Use

Indication	Frequency	%
Sepsis including clinical suspicion	170	34.4
Bone and joint infection	52	10.5
Skin and soft tissue infection	51	10.3
Obstetric/Gynaecological infection/STD in women	38	7.8
Pneumonia	35	7.0
Central Nervous System infections	33	6.7
Intra-abdominal sepsis	33	6.7
Undefined site with no systemic inflammation	24	4.9
Genito urinary infection/STD in men	12	2.4
Gastrointestinal infections	11	2.2
Symptomatic Upper urinary tract infections/pyelonephritis	10	2.0
Acute bronchitis/Chronic bronchitis	6	1.2
Lower urinary tract infections	6	1.2
Systemic inflammatory response with no clear anatomical site	5	1.0
Ear Nose Throat and Mouth infections	4	0.8
Febrile Neutropenia	4	0.8

Figure 1: Statistics of Admission of Surveyed Patients

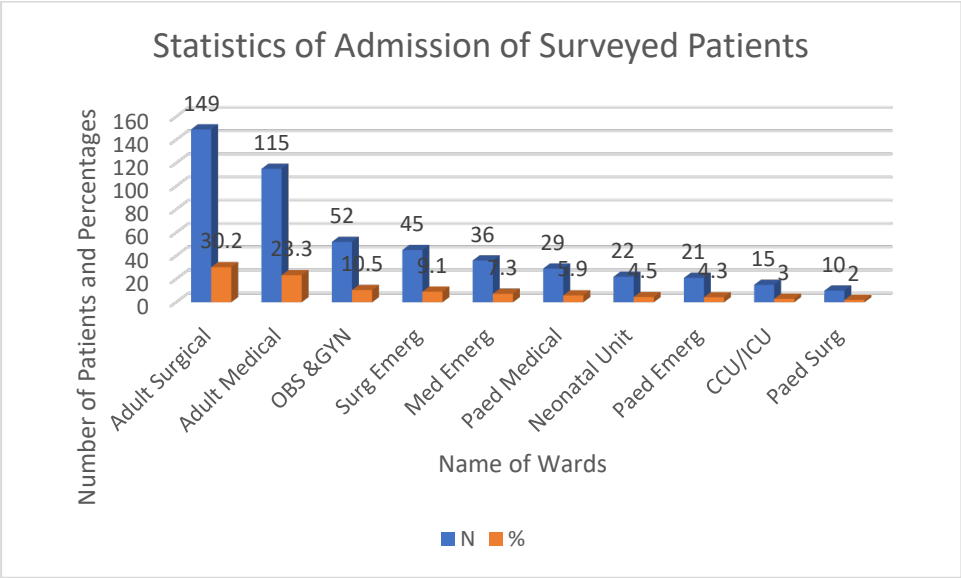
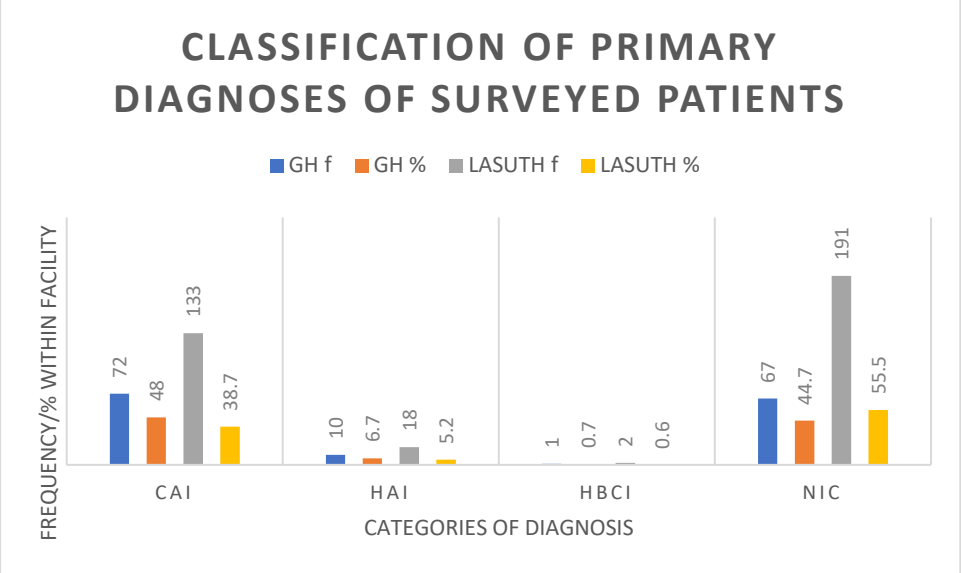


Figure 2: Classification of Primary Diagnoses of Surveyed Patients



CAI = Community Acquired Infection, HAI = Healthcare Associated Infection, HBCI = Home Base Care Infection, NIC = Non-Infectious Conditions, GH = General Hospital, Lagos (Secondary Hospital), LASUTH = Lagos State University Teaching Hospital (Tertiary Hospital)

Supplemental material 1: Prescribed Antibiotics by Classes in the two Surveyed Hospitals

Antibiotics Class	**GH, Lagos (Secondary) Number**	**LASUTH (Tertiary) Number**	**Total**	**%**
Aminoglycosides	0	34	34	4.4
Amphenicols	0	2	2	0.3
Carbapenems	4	16	20	2.6
Cephalosporins	99	238	337	43.5
Glycopeptides	0	3	3	0.4
Lincosamides	0	1	1	0.1
Macrolides	5	12	17	2.2
Nitroimidazoles	90	133	223	28.8
Penicillins	27	58	85	11.0
Polymyxins	0	1	1	0.1
Quinolones	14	31	45	5.8
Sulphonamides	5	0	5	0.6
Tetracyclines	0	1	1	0.1
TOTAL	**244**	**530**	**774**	**100**

Supplemental material 2: Previous Antibiotics Use by Surveyed Patients at GH, Lagos (Secondary Hospital)

ATC CODE	ANTIBIOTICS	FREQUENCY	%
J01DD04	Ceftriaxone	31	30.7
J01XD01	Metronidazole Parenteral	31	30.7
J01DD54	Ceftriaxone, Combinations	10	9.9
J01CR02	Amoxycillin +Enzyme Inhibitor	9	8.9
P01AB01	Metronidazole Oral	6	5.9
J01DC02	Cefuroxime	2	2.0
J01DD02	Ceftazidime	2	2.0
J01DH02	Meropenem	2	2.0
J01MA02	Ciprofloxacin	2	2.0
J01MA12	Levofloxacin	1	1.0
P01AB01	Metronidazole oral	1	1.0
J01DD08	Cefixime	1	1.0
J01CA04	Amoxycillin	1	1.0
J01GB03	Gentamycin	1	1.0
J01FA09	Clarithromycin	1	1.0
TOTAL		**101**	**100**

Supplemental material 3: Previous Antibiotics Use by Surveyed Patients at LASUTH (Tertiary Hospital)

ATC CODE	ANTIBIOTICS	N	%		ATC CODE	ANTIBIOTICS	N	%
J01DD04	Ceftriaxone	103	26.9		**J01DH51**	Imipenem Combinations	2	0.5
J01XD01	Metronidazole Parenteral	77	20.1		**J01XD02**	Tinidazole	2	0.5
J01CR02	Amoxycillin +Enzyme Inhibitor	38	9.9		**J01CR05**	Piperacillin + Enzyme Inhibitor	2	0.5
J01DC02	Cefuroxime	25	6.5		**A07AA01**	Neomycin	2	0.5
P01AB01	Metronidazole Oral	22	5.7		**J01AA12**	Tigecycline	2	0.5
J01MA12	Levofloxacin	18	4.7		**J01CR03**	Ticarcillin + Enzyme Inhibitor	1	0.3
J01DD54	Ceftriaxone, Combinations	11	2.9		**J01DD07**	Ceftizoxime	1	0.3
J01FA01	Erythromycin	9	2.3		**J01DE01**	Cefepime	1	0.3
J01DD02	Ceftazidime	8	2.1		**J01MA01**	Ofloxacin	1	0.3
J01DH02	Meropenem	8	2.1		**J01MA14**	Moxifloxacin	1	0.3
J01GB06	Amikacin	8	2.1		**J01BA01**	Chloramphenicol	1	0.3
J01DD01	Cefotaxime	7	1.9		**J01AA01**	Demeclocycline	1	0.3
J01DD08	Cefixime	7	1.9		**J01CA01**	Ampicillin	1	0.3
J01GB03	Gentamycin	7	1.9		**J01CA51**	Ampicillin Combinations	1	0.3
J01DD13	Cefpodoxime	6	1.6		**A07AA07**	Amphotericin B	1	0.3
J01FA09	Clarithromycin	3	0.8					
J01MA02	Ciprofloxacin	3	0.8					
J01CA04	Amoxycillin	3	0.8					
TOTAL							**383**	**100**

Supplemental material 4: Existing Institutional Infrastructure and Capacity to Promote Appropriate Antimicrobial Use

CATEGORY		QUESTIONS	RESPONSES	
			GH, LAGOS	LASUTH
INFRASTRUCTURE	1	Presence of a formal ASP program?	No	No
	2	ASP as part of hospital organizational structure	No	No
	3	Have an antimicrobial stewardship team	No	No
	4	A physician leading ASP	No	No
	5	Who leads ASP when a physician is not available? A pharmacist?	Not Applicable	Not Applicable
	6	Can access a microbiologist	Yes	Yes
	7	A Pharmacist responsible for ensuring appropriate antimicrobial use	Nil	Nil
	8	Any salary support for ASP activities	No	No
	9	Have the information technology (IT) to support ASP activities	No	No
	10	Functional microbiology lab	Yes	Yes

	11	Number of culture test done in last 3 months	994	2126
	12	Continuous supply of reagents for microbiology	Yes	Yes
	13	Availability of culture media in last 90 days	Yes	Yes
	14	Availability of antibiotics disc in last 90 days	Yes	Yes
	15	Availability of equipment for microbiology	Yes	Yes
	16	Availability of national or local antimicrobial guidelines on the wards	No	No
	17	Have a functional Infection Prevention and Control Committee (IPC)	No	Yes
	18	Have a functional Drugs and Therapeutics Committee (DTC)	No	No
	19	Availability of Nigerian or Local Essential Medicine Lists (EML) in the wards	No	No
POLICY AND PRACTICE	20	Facility specific treatment recommendation based on local CSTs	Nil	Nil
	21	Prescribing policy to document indication on medical record	No	No
	22	Routine practice for pre-authorization of some specified antimicrobial by a physician or pharmacist	No	No
	23	Formal procedure to review appropriateness of antimicrobials after 48 hours	None	None

	24	National or local antimicrobial guidelines used for empiric decision making	None	None
	25	Availability of current antibiogram	Yes	Yes
	26	Continuing education provided on local antimicrobial resistance pattern	No	No
MONITORING AND FEEDBACK	27	Cumulative antimicrobial susceptibility report produced by facility	None	None
	28	Monitoring of indication of antimicrobials captured or not in the medical records by facility	No	No
	29	Audit or review of choice of antimicrobials and duration by facility	No	No
	30	Audit report communicated directly to prescribers	No	No
	31	Facility monitors DDDs or counts of antimicrobials per patient days	No	No
	32	Annual report by facility focused on antimicrobial susceptibilities	None	None