Original Article

Antibiotic Prescribing Patterns at a Leading Referral Hospital in Kenya: A Point Prevalence Survey

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ABSTRACT

Objective: Antibiotics are essential with inappropriate use leading to antimicrobial resistance (AMR). Currently, little is known about antibiotic use among hospitals in Kenya, which is essential to tackle as part of the recent national action plan addressing rising AMR rates. Consequently, the objective was to overcome this gap in a leading referral hospital in Kenya. The findings will subsequently be used to develop quality improvement programs for this and other hospitals in Kenya. **Methods:** This was a point prevalence survey. Data on antibiotic use were abstracted from patient medical records by a pharmacy team. **Findings:** The prevalence of antibiotic prescribing was 54.7%, highest in the intensive care unit and isolation wards. Most antibiotics were for treatment (75.4%) rather than prophylaxis (29.0%). The majority of patients on surgical prophylaxis were on prolonged duration (>1 day), with only 9.6% on a single dose as per current guidelines. Penicillins (46.9%) followed by cephalosporins (44.7%) were the most prescribed antibiotic classes. The indication for antibiotic use was documented in only 37.3% of encounters. Generic prescribing was 62.5% and empiric prescribing was seen in 82.6% of encounters. Guideline compliance was 45.8%. **Conclusion:** Several areas for improvement were identified including addressing prolonged duration for prophylaxis, extensive prescribing of broad-spectrum antibiotics, high rates of empiric prescribing, and lack of documenting the indication for antimicrobials. Initiatives are ongoing to address this with pharmacists playing a key role.

Keywords: *Antibiotics, Kenya, point prevalence survey, prescribing, utilization*

Introduction

Antibiotics are widely prescribed globally with antibiotic use increasing by 36% during the past decade.[1] However, their overuse has increased rates of

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antimicrobial resistance (AMR), increasing morbidity, mortality, and costs.[2] This has resulted in international and national programs to address rising AMR rates.[3,4] This is particularly important in countries such as Kenya with high rates of HIV and tuberculosis (TB) and growing AMR rates,[5-7] resulting in the recent launch of the Kenyan National Action Plan.[5] This includes a need for greater understanding of antibiotic use including hospitals to inform future policies.

We have previously reported on concerns with antibiotic use in a referral hospital in Western Kenya as well as antibiotic prophylaxis to prevent surgical site infections (SSIs) in patients with neurotrauma.[8,9] However, we have not previously reported antibiotic utilization patterns within a level 5 facility in Kenya. This is important as this is a leading teaching hospital in Kenya providing direction to others. In addition, the recent Global Point Prevalence Survey (PPS) only contained data from five African countries excluding Kenya and children.[10] Consequently, the study was undertaken to address this knowledge gap with Kenya one of the most populous African countries. The findings will be applicable across Kenya.

Methods

A PPS study[8,10] was undertaken in April 2017 to ascertain the prevalence and patterns of antibiotic prescribing at a specific point in time at the Rift Valley Provincial General Hospital, a level 5 teaching hospital. It is the fourth largest government referral hospital in Kenya with 532 beds.

All the neonatal, pediatric, adult, and mixed departments were included. All patients who were receiving systemic antibiotic therapy at 8 AM on the day of the survey were eligible, with the antibiotics including antibacterials for systemic use (J01), TB (J04A), intestinal anti-infectives (A07AA) and antiprotozoals (P01AB).[11] Outpatients and daytime admissions for ambulatory patients for procedures such as endoscopy or renal dialysis were excluded as well as antibiotics for topical use.

Antibiotic use was recorded by prescription, with usage broken down into either prophylaxis or treatment. Prophylaxis was further divided into medical or surgical prophylaxis. Medical prophylaxis was documented when antibiotics were prescribed to prevent infections in patients with medical conditions. Surgical prophylaxis included the use of antibiotics to prevent SSIs.[9] The extent of comorbidities were also recorded including HIV, which is particularly prevalent in sub-Sarah Africa for patients admitted to hospitals.[12] Infections were further divided into community-acquired infection (CAI) and hospital-acquired infection (HAI), especially given the extent of HAIs in sub-Sahara Africa.[13]

CAIs were documented if symptoms started <48 h from admission to hospital (or present on admission) and HAIs if symptoms started 48 h after admission.[10,13] We also assessed whether there was an association between antibiotic classes and departments for possible future interventions.

Prescribing patterns were assessed against the findings of the Global PPS study, especially among African countries.[10] The quality of antibiotic prescribing was also assessed by evaluating whether the reason for the prescription was documented, current generic prescribing rates and the extent of empiric versus targeted prescribing. Guideline compliance was also assessed. While there is currently no hospital formulary, prescriptions are guided by the Kenyan Essential Medicine List and relevant international guidelines.[14,15] This formed the basis of whether treatment was guideline compliant or not. Sampling of patients' notes was undertaken as part of ethical approval. The sample size was calculated using the Fisher formula adjusted for average hospital bed occupancy.[16] However, there was no sampling for antibiotic use.

On the day of the survey, the total number of patients admitted by 8 AM was recorded followed by the total number of patients on systemic antibiotics at 8 AM. The medical records of all inpatients on systemic antibiotics were obtained, with their file numbers entered onto Microsoft Excel, with the computer providing a random sample of files to be studied in full. There was no direct engagement of patients. The patients' files were subsequently reviewed by the data collectors including medical students led by a pharmacist, and the data were entered onto the PPS form. Data were recorded as anonymous by employing a study number for each patient. The data were subsequently validated for completeness and correctness by two other pharmacists.

To calculate the prevalence of antibiotic use, the denominator was the total number of admitted patients while the numerator was the total number of patients on systemic antibiotics at 8 AM of the day the ward was surveyed.

The prevalence of antibiotic use in the various departments including whether for prophylaxis or treatment was also calculated. Descriptive statistics were used to summarize and describe the study variables as appropriate using means and standard deviations for continuous variables while using frequency and percentages for categorical variables. The Chi-square test was used to test the association between the use of various antibiotic classes among the different hospital departments, whereas the Fisher exact test was used instead of the Chi-square test when the Chi-square test assumptions (≥80% of the expected values in various cells were ≥5 or no expected values were <1) were violated, consequently invalid.

Ethical approval was obtained from the KNH-UON Ethics Committee reference number P36/01/2017. Further approval was obtained from the hospital administration of the Rift Valley Provincial General Hospital before commencement of the study. Confidentiality of the data was stringently maintained throughout.

Results

The study was conducted on 179 patients whose median age was 25.3 years (interquartile range = 4–38). Adults (20–59 years) formed the largest proportion (93, 52%) followed by neonates (23, 12.9%). There were more females (99, 55.3%) than males (44.6%). The adult surgical ward (53, 29.6%) and the adult medical ward (41, 22.9%) had the largest proportion of patients with least in the intensive care unit (ICU) (4, 2.2%).

The overall prevalence of antibiotic prescribing was 54.7%, with the highest level of prescribing for treatment (75.4%).

The ICU (100.0%) and the isolation ward (100.0%), classified under a mixed department, had the highest prevalence of antibiotic prescribing (100.0%), followed by the newborn unit (93.7%), the pediatric medical ward (84.2%), the adult medical ward (61.5%), and the adult surgical ward (57.3%). The obstetric or gynecological (OBGYN) department had the least prevalence of antibiotic prescribing (20.8%).

The majority of patients had no comorbidities (96, 53.6%). Among those with comorbidities, the most prevalent was HIV (8.4%) followed by diabetes mellitus (6.7%), low birth weight (6.7%), anemia (5.6%), respiratory distress (5.0%), and hypertension (3.9%). The most frequent indication for antibiotic use was for CAIs (54.2%) followed by prolonged surgical prophylaxis at >1 day (22.4%), medical prophylaxis (15.1%), 1-day surgical prophylaxis (3.9%), single-dose surgical prophylaxis (2.8%), and HAIs (2.8%).

The respiratory system was the anatomical site with the greatest proportion of antibiotics prescribed for treatment (24.6%) followed by the skin, soft tissue, bone, and joint infections (SSTBJ) at 12.3%. Eyes (0.6%), the cardiovascular system (0.6%), and ENT (0%) had the least antibiotics prescribed. For prophylactic use, OBGYN surgery was highest (10.1%) followed by SSTBJ anatomical sites (8.9%), with the least for urinary tract infections (0%) and the cardiovascular system (0%).

The penicillins (46.9%) (J01C) were the most prescribed class followed by the cephalosporins (44.7%) (J01D) and aminoglycosides (26.3%) (J01G). There was limited prescribing of the nitrofurans (0.6%) (J01XE) [Figure 1].

Individually, ceftriaxone was the most prescribed antibiotic (39.7%) followed by benzylpenicillin (29.0%) and metronidazole (25.1%) [Table 1].

There was a statistically significant association between antibiotic prescribing and departments. Aminoglycosides were commonly prescribed in the pediatric medical wards ($P < 0.001$). Macrolides ($P = 0.002$), nitroimidazole derivatives ($P = 0.002$), and anti-TB antimicrobials ($P < 0.001$) were the most frequently prescribed in the adult medical wards. Penicillins ($P = 0.002$) were commonly prescribed in the adult surgical wards. Tetracyclines were prescribed mostly in the OBGYN departments ($P = 0.004$). Carbapenems were commonly prescribed in the ICU and pediatric medical wards ($P = 0.002$) [Table 2].

The pattern of antibiotic prescribing varied by indication [Figure 2].

The most commonly prescribed antibiotic classes for respiratory infections were aminoglycosides (19.5%) and penicillins (18.6%). For SSTBJ infections, cephalosporins (37.8%) and penicillins (27.0%) were commonly prescribed. For neonatal infections, aminoglycosides (41.2%) and penicillins (41.2%) were commonly prescribed.

Less than half of the patients were on a single antibiotic (41.3%), with the majority (58.7%) on combination therapy, and 17.9% having 3 or more antibiotics. The most prevalent antibiotic combinations were aminoglycosides and penicillins (20.7%), followed by cephalosporins and nitroimidazole derivatives (13.4%), penicillins and nitroimidazole derivatives (9.5%), and cephalosporins and penicillins (6.7%). There were also some unusual combinations.

The reason for the antibiotic prescription was documented in 37.3% (n = 133) of occasions.

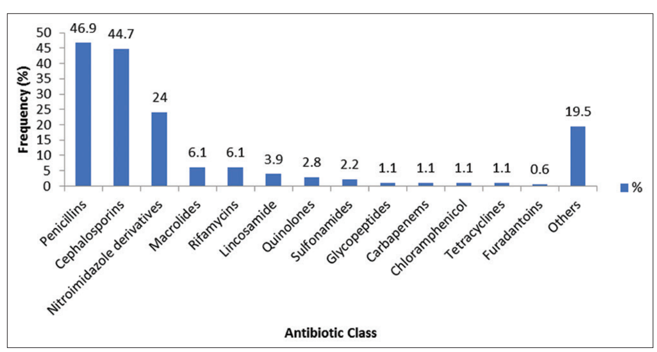

Figure 1: Prevalence of antibiotic prescribing by class

Table 1: Prevalence of specific antibiotics prescribed

	Specific antibiotics	n (%)
Cephalosporins	Ceftriaxone	71 (39.7)
	Ceftazidime	7 (3.9)
Penicillins	Benzyl penicillin	52 (29.0)
	Flucloxacillin	20 (11.2)
	Ampicillin/cloxacillin	14 (7.8)
	Amoxicillin/clavulanic acid	10 (5.6)
	Amoxicillin	4 (2.2)
Nitroimidazole derivatives	Metronidazole	45 (25.1)
Aminoglycosides	Gentamicin	40 (22.3)
	Amikacin	7 (3.9)
Rifamycins	Rifampicin	11 (6.1)
Macrolides	Erythromycin	10 (5.6)
	Clarithromycin	1 (0.6)
Lincosamides	Clindamycin	7 (3.9)
Sulfonamides	Cotrimoxazole	5 (2.8)
Chloramphenicol	Chloramphenicol	3 (1.7)
Quinolones	Ciprofloxacin	3 (1.7)
	Levofloxacin	1 (0.6)
Tetracyclines	Doxycycline	2 (1.1)
Carbapenems	Meropenem	2 (1.1)
Glycopeptides	Vancomycin	2 (1.1)
Furadantin	Nitrofurantoin	1 (0.6)
Others	Ethambutol	12 (6.7)
	Pyrazinamide	12 (6.7)
	Isoniazid	11 (6.1)
	Capreomycin	2 (1.1)
	Cycloserine	1 (0.6)
	Prothionamide	1 (0.6)

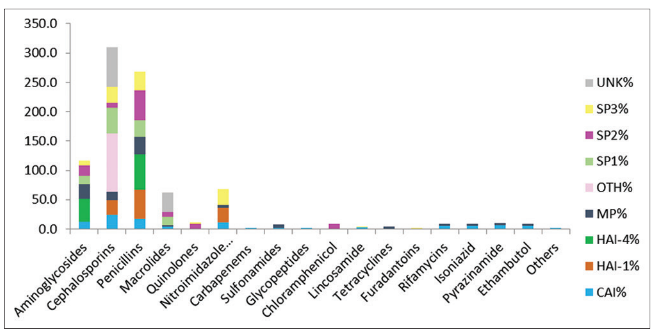

Figure 2: Antibiotic prescribing by indication

Clarithromycin, levofloxacin, and the anti-TB antimicrobials had the reason for their use documented all the time. Ampicillin-cloxacillin, doxycycline, nitrofurantoin, and vancomycin did not have their reason documented at all. The generic prescribing rate was 62.5%, while the empiric prescribing rate was 82.6%. Four antimicrobials which were always used for targeted therapy including clarithromycin, cycloserine, prothionamide, and levofloxacin. Overall, antimicrobial prescribing was guideline compliant on 45.8% of occasions.

Discussion

The prevalence of antibiotic prescribing was 54.7%, comparable to Nigerian hospitals at 55.9%,[17] Egyptian hospitals at 59%.[18] Western Kenya at 67.7%,[8] Uganda (79%),[19] and Ghana (51.4%),[20] as well as the African countries in the Global PPS (50.0%).[10] However, this was higher than the overall rate for antimicrobial prescribing in the Global PPS study (34.1%).[10] This may reflect the higher burden of infectious diseases among African countries including Kenya.[6,7,12]

The ICU and the isolation departments had the highest rate of antibiotic prescribing (100%), similar to Egypt[18] and the African countries in the Global PPS,[10] probably due to the critical nature of the patients' illness and increased risk of infections, especially if patients are on a ventilator.[21] The OBGYN department (20.8%) had the least prevalence of antibiotic prescribing, similar to Ghana[20] but different to a previous Kenyan study.[8]

75.4% of antibiotic prescribing was for treatment, similar to the Global PPS.[10] The respiratory system had the largest proportion of antibiotics prescribed (24.6%) followed by SSTBJ infections (12.3%), similar to Egypt[18] and a previous study in Kenya.[8] The gynecological system had the highest proportion of prophylactic antibiotic use (10.1%), again similar to Egypt[18] and a previous Kenyan study.[8] This could be due to the frequent use of prophylactic antibiotics for cesarean sections.

The most common indication for antibiotic use was CAIs (54.2%), followed by surgical prophylaxis (29.1%) which was similar to the African countries in the Global PPS (57.4%, 23.2%) and Ghana (40.1%, 33.6%), respectively.[10,20] HAIs accounted for 2.8% of antibiotic prescribing, comparable to Egypt[18] but considerably lower than the African countries in the Global PPS (9.5%) and generally across Africa,[10,13,20] which may be due to poor documentation in our study.

The use of penicillins was prevalent across indications [Table 2 and Figure 2]. Cephalosporins were the most prescribed class for CAIs (24.1%) with ceftriaxone the most prescribed (91.3%). Ceftriaxone was also the most prescribed agent for single-dose surgical prophylaxis (100%), similar to a previous Kenyan study for patients with neurotrauma,[9] African countries in the Global PPS, and other African countries.[10,19,22,23] This is a concern as ceftriaxone is a broad-spectrum antibiotic used first line in many bacterial infections, and overuse will increase AMR rates, with guidelines advocating against broad-spectrum antibiotics in this situation.[24] In addition, the majority (76.9%) of patients on surgical prophylaxis were on prolonged duration

Table 2: Variation of antibiotic prescribing by classes across the various departments

Antibiotic class	PMW, *n* (%)	NMW, *n* (%)	AMW, *n* (%)	ASW, *n* (%)	ICU, *n* (%)	OBGY, *n* (%)	MIXED, *n* (%)	*P*
Aminoglycosides	17 (9.5)	13 (7.3)	6 (3.3)	8 (4.5)	2 (1.1)	1 (0.6)	0 (0.0)	<0.001
Cephalosporins	16 (8.9)	2 (1.1)	19 (10.6)	29 (16.2)	2 (1.1)	7 (3.9)	5 (2.8)	0.114
Penicillins	16 (8.9)	13 (7.3)	13 (7.3)	27 (15.1)	0 (0.0)	5 (2.79)	10 (5.6)	0.002
Macrolides	0 (0.0)	0 (0.0)	4 (2.2)	0 (0.0)	0 (0.0)	3 (1.7)	4 (2.2)	0.002
Quinolones	0 (0.0)	0 (0.0)	2 (1.1)	2 (1.1)	0 (0.0)	0 (0.0)	1 (0.6)	0.758
Nitroimidazole	2 (1.1)	1 (0.6)	10 (5.6)	2 (1.1)	0 (0.0)	7 (3.9)	2 (1.1)	0.002
Carbapenems	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	0.002
Sulfonamides	1 (0.6)	0 (0.0)	3 (1.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.287
Glycopeptides	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	0.409
Chloramphenicol	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	0.480
Lincosamide	1 (0.6)	0 (0.0)	0 (0.0)	6 (3.3)	0 (0.0)	0 (0.0)	0 (0.0)	0.071
Tetracycline	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.1)	0 (0.0)	0.004
Furadantin	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	<0.001
Rifamycins	2 (1.1)	0 (0.0)	9 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<0.001
Isoniazid	2 (1.1)	0 (0.0)	9 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<0.001
Pyrazinamide	2 (1.1)	0 (0.0)	10 (5.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<0.001
Ethambutol	2 (1.1)	0 (0.0)	9 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<0.001
Others	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.759

PMW=Pediatric medical ward, NMW=Neonatal medical ward, AMW=Adult medical ward, ASW=Adult surgical ward, OBGYN=Obstetrics and gynecology, ICU=Intensive care unit, Mixed=all those departments that have both adults and pediatrics in the same ward

(>1 day) with only 9.6% on a single dose as per current guidelines,[24] similar to Egypt[18] and Botswana.[22] This prolonged use may be due to misconceptions that this reduces SSIs[17,22] and a key area for improvement. In Thika hospital in Kenya, another level 5 hospital, there was a 98% adherence to the policy to improve surgical prophylaxis within 6 weeks of implementation of a program, leading to a significant reduction in the risk of SSIs,[25] providing guidance to other hospitals.

Other concerns include clinically unjustified antibiotic combinations, the reason for which antimicrobials were prescribed was recorded in only 37.3% of all encounters, and only 45.8% of prescriptions were guideline compliant. In addition, empiric prescribing accounted for 82.6% of total antibiotic encounters. This needs addressing. Another concern is that generic (International Nonproprietary Name) prescribing was documented in only 62.5% of cases, although an improvement compared to 31.8% in 2008.[26] Antimicrobial stewardship (AMS) programs can help with quality improvement programs, with pharmacists playing a key role in their implementation and the monitoring of subsequent antibiotic use.[27]

The study had several limitations. There were challenges in obtaining all relevant medical records and limitations with the PPS study design including not documenting AMR rates and not contacting physicians to clarify their actions. Notwithstanding this, we identified several potential areas for improvement.

The prevalence of antibiotic prescribing at RVPGH was high although similar to other African countries. There was also extensive use of broad-spectrum antibiotics and prolonged duration of antibiotic prophylaxis. This is being addressed along with encouraging increased documentation of antibiotic indications in patients' charts and reducing empiric use of antibiotics. Other interventions to improve future antibiotic use include establishing AMS programs with the help of pharmacists.

Authors' Contribution

David Nyamu and Margaret Oluka are supervisors while Lydia Momanyi is the principal investigator. Lydia Momanyi, David Nyamu, and Margaret Oluka participated in the study design. Lydia Momanyi was involved in the data collection and data analysis under the supervision of David Nyamu and Margaret Oluka. Lydia Momanyi prepared the first draft of the manuscript while David Nyamu and Margaret Oluka provided critical review to the manuscript. All authors read and approved the final manuscript.

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Conflicts of interest

There are no conflicts of interest.

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