

# High Prevalence of Antimicrobial Prescribing Among Public Health Facilities in Central Uganda: Findings from Point Prevalence Survey

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**Background:** Antimicrobial resistance (AMR) is the number one cause of death globally, and Sub-Saharan Africa bears the most significant burden. Previous studies conducted in Uganda have revealed high rates of antimicrobial prescribing in hospitals, with evidence of widespread inappropriate use, which necessitates the development of targeted interventions. The inappropriate use of antimicrobials is a driver of AMR. We conducted point-prevalence surveys of antimicrobial prescribing in selected health facilities in central Uganda to identify areas for improvement.

**Methods:** The study utilised the Global Point Prevalence Survey (GPPS) to collect data on antimicrobial prescribing among eight public health facilities in Central Uganda from February to April 2024. Both inpatient and outpatient data were collected in three hospitals and five lower-level health facilities, respectively. The data collection tools adopted from GPPS were employed. Data were collected on patient demographics, antimicrobial therapy details, and compliance with standard treatment guidelines.

**Results:** The overall prevalence of antimicrobial use among inpatients at the hospitals was 87.2%, and ceftriaxone was the most frequently prescribed antimicrobial, accounting for 30.6% of the prescriptions. Prescriptions for prophylactic use were the most predominant, with prophylaxis for obstetric and gynaecological surgery accounting for 30.7% of the prescriptions. The prevalence of antimicrobial use among outpatients at lower-level health facilities was 60.7%. Amoxicillin was the most prescribed antimicrobial across the sites, accounting for 39.1% of the prescriptions. Upper respiratory tract infections accounted for most prescriptions (45.1%). Standard treatment guideline compliance was nearly half (50.5%) among hospitals, with variations observed among the different study sites.

**Conclusion:** A high prevalence of antimicrobial prescribing was observed, highlighting the need to enhance antimicrobial stewardship practices in health facilities. Compliance with standard treatment guidelines was average among hospitals but high among the lower-level health facilities. Some of the potential areas for stewardship interventions include broad-spectrum antibiotic prescriptions, prolonged antibiotic prophylactic courses, and inappropriate prescription of antibiotics for upper respiratory tract infections.

**Keywords:** antimicrobials, antimicrobial stewardship, antimicrobial resistance, Uganda

## Introduction

Antimicrobial Resistance (AMR) is a leading cause of death, with the highest burden found in low-resource settings. In 2019, it was estimated that 4.95 million deaths were associated with, and 1.27 million deaths were attributable to bacterial antimicrobial-resistant infections worldwide.<sup>1</sup> Specifically, sub-Saharan Africa had the highest all-age death rate of 27.3 deaths per 100,000 attributable to and associated with AMR.<sup>1</sup> The global burden of AMR has reached crisis

proportions, with resistant bacterial isolates identified for almost every antibiotic, including carbapenems.<sup>1,2</sup> Data from 2019 indicated that more than 100,000 deaths were attributable to methicillin-resistant *Staphylococcus aureus* (MRSA) infections,<sup>1</sup> with peak annual incidences of more than 40% reported in several countries over the last two decades.<sup>3</sup> This finding is consistent with a study of patients, healthcare workers, and the environment in the burns unit of Uganda's largest referral hospital (Mulago Hospital), which found a 46% prevalence of MRSA.<sup>4</sup>

Resistance to first-line antimicrobials increases the risk of morbidity and mortality. Unfortunately, the global rise in AMR has not been matched by the development of novel antibiotics that are effective against resistant bacteria. As a result, healthcare costs are anticipated to rise alongside depressed economic activity due to reduced workforce activity and a predicted loss of 1.8 years in life expectancy globally.<sup>2,5</sup> This existential threat to humans must be averted to avoid a post-antibiotic era in which even minor infections could be fatal.<sup>6</sup> The development of AMR by bacterial pathogens is exacerbated and accelerated by antibiotic misuse or overuse.<sup>3,7,8</sup> Inappropriate antibiotic use fuels antibacterial resistance by providing and sustaining selective pressures that favour the proliferation of resistant bacterial strains over sensitive ones in both the user and the environment.<sup>2,7,9</sup>

Globally, the pooled prevalence of antibiotic use in hospitals is 47.7% in inpatient settings and 34.3% in outpatient settings.<sup>10</sup> Notably, the prevalence is highest in Sub-Saharan Africa, with a prevalence of 51.5% in outpatient settings.<sup>10</sup> In Uganda, two previous point prevalence surveys carried out in hospitals revealed that the prevalence of antibiotic use in inpatient settings ranged from 47.3 to 73.7%.<sup>11,12</sup> Antibiotics are used by both inpatients (20%) and outpatients (80%), and inappropriate use is evident in both settings.<sup>3</sup> Excessive use, often for non-bacterial indications, inappropriate choice, dose, and duration of treatment, as well as the absence of a local antibiotic sensitivity profile, have all been linked to the high prevalence of antibiotic-resistant infections in hospital settings.<sup>3,8,9</sup> High rates of infection treatment without determining the pathogen have been frequently reported in both developed and developing countries.<sup>8</sup> A retrospective study of outpatient records in five public health facilities in a rural countryside district in Uganda discovered that 42% of antibiotic prescriptions were for non-bacterial illnesses such as malaria, helminthiasis, viruses, and non-infectious diseases.<sup>13</sup> Another study of outpatient records for children under the age of five at public health centres in Western Uganda discovered that 68% of antibiotic prescriptions were inappropriate.<sup>14</sup>

Point prevalence surveys (PPS) are a widely recognised method for assessing the prevalence of antibiotic use in healthcare facilities. Given that a significant proportion of antibiotics are used in the community setting or for outpatients, these patient groups and the prescribing patterns must not be overlooked. The Global-PPS (GPPS) expanded its focus and launched an outpatient module in 2023, which has been field-tested in several African countries.<sup>15</sup>

The use of antibiotics and prescribing practices in healthcare facilities should be systematically monitored to identify and address inappropriate practices. This ongoing surveillance is essential for implementing antimicrobial stewardship (AMS) interventions to reduce and optimise antibiotic use and improve patient outcomes.<sup>16,17</sup> In 2020, Uganda developed guidelines for antimicrobial consumption and use surveillance in human health.<sup>18</sup> However, the effective implementation of antimicrobial use (AMU) surveillance has been met with numerous challenges, including a lack of nationally adopted surveillance tools linked to the existing Health Management Information System (HMIS).<sup>19</sup> In addition, surveillance has not been implemented at all levels of care, and most health facilities lack the technical expertise to conduct surveys.<sup>20,21</sup> Most surveys have been carried out based on the World Health Organisation (WHO) PPS methodology, which focuses on inpatient antimicrobial use despite the higher prevalence in outpatient settings. The current tool used for outpatient AMU surveillance is adapted from the WHO/ International Network for Rational Use of Drugs (INRUD) drug indicator survey, which collects data on all medicines and measures only one indicator of antimicrobial use.<sup>19,21</sup> There is paucity of data on antibiotic prescribing at the health facility level in many low-and middle-income countries (LMICs).<sup>10</sup> Our study aimed to assess antimicrobial prescribing at different levels of care in selected health facilities in Central Uganda. We conducted GPPS across inpatient and outpatient settings within selected health facilities in Central Uganda to gain broader insights into the health system.

## Materials and Methods

### Study Design and Setting

Inpatient and outpatient GPPS surveys were conducted from February to April 2024 in eight public health facilities in Central Uganda. The health facilities were purposively selected to represent different levels of care: five primary level (health centre

(HC) II and III), two secondary level (general hospitals), and one tertiary level (regional referral hospital). The health facilities are government-owned, funded by taxes and donors. They providing free health services, including essential medicines.<sup>22</sup>

Health service delivery in the public sector in Uganda comprises seven levels: community, HC II, HC III, HC IV, district hospital, regional referral hospital, and national referral hospital. Community health workers, locally known as village health teams (VHTs), provide community-based preventive and promotive health services at the community level. At parish level, a HC II provides preventive, promotive, outpatient, curative, outreach, and emergency care services. At the subcounty level, HC III provides preventive, promotive, outpatient, curative, maternity, inpatient health, and laboratory services. At county level, we have a HC IV that provides preventive, promotive, outpatient, curative, maternity, inpatient health services, emergency surgery, blood transfusion and laboratory services. At district level, a general hospital offers, in addition to the services offered at the HCIV, specialist services in medicine, surgery, paediatrics, community medicine, and obstetrics and gynaecology. The general hospital also provides in-service training and basic research. At regional level, a regional referral hospital provides, in addition to the services offered at the general hospital, specialist services including psychiatry, ear, nose, and throat care, ophthalmology, dentistry, intensive care, radiology, pathology, and higher-level surgical and medical services. It also provides in-service and pre-service training, as well as internships. At national level, a national referral hospital that offers, in addition to services provided at the regional referral hospitals, superspecialist services such as nuclear medicine, neurosurgery, cardiothoracic surgery, among others. Furthermore, it provides postgraduate and undergraduate training, internships.<sup>23–26</sup>

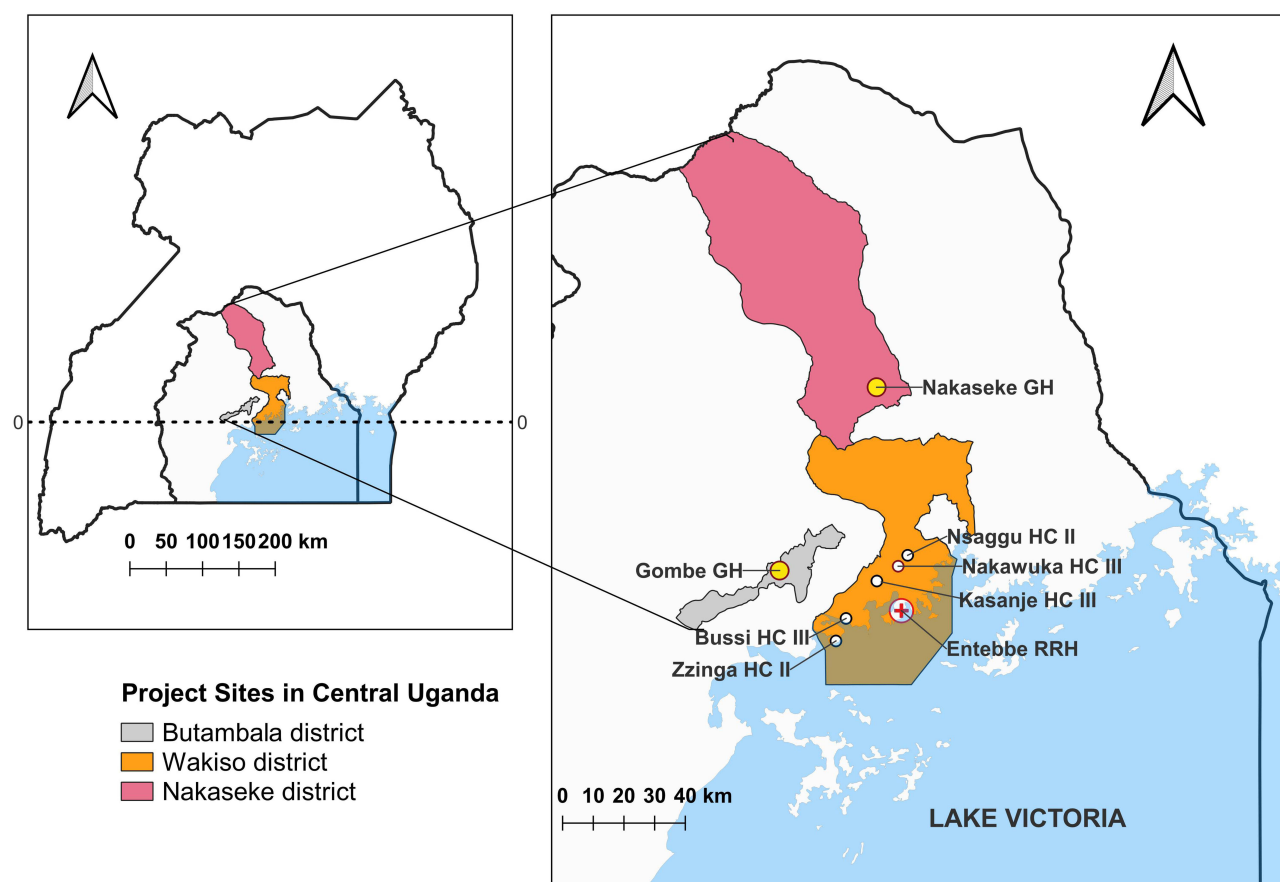
The inpatient surveys were conducted at Entebbe Regional Referral Hospital (RRH), Gomba General Hospital (GH) and Nakaseke GH. The outpatient surveys were performed at five lower-level health facilities: Nakawuka Health Centre (HC) Level III, Kasanje HCIII, Bussi HCIII, Zzinga HC Level II and Nsaggu HCII. The facilities were selected purposively based on the implementation of the Commonwealth Partnerships for Antimicrobial Stewardship (CwPAMS) Phase 2 project in Central Uganda. Makerere University School of Public Health, Uganda, Nottingham Trent University, UK, Entebbe RRH and Buckinghamshire Healthcare NHS Trust, UK operate together as a partnership for the delivery of the CwPAMS project, which aims to develop and implement AMS at each healthcare facility involved in the project.<sup>27</sup> The partnership provides expertise, capacity, and support for eight health facilities as shown in Figure 1. In addition to PPS, the CwPAMS project interventions included training of health facility staff in conducting PPS on antimicrobial use, providing mentorship support on AMS to the sites, training of health practitioners on AMS/IPC (Infection Prevention and Control)/AMR/substandard and falsified medicines, training of CHWs on AMS, IPC, AMR, substandard and falsified antimicrobials, conducting a community survey on substandard and falsified antimicrobials in the community, AMS / AMR / microbiology workshops to increase knowledge on the need for microbiology and antimicrobial prescribing data among clinicians and laboratory staff, dissemination of GPPS findings among the hub and spokes. These interventions were implemented after completion of PPS.

## Data Collection

Data were collected by a multi-disciplinary team of healthcare staff at each facility. Data collection utilised the standardised GPPS forms and protocols developed by the University of Antwerp, Belgium.<sup>28</sup> The GPPS tool is a free, online, comprehensive healthcare surveillance initiative designed to monitor and evaluate the prescribing practices of antimicrobial agents in hospitals [18]. The GPPS tool has both inpatient and outpatient modules.

At each facility, data collection was preceded by a one-day simulation training session for the participating health facility staff on utilising hard copies and electronic tools. Health facility staff selected for the training were drawn from multiple health professions, including medical doctors, nurses, midwives, pharmacists, intern pharmacists, pharmacy technicians, biomedical laboratory technicians, and clinical officers. The one-day training was conducted by partnership personnel, including a pharmacist, an intern pharmacist, and environmental health scientists. We used the PowerPoint presentation available on the GPPS website to conduct the training. Data collection at each facility was conducted continuously until all wards or departments with eligible patients were completed.

The inpatient GPPS focuses on hospital wards, allowing for the collection of valuable data regarding the prevalence and patterns of antimicrobial use among hospitalised patients. For the inpatient survey, we included all patients admitted to a ward at 8:00 am on the survey day who were prescribed antimicrobials. The following were excluded: day



**Figure 1** Map of Uganda showing the GPPS sites.

hospitalisations, outpatients and patients admitted after 8:00 am on the survey day. Each ward chosen for the survey was surveyed only once on a single day, from start to completion. Data about the ward and admitted patients were collected. Ward-related data included activity types (medical, surgical and intensive care) and ward type. The total number of admitted inpatients and the number of beds were noted. Patient data included patient demographics and details about antimicrobial therapy, including start date, dose, route of administration, diagnosis, and type of indication. The type of indication referred to whether it concerned therapeutic treatment (community-acquired infection (CAI) or Healthcare-Associated Infection (HAI)), or prophylactic use (surgical prophylaxis (SP) or medical prophylaxis (MP)). CAI was defined as the onset of symptoms starting less than or equal to 48 hours before admission to the hospital or being present on admission. HAI was where symptoms started 48 hours after hospital admission.

Additionally, data were captured on whether treatment was based on a biomarker, targeted, or empirical, and included quality indicators such as documentation of the diagnosis in the patient file, compliance with local guidelines, and a documented stop/review date. The local guidelines used in this study were the Uganda Clinical Guidelines.<sup>29</sup> The Ministry of Health developed guidelines to offer evidence-based and practical guidance for prescribers in the provision of cost-effective management of priority health conditions in the country. The treatments listed in the guidelines are the nationally recognised standard treatments and are derived from recommendations by MOH vertical programs, WHO and other international guidelines.

For the outpatient GPPS at lower-level health facilities, all outpatients seen at the selected facility within the half-day duration of the survey period were included in the outpatient survey. Patients whose consultations fell beyond the half-day duration of the survey were excluded. Data were collected on both the unit and the patients. Unit data included the type of speciality, the number of prescribers present, and the timeslot for data collection. Patient data included age, weight, sex,

presenting symptoms, underlying conditions, and details of antimicrobial therapy if applicable. For patients with an antimicrobial prescription, the collected antimicrobial details included the dose, frequency, route of administration, intended duration of therapy, clinical diagnosis, and type of indication. Additionally, the survey recorded whether the reason for antimicrobial use was documented in the patient files and whether the prescription complied with established local guidelines.

We restricted data collection to inpatients in hospitals and outpatients in the lower-level health facilities based on methodological and operational reasons. The GPPS was introduced to the health facilities for the first time. To ensure effective implementation and capacity building for health facility staff, we chose a single survey module per facility. Furthermore, the selection of patient types aligned with the service profiles of the different levels of care included in the study. Hospitals generally have a larger inpatient population, while lower-level health facilities mainly serve outpatients with, few or no admissions.

## Data Analysis

Data were collected using hardcopy forms and later entered into the online GPPS tool. The web app was used to validate data for accuracy and completeness and to analyse and generate reports for each surveyed health facility. Results for inpatient and outpatient surveys were aggregated and analysed separately. The prevalence of antimicrobial use was expressed as the proportion of patients receiving at least one systemic antimicrobial relative to the total number of eligible patients. Statistical analysis was performed using the GPPS web application and Microsoft Excel for Microsoft 365 (MSO, Version 2409, Build 16.0.18025.20030, 64-bit). Percentages and means were calculated where appropriate.

## Results

### Inpatient Survey

#### Demographic Characteristics of Enrolled Patients

A total of 225 patients were enrolled in the survey from the three participating hospitals, as they had been prescribed at least one antimicrobial. Most patients were adults (68.4%), followed by children (17.8%) and neonates (13.8%). There was a higher proportion of female patients (72%) than male patients (28%). Entebbe RRH accounted for about half of the patients (51%), followed by Nakaseke GH (27%) and Gombe GH (22%). The majority of patients prescribed at least one antimicrobial were in medicine wards (50.2%), followed by surgery (41.3%) and Intensive Care (8.4%). The adult medical ward had the highest patient count (61.8%). The demographic characteristics are presented in [Table 1](#).

#### Prevalence of Inpatient Antimicrobial Use

A total of 258 patients were included in this study, with the majority (225/258, 87%) receiving antimicrobial treatment across the three hospitals. Antimicrobial use prevalence was highest at Entebbe RRH (97%), followed by Nakaseke GH (94%), and lowest at Gombe GH (66%) ([Table 2](#)).

#### Proportional Antimicrobial Use by Hospitals

Data were collected on 438 antimicrobial prescriptions for the 225 patients in our study. Among these, ceftriaxone was the most commonly prescribed antimicrobial, accounting for 30.6% of the prescriptions. This was followed by

**Table 1** Demographic Characteristics of Eligible Patients  
(Prescribed at Least One Antimicrobial)

| Variable | N = 225 | Percentage (%) |
|----------|---------|----------------|
| Category |         |                |
| Adults   | 154     | 68.4           |
| Children | 40      | 17.8           |
| Neonates | 31      | 13.8           |

(Continued)

**Table 1** (Continued).

| Variable                    | N = 225 | Percentage (%) |
|-----------------------------|---------|----------------|
| <b>Sex</b>                  |         |                |
| Males                       | 63      | 28             |
| Females                     | 162     | 72             |
| <b>Institution</b>          |         |                |
| Entebbe RRH                 | 115     | 51             |
| Nakaseke GH                 | 61      | 27             |
| Gombe GH                    | 49      | 22             |
| <b>Ward Activity</b>        |         |                |
| Medicine                    | 113     | 50.2           |
| Surgery                     | 93      | 41.3           |
| Intensive care <sup>a</sup> | 19      | 8.4            |
| <b>Department</b>           |         |                |
| Adult Medical Ward (AMW)    | 139     | 61.8           |
| Adult Surgical Ward         | 25      | 11.1           |
| Isolation-AMW               | 1       | 0.4            |
| Neonatal ICU                | 26      | 11.6           |
| Pediatric Medical Ward      | 34      | 15.1           |

**Notes:** <sup>a</sup>Activity categorised as Intensive Care also includes high-dependency units.

metronidazole at 26.3%, gentamicin at 14.4%, and ampicillin at 8.9% (Table 3). A further breakdown of the results by age group (adults, children and neonates) is provided in [Supplementary Table 1](#).

### Access, Watch, Reserve (AWaRe) Classification of Prescribed Antimicrobials for Inpatients

Antimicrobials prescribed were classified according to the WHO AWaRe categories.<sup>30</sup> Access-class antibiotics were the most frequently prescribed, accounting for slightly more than half (55%) of the total prescriptions in the three hospitals. At Gombe GH, antibiotics in the Watch category were most prescribed, making up nearly half (51%) of total prescriptions. Nakaseke GH accounted for most antibiotic prescriptions in the “Not recommended” category (9%). No antibiotics from the Reserve category were prescribed at the hospitals (Figure 2).

**Table 2** Prevalence of Antimicrobial Use Among the Three Hospitals Included in GPPS

| Hospital     | Total Number of Patients Admitted | Number of Patients Prescribed Antimicrobials | Proportion (%) |
|--------------|-----------------------------------|----------------------------------------------|----------------|
| Entebbe RRH  | 119                               | 115                                          | 97             |
| Nakaseke GH  | 65                                | 61                                           | 94             |
| Gombe GH     | 74                                | 49                                           | 66             |
| <b>Total</b> | 258                               | 225                                          | 87             |

**Table 3** Prevalence of Inpatient Antimicrobial Use Among the Three Hospitals

| Antimicrobial Name <sup>a</sup> | ATC Code | Total (n=438) | Entebbe RRH (n=221) | Nakaseke GH (n=135) | Gombe GH (n=82) |
|---------------------------------|----------|---------------|---------------------|---------------------|-----------------|
| Ceftriaxone                     | J01DD04  | 134 (30.6%)   | 76 (34.4%)          | 28 (20.7%)          | 30 (36.6%)      |
| Metronidazole                   | J01XD01  | 115 (26.3%)   | 61 (27.6%)          | 28 (20.7%)          | 26 (31.7%)      |
| Gentamicin                      | J01GB03  | 63 (14.4%)    | 28 (12.7%)          | 31 (23.0%)          | 4 (4.9%)        |
| Ampicillin                      | J01CA01  | 39 (8.9%)     | 24 (10.9%)          | 14 (10.4%)          | 1 (1.2%)        |
| Levofloxacin                    | J01MA12  | 14 (3.2%)     | 3 (1.4%)            | 4 (3.0%)            | 7 (8.5%)        |
| Ciprofloxacin                   | J01MA02  | 14 (3.2%)     | 11 (5.0%)           | 2 (1.5%)            | 1 (1.2%)        |
| Ampicillin-Cloxacillin          | J01CR50  | 12 (2.7%)     | 4 (1.8%)            | 5 (3.7%)            | 3 (3.7%)        |
| Benzylpenicillin                | J01CE01  | 9 (2.1%)      | 0 (0.0%)            | 5 (3.7%)            | 4 (4.9%)        |
| Ceftriaxone combinations        | J01DD54  | 7 (1.6%)      | 0 (0.0%)            | 7 (5.2%)            | 0 (0.0%)        |
| Artesunate                      | P01BE03  | 6 (1.4%)      | 4 (1.8%)            | 2 (1.5%)            | 0 (0.0%)        |
| Other <sup>b</sup>              |          | 25 (5.7%)     | 10 (4.5%)           | 9 (6.7%)            | 6 (7.3%)        |

**Notes:** <sup>a</sup> Antibiotic AwaRe classification ■ Access ■ Watch ■ Not recommended; <sup>b</sup> Other antimicrobials include artemether-lumefantrine, azithromycin, artemisinin and piperazine, amikacin, cefixime, piperacillin and enzyme inhibitor, cefotaxime, erythromycin, fluconazole, flucloxacillin and cloxacillin.

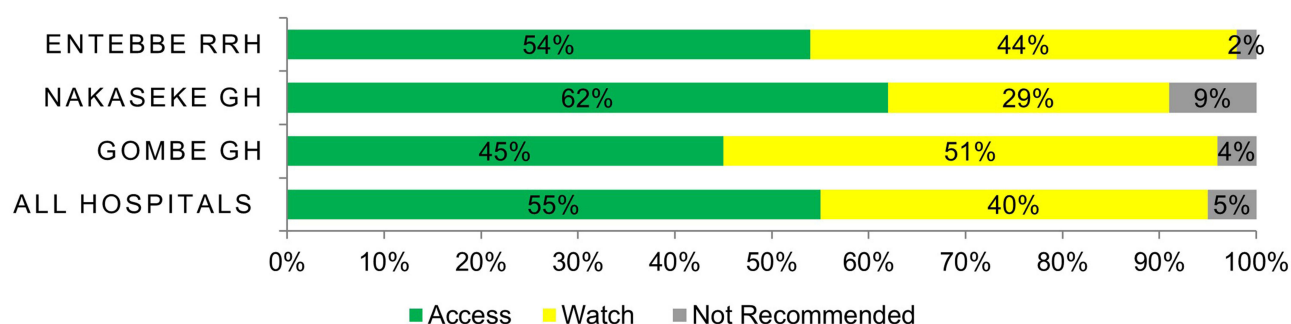
### Intended Purpose for Prescribing Antimicrobials for Inpatients

The indications for antimicrobial prescribing were categorised into therapeutic, prophylactic, other, and unknown. Prophylactic use accounted for slightly more than half (52.1%) of the prescriptions. Of these, surgical prophylaxis prescriptions were the majority (58.8%), while medical prophylaxis accounted for 41.2%. Surgical prophylaxis for more than one day (SP3) was the most frequent subtype (80.6%). Gombe GH had the highest proportion of prescriptions for prophylactic use (78%) for its patients who were prescribed at least one antimicrobial. Therapeutic use made up 45% of the prescriptions. Of these, community-acquired infections (CAI) were the majority (62.4%), followed by healthcare-associated infections (HAI) (37.6%). HAI (postoperative infections) was the most frequent subtype (60.8%). Therapeutic use prescriptions were highest (51.9%) at Nakaseke GH. The “Other” category accounted for only 2.5% of prescriptions and 0.5% as unknown (Table 4). A further breakdown of the data by age group (adults, children and neonates) is provided in [Supplementary Table 2](#).

Across all three hospitals, the most common reason for prescribing antimicrobials was for prophylaxis in obstetrics and gynaecological surgery (30.4%), followed by prophylaxis of neonatal medical conditions (9.6%) (Table 5).

### Quality Indicators for Antimicrobial Prescribing

The quality of antimicrobial prescribing was assessed using criteria specified in the GPPS protocol, which included evaluating whether the indication for the prescription was documented, if the prescription complied with guidelines,

**Figure 2** Proportion of prescribed antibiotics under WHO AwaRe classification across the three hospitals.

**Table 4** Type of Indication for Antimicrobial Prescribing

|                                              | Total       | Entebbe RRH | Nakaseke GH | Gombe GH   |
|----------------------------------------------|-------------|-------------|-------------|------------|
| <b>Number of antimicrobial prescriptions</b> | 438         | 221         | 135         | 82         |
| <b>Therapeutic use</b>                       | 197 (45.0%) | 110 (49.8%) | 70 (51.9%)  | 17 (20.7%) |
| Community-acquired infection(CAI);           | 123 (62.4%) | 49 (44.5%)  | 57 (81.4%)  | 17 (100%)  |
| Healthcare-associated infection(HAI);        | 74 (37.6%)  | 61 (55.5%)  | 13 (18.6%)  | -          |
| HAI1                                         | 45 (60.8%)  | 40 (65.6%)  | 5 (38.4%)   | -          |
| HAI2                                         | 2 (2.7%)    | -           | 2 (15.4%)   | -          |
| HAI4                                         | 23 (31.1%)  | 21 (34.4%)  | 2 (15.4%)   | -          |
| HAI6                                         | 4 (5.4%)    | -           | 4 (30.8%)   | -          |
| <b>Prophylactic use</b>                      | 228 (52.1%) | 104 (47.1%) | 60 (44.4%)  | 64 (78%)   |
| Medical Prophylaxis; MP                      | 94 (41.2%)  | 47 (45.2%)  | 15 (25.0%)  | 32 (50.0%) |
| Surgical Prophylaxis; SP                     | 134 (58.8%) | 57 (54.8%)  | 45 (75.0%)  | 32 (50.0%) |
| SP1                                          | 8 (6.0%)    | 7 (12.3%)   | 1 (2.2%)    | -          |
| SP2                                          | 18 (13.4%)  | 12 (21.0%)  | 6 (13.3%)   | -          |
| SP3                                          | 108 (80.6%) | 38 (66.7%)  | 38 (84.4%)  | 32 (100%)  |
| <b>Other (OTH)</b>                           | 11 (2.5%)   | 7 (3.2%)    | 4 (3.0%)    | -          |
| <b>Unknown (UNK)</b>                         | 2 (0.5%)    | -           | 1 (0.7%)    | 1 (1.2%)   |

**Abbreviations:** HAI1, Postoperative surgical site infection; HAI2, Intervention-related infections of mixed origin; HAI4, Other hospital-acquired infection of mixed or undefined origin; HAI6, Infection present on admission from long-term care facility; SP1, Surgical prophylaxis single dose, SP2, Surgical prophylaxis for 1 day, SP3, Surgical prophylaxis for greater than 1 day.

**Table 5** The Ten Most Common Diagnoses Among Patients Receiving Antimicrobials at the Three Hospitals

| Diagnosis  | Total (n=438) | Entebbe RRH (n=221) | Nakaseke GH (n=135) | Gombe GH (n=82) |
|------------|---------------|---------------------|---------------------|-----------------|
| Proph OBGY | 133 (30.4%)   | 63 (28.5%)          | 38 (28.1%)          | 32 (39.0%)      |
| NEO-MP     | 42 (9.6%)     | 24 (10.9%)          | 16 (11.9%)          | 2 (2.4%)        |
| Pneu       | 36 (8.2%)     | 19 (8.6%)           | 14 (10.4%)          | 3 (3.7%)        |
| OBGY       | 27 (6.2%)     | 10 (4.5%)           | 2 (1.5%)            | 15 (18.3%)      |
| Other      | 23 (5.3%)     | 13 (5.9%)           | 6 (4.4%)            | 4 (4.9%)        |
| SEPSIS     | 22 (5.0%)     | 18 (8.1%)           | 0 (0.0%)            | 4 (4.9%)        |
| GI         | 22 (5.0%)     | 9 (4.1%)            | 2 (1.5%)            | 11 (13.4%)      |
| SST        | 20 (4.6%)     | 11 (5.0%)           | 8 (5.9%)            | 1 (1.2%)        |
| URTI       | 18 (4.1%)     | 12 (5.4%)           | 2 (1.5%)            | 4 (4.9%)        |
| BAC        | 16 (3.7%)     | 0 (0.0%)            | 13 (9.6%)           | 3 (3.7%)        |
| Others*    | 79 (18%)      | 42(19.0%)           | 36(26.7%)           | 1(1.2%)         |

**Note:** \*Others-additional diseases beyond the top ten.

**Abbreviations:** Proph OBGY, Prophylaxis for Obstetric and Gynecological surgery, NEO-MP, Medical Prophylaxis for Newborn risk factors, Pneu, Pneumonia or lower respiratory tract infection, OBGY, Obstetric/Gynecological infections, Other, Antimicrobial prescribed with documentation but no defined diagnosis group, SEPSIS, Sepsis of any origin, GI, Gastrointestinal infections, SST, Skin and Soft Tissue infections, URTI, Upper respiratory tract infection, BAC, Bacteremia or Fungaemia with no clear anatomic site and no shock.

whether a review or stop date was documented, and whether guidelines for managing a particular indication were missing (Table 6). In almost all the prescriptions (99.1%), the reason for prescribing an antimicrobial was documented. At Entebbe RRH, all the prescriptions (100%) had a documented reason. Compliance with guidelines was evident in approximately half of the prescriptions (50.5%), with the lowest compliance at Entebbe RRH (33.0%). The stop or

**Table 6** The Proportion of Antimicrobial Prescriptions Adhering to the Four Quality Indicators

| Quality Indicator                       | Total       | Entebbe RRH | Nakaseke GH  | Gombe GH   |
|-----------------------------------------|-------------|-------------|--------------|------------|
| Number of antimicrobial prescriptions   | 438         | 221         | 135          | 82         |
| Reason documented in patient notes*     | 434 (99.1%) | 221 (100%)  | 133 (98.5%)  | 80 (97.6%) |
| Prescription was guideline compliant*** | 221 (50.5%) | 73 (33.0%)  | 72 (53.3%)   | 76 (92.7%) |
| Stop/review date was documented         | 406 (92.7%) | 196 (88.7%) | 133 (98.52%) | 77 (93.9%) |
| Guideline missing (NA)**                | 67 (15.3%)  | 6 (2.7%)    | 58 (43.0%)   | 3 (3.7%)   |

**Notes:** \*For reason in notes and stop/review date documented: Count was at antibacterial level. \*\*For guidelines missing: Count on NA (= no guideline for an indication) at patient level and diagnosis over total scores for this indicator. \*\*\*For guideline compliance: Count at patient level and diagnosis for compliance = yes or no only. For combination therapy with >1 antibiotic: if one antibiotic by diagnosis is not compliant, this combination therapy as a whole for this diagnosis will be counted as non-compliant.

review date was documented for most prescriptions (92.7%). The absence of antimicrobial prescribing guidelines varied between the hospitals, between 2.7–43% (Table 6).

### Missed Doses for Inpatients

The prevalence of missed doses was 16% (70/438). The highest proportion of missed doses was at Gombe GH at 29.3%. The pooled mean missed doses was 3.7, with Entebbe RRH reporting the highest number of missed doses per patient (6.7). Stockouts were a significant reason (27.1%) for missed doses. It was impossible to determine the reason for missed doses in 67.1% of cases (Table 7).

## Outpatient Survey

### Demographic Characteristics of the Patients

The study included 308 outpatients, with adults constituting slightly more than half (56.5%, 174). The majority of patients were female (61.4%, 189). Kasanje Health III accounted for the highest number of outpatients, representing 28.9% (89) (Table 8).

**Table 7** Prevalence of Missed Doses Among the Three Hospitals

|                                           | Total | Entebbe RRH | Nakaseke GH | Gombe GH |
|-------------------------------------------|-------|-------------|-------------|----------|
| Number of antimicrobial prescriptions     | 438   | 221         | 135         | 82       |
| Number of prescriptions with missed doses | 70    | 19          | 27          | 24       |
| Percentage of missed doses                | 16.0% | 8.6%        | 20.0%       | 29.3%    |
| Mean missed doses                         | 3.7   | 6.7         | 2.5         | 2.6      |
| Median missed doses                       | 2     | 3           | 2           | 2        |
| Interquartile Range                       | 2-3   | 2-5         | 1-2         | 1-2      |
| Reasons for missed doses                  |       |             |             |          |
| Stock out                                 | 27.1% | 42.1%       | 37.0%       | 4.2%     |
| Patient could not purchase                | 1.4%  | 0.0%        | 3.7%        | 0.0%     |
| Multiple reasons                          | 4.3%  | 0.0%        | 3.7%        | 8.2%     |
| Unknown*                                  | 67.1% | 57.9%       | 55.6%       | 87.5%    |

**Note:** \*The reason is not documented or ascertainable.

**Table 8** Sociodemographic Characteristics of Outpatients Surveyed

| Variable                          | N   | Percentage |
|-----------------------------------|-----|------------|
| Total number of included patients | 308 | 100        |
| <b>Age</b>                        |     |            |
| Adults                            | 174 | 56.5       |
| Children                          | 134 | 43.5       |
| <b>Sex</b>                        |     |            |
| Males                             | 119 | 38.6       |
| Females                           | 189 | 61.4       |
| <b>Institution</b>                |     |            |
| Nsaggu Health Centre II           | 56  | 18.2       |
| Zzinga Health Centre II           | 47  | 15.3       |
| Nakawuka Health Centre III        | 68  | 22.1       |
| Kasanje Health Centre III         | 89  | 28.9       |
| Bussi Health Centre III           | 48  | 15.6       |

### Prevalence of Outpatient Antimicrobial Use

Of the 308 patients surveyed, 187 (60.7%) received at least one antimicrobial. Children had a higher prevalence of antimicrobial prescriptions (69.4%, 93/134) than adults. Males had a higher prevalence of antimicrobial prescriptions (64.7%, 77/119) than females. Zzinga Health Centre II had the highest prevalence of antimicrobial prescriptions (85.1%, 40/47), whereas Nsaggu Health Centre II had the lowest prevalence (35.7%, 20/56) ([Table 9](#)).

### Proportional Antimicrobial Use for Outpatients

Amoxicillin was the most commonly prescribed antibiotic, accounting for 39.1% of the antimicrobial prescriptions. This was followed by artemether and lumefantrine at 17.9%, metronidazole at 12.3%, and doxycycline at 6% ([Table 10](#)). A breakdown of commonly prescribed antimicrobials by age group is provided in [supplementary Table 3](#).

**Table 9** Prevalence of Antimicrobial Use by Age, Sex and Health Facility

|              | Patients with AtLeast One Antimicrobial |            |
|--------------|-----------------------------------------|------------|
|              | N                                       | Prevalence |
| All patients | 187                                     | 60.7       |
| <b>Age</b>   |                                         |            |
| Adults       | 94                                      | 54         |
| Children     | 93                                      | 69.4       |
| <b>Sex</b>   |                                         |            |
| Males        | 77                                      | 64.7       |
| Females      | 110                                     | 58.2       |

(Continued)

**Table 9** (Continued).

|                            | Patients with AtLeast One Antimicrobial |            |
|----------------------------|-----------------------------------------|------------|
|                            | N                                       | Prevalence |
| <b>Health facility</b>     |                                         |            |
| Nsaggu Health Centre II    | 20                                      | 35.7       |
| Nakawuka Health Centre III | 47                                      | 69.1       |
| Kasanje Health Centre III  | 47                                      | 52.8       |
| Bussi Health Centre III    | 33                                      | 68.8       |
| Zzinga Health Centre II    | 40                                      | 85.1       |

### AWaRe Classification of Antimicrobials for Outpatients

Antibiotics prescribed were classified according to the WHO AWaRe categories.<sup>30</sup> Generally, antibiotics in the Access category were the most frequently prescribed among all the lower-level health facilities, ranging from 71% to 98% of total prescriptions. Nsaggu HCII had the highest prevalence of Watch antibiotics (29%), followed by Bussi HCIII (20%). Kasanje HCIII had the lowest prevalence of prescriptions under the Watch category. Notably, Nakawuka HCIII had a 4% prevalence of antibiotics in the unclassified category. No prescriptions of antibiotics from the Reserve category were reported (Figure 3).

Among the Access category, the most frequently prescribed antibiotics were Amoxicillin (45.9%), metronidazole (15.1%), and Sulfamethoxazole and Trimethoprim (14.1%). Ciprofloxacin (6.8%) and ceftriaxone (3.1%) were the most commonly prescribed for the Watch category. In the “Unclassified” category, combinations of benzylpenicillin (1%) were most frequently prescribed.

### Intended Purpose for Prescribing Antimicrobials in Outpatients

Across all five health centres, the most common reason for prescribing antimicrobials (47.5%) was for the treatment of Upper respiratory tract infections (URTI). This was followed by malaria (17.9%) (Table 11). The most common diagnoses broken down by age group is provided in [supplementary Table 4](#).

### Quality Indicators for Antimicrobial Use in Outpatients

The quality of antimicrobial prescribing was assessed using criteria specified in the GPPS protocol, which included evaluating whether local guidelines for managing the indication existed, if the drug’s choice complied with guidelines, and whether the dosing and duration of treatment complied with the guidelines (Table 12).

The findings showed that for most antimicrobial prescriptions (98.3%), local guidelines existed for indication. There was also high compliance to treatment guidelines by choice of antimicrobial (93.1%), dosing (81.8%) and duration of therapy (91.8%).

## Discussion

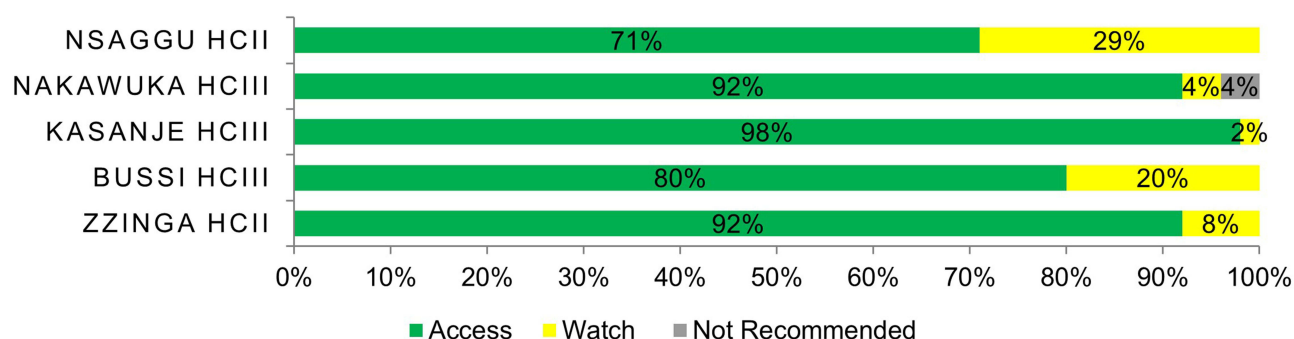
The study aimed to determine the prevalence of antibiotic prescribing in three hospitals and five lower-level health facilities in Central Uganda. There was a high prevalence of antimicrobial prescribing in both inpatient and outpatient settings, with most prescriptions categorised as access class, followed by watch class. To our knowledge, this was the first outpatient GPPS carried out in Uganda.

The study found a high prevalence of inpatient antimicrobial prescribing (87.2%) among the three hospitals surveyed. This prevalence is higher than findings from previous point prevalence surveys conducted in Uganda,<sup>11,12,31</sup> other SSA countries<sup>11</sup> and a recent systematic review and meta-analysis, which indicated prevalence from 30–74%.<sup>10</sup> Another systematic review and meta-analysis had comparable findings, with a pooled prevalence of 64%.<sup>32</sup> Variability in overuse and misuse of antimicrobials, infection prevention and control, water, sanitation and hygiene practices, surveillance of

**Table 10** The Eight Most Commonly Prescribed Antimicrobials for Outpatients

| Antimicrobial Name <sup>a</sup>   | Total (n=235) | Nsaggu HCII (n=21) | Nakawuka HCII (n=65) | Kasanje HCIII (n=56) | Bussi HCIII (n=41) | Zzinga HCII (n=52) |
|-----------------------------------|---------------|--------------------|----------------------|----------------------|--------------------|--------------------|
| Amoxicillin                       | 92 (39.1%)    | 12 (57.1%)         | 16 (24.6%)           | 24 (42.9%)           | 18 (43.9%)         | 22 (42.3%)         |
| Artemether and lumefantrine       | 42 (17.9%)    | 0 (0%)             | 12 (18.5%)           | 16 (28.6%)           | 1 (2.4%)           | 13 (25%)           |
| Sulfamethoxazole and trimethoprim | 31 (13.2%)    | 0 (0%)             | 12 (18.5%)           | 0 (0%)               | 7 (17.1%)          | 8 (15.4%)          |
| Metronidazole                     | 29 (12.3%)    | 1 (4.8%)           | 11 (16.9%)           | 11 (19.6%)           | 3 (7.3%)           | 3 (5.8%)           |
| Doxycycline                       | 14 (6.0%)     | 2 (9.5%)           | 4 (6.2%)             | 3 (5.4%)             | 2 (4.9%)           | 3 (5.8%)           |
| Ciprofloxacin                     | 13 (5.5%)     | 6 (28.6%)          | 2 (3.1%)             | 0 (0%)               | 2 (4.9%)           | 3 (5.8%)           |
| Ceftriaxone                       | 6 (2.6%)      | 0 (0%)             | 0 (0%)               | 0 (0%)               | 6 (14.6%)          | 0 (0%)             |
| Benzylpenicillin                  | 4 (1.7%)      | 0 (0%)             | 2 (3.1%)             | 0 (0%)               | 2 (4.9%)           | 0 (0%)             |
| Other <sup>b</sup>                | 4 (1.7%)      | 0 (0%)             | 5(7.7%)              | 1(1.8%)              | 2(4.9%)            | 0(0%)              |

**Notes:** <sup>a</sup> Antibiotic AWaRE classification ■ Access ■ Watch; <sup>b</sup> Other antimicrobials include; combinations of benzylpenicillin, cefixime and acyclovir.



**Figure 3** Proportion of prescribed antibiotics under WHO AWaRe classification across the five health facilities.

antimicrobial resistance,<sup>32</sup> disease burden, compliance to clinical guidelines, access to antimicrobials and differences in patient characteristics<sup>33</sup> might be the cause of divergent findings among hospitals and World regions. Nevertheless, the present study's findings highlight a high reliance on antimicrobials in Uganda hospital settings, which drives AMR. The high prescribing prevalence of antimicrobials in Uganda and other SSA countries may be due to various factors: misuse and overuse of antimicrobials, limited diagnostic and laboratory facilities, high burden of infectious diseases, inadequate water, sanitation, and hygiene (WASH) systems and infection prevention and control (IPC) measures that increase incidence of infections, poor compliance to treatment guidelines and lack of antimicrobial stewardship in the hospitals.

High antimicrobial prescribing may also be exacerbated by the limited or no capacity for antibiotic susceptibility testing (AST) in most public health facilities in Uganda. Apart from a few regional referral hospitals, most health facilities have no functional microbiology laboratories, resulting in clinicians prescribing antimicrobials empirically<sup>34</sup> which may contribute to inappropriate use and resistance. Addition of laboratory infrastructure, training of laboratory personnel, and integration of AST into routine clinic workflows would enhance evidence-based prescribing. The presence of substandard and falsified (SF) antimicrobials remains a concern in Uganda, as highlighted by previous reports<sup>34,35</sup> and related CwPAMS community surveys.<sup>36</sup> However, there is paucity of data on the prevalence of SF antimicrobials in Uganda. Strengthening medicine and routine medicine quality testing is therefore essential in supporting effective antimicrobial stewardship.

**Table 11** The Eight Most Common Diagnoses

| Diagnosis          | Total (%)   | Nsaggu HCII | Nakawuka HCIII | Kasanje HCIII | Bussi HCIII | Zzinga HCII |
|--------------------|-------------|-------------|----------------|---------------|-------------|-------------|
| URTI               | 106 (45.1%) | 4 (19.0%)   | 20 (30.8%)     | 26 (46.4%)    | 25 (61.0%)  | 31 (59.6%)  |
| Malaria            | 40 (17.0%)  | 0 (0.0%)    | 12 (18.5%)     | 14 (25.0%)    | 1 (2.4%)    | 13 (25.0%)  |
| Cys                | 35 (14.9%)  | 10 (47.6%)  | 10 (15.4%)     | 4 (7.1%)      | 3 (7.3%)    | 8 (15.4%)   |
| GI                 | 19 (8.1%)   | 2 (9.5%)    | 5 (7.7%)       | 10 (17.9%)    | 2 (4.9%)    | 0 (0.0%)    |
| SST                | 13 (5.5%)   | 2 (9.5%)    | 6 (9.2%)       | 0 (0.0%)      | 5 (12.2%)   | 0 (0.0%)    |
| Pneu               | 4 (1.7%)    | 2 (9.5%)    | 2 (3.1%)       | 0 (0.0%)      | 0 (0.0%)    | 0 (0.0%)    |
| Pye                | 3 (1.3%)    | 0 (0.0%)    | 0 (0.0%)       | 0 (0.0%)      | 3 (7.3%)    | 0 (0.0%)    |
| ENT                | 3 (1.3%)    | 0 (0.0%)    | 2 (3.1%)       | 0 (0.0%)      | 1 (2.4%)    | 0 (0.0%)    |
| Other <sup>a</sup> | 12 (5.1%)   | 1 (4.8%)    | 8 (12.3%)      | 2 (3.5%)      | 1 (2.4%)    | 0 (0.0%)    |

**Notes:** Other includes; Therapy for Eye infections, Acute Otitis Media, Genito Urinary infections in Males; Other is where antimicrobial prescribed with documentation but no defined diagnosis group.

**Abbreviations:** URTI, Upper respiratory tract infection; Cys, Lower Urinary Tract infection (cystitis); GI, Gastro-Intestinal infections; SST, Skin and Soft Tissue infection; Pneu, Pneumonia; Pye, Upper UTI (pyelonephritis); ENT, Ear Nose and Throat infections.

**Table 12** Quality Indicators for Antimicrobial Use

| Quality Indicators                    | N   | %    |
|---------------------------------------|-----|------|
| Local guidelines exist for diagnosis* | 231 | 98.3 |
| Guideline compliant – drug**          | 215 | 93.1 |
| Guideline compliant - dosing          | 189 | 81.8 |
| Guideline compliant - duration        | 212 | 91.8 |

**Notes:** \*Numerator is the number of prescriptions. The denominator is the total number of prescriptions (235). The availability of guidelines can be one of the following values: Yes, No, Unknown indication or Unknown. Unknown indication is selected when the diagnosis is not known. \*\*Numerator is the number of guideline-compliant (Yes) prescriptions at patient- and diagnosis-level, meaning compliance is calculated for each patient diagnosis. For combination therapy with >1 antimicrobial: if one antimicrobial by diagnosis is not compliant, the whole combination therapy is counted as non-compliant. The denominator is the total number of compliant (Yes) and non-compliant (No) prescriptions at the patient and diagnosis levels.

Most of the antimicrobials prescribed belonged to the WHO Access (55%) followed by Watch (40%) classes. Antimicrobials that are not recommended accounted for 5% of prescriptions, and there were no prescriptions for reserve-class antimicrobials. These findings are comparable to a study in Uganda in 2021,<sup>12</sup> which reported that the proportion of prescriptions from the Access group was 44.1%. Another study in Uganda also found proportions of 52% and 47.7%, respectively<sup>31</sup> and other countries in Sub-Saharan Africa had nearly 50%.<sup>32</sup> The significant proportion of Access antibiotics aligns with WHO's goal of promoting access to antibiotics that are important for managing common conditions and have a low risk of antibiotic resistance. Furthermore, the proportion of Access antibiotics was near the WHO-recommended target of 60%.<sup>37</sup> A considerable proportion (40%) of the prescribed antibiotics belonged to the Watch class, which comprises antibiotics with a higher risk for AMR. The findings indicate that the Watch class was the second most prescribed class in the current study, aligning with previous studies done in Uganda that found that Watch antibiotics were 40%,<sup>11</sup> 44.1%,<sup>12</sup> and 44.4%.<sup>31</sup> The WHO recommendation implies that the other categories of antimicrobials should constitute less than 40% of the total consumption. This means that our current study findings are slightly above the recommended target.

The antibiotic prescription proportions do not appear to correlate with the national average proportions of antibiotics supplied to the public facilities by National Medical Store (NMS), indicating that regional referrals consume 61% access, 37% watch, and 2% reserve, while general hospitals consume 79% access, 20% watch and only 0.1% reserve.<sup>38</sup> This suggests that the prescription rates for Watch antibiotics are higher than the national average. It could also be interpreted with caution that national consumption averages used data from all health facilities in the country and considered three years of consumption data. The absence of reserve-class antibiotics is commendable, but it could be due to the low proportions of these antibiotics on the hospital list of medicines supplied by the NMS.<sup>38</sup> Whilst Reserve antibiotics should not be used routinely, appropriate use when treating drug-resistant infections is life-saving. Previous study findings agree with our findings and speak to the unaffordability of such drugs.<sup>11,12,31</sup> Supplies data showed that only national and regional referral hospitals obtained reserve antimicrobials.<sup>38</sup> Findings elsewhere also show that reserve antimicrobials may not be prescribed because of availability-related challenges.<sup>39</sup>

Not recommended antimicrobials constituted 5% of prescriptions, including ampicillin and cloxacillin combinations, and ceftriaxone combinations. A previous study in Uganda revealed comparable findings showing 8%,<sup>11</sup> 7.8%<sup>31</sup> prescription rates for not recommended antimicrobial combinations. This is a noteworthy finding because the combinations are not included in the current national essential medicines list of Uganda, where only Piperacillin-Tazobactam is included<sup>40</sup> and are consequently not supplied by NMS. It is quite probable that these prescriptions were made outside the essential medicines list, necessitating patients to buy the medicines from retail outlets. This indicates that antibiotic prescriptions are likely made outside the Uganda Clinical Guidelines (UCG) and sourced privately by patients. Although

fixed dose combinations (FDCs) have been prohibited by WHO because of their disadvantages, LMICs like Uganda continue to include them in their national drug registers and prescriptions are written for them even though they are detrimental to AMS efforts.<sup>41,42</sup> From the findings above, achieving the WHO target of 60% access would be possible in Ugandan hospitals by strict prohibition of not recommended combinations through promotion of compliance to the UCG which would enable greater utilisation of access category antibiotics. Prescribers should be educated about the reasons why FDCs are not recommended and advise on alternatives.

The most commonly prescribed antibiotics were ceftriaxone (30.6%) and metronidazole (26.3%). This finding is consistent with previous studies in Uganda, where ceftriaxone accounted for 37%, 24%, 50.6%<sup>11,12,43</sup> and other SSA countries have similar findings, accounting for 7.4–51.7%, 34.7%, 28%.<sup>32,33,44</sup> The high use of ceftriaxone could also be driven by its high availability in hospitals, ease of administration and the broad spectrum of activity.<sup>12,45,46</sup> A study on antimicrobial consumption in Uganda revealed that ceftriaxone accounted for more than half of all injectable antimicrobials distributed to hospitals between 2017 and 2019.<sup>38</sup> It is, therefore, not surprising that it was the most prescribed antibiotic as supply encourages use, and quantification follows historical use. Ceftriaxone, a third-generation cephalosporin with a broad spectrum, belongs to the Watch class. The overuse of ceftriaxone could lead to resistance, as observed in Uganda<sup>43</sup> and other countries.<sup>39</sup> Moreover, its inappropriate use has been recorded in hospitals in Uganda at 32.1%.<sup>47</sup> Previous studies have also shown that metronidazole is frequently prescribed alongside ceftriaxone for surgical prophylaxis.<sup>48</sup> It is, therefore, not surprising that metronidazole was the second most prescribed antibiotic in the current study. AMS initiatives targeting ceftriaxone and metronidazole prescribing could be introduced to improve antimicrobial prescribing.

The study evaluated indications for antimicrobial prescribing in the three hospitals surveyed. Prescriptions for prophylactic use accounted for the highest proportion (52.1% of prescriptions), which is higher than that of a study conducted in Uganda in 2021.<sup>11</sup> However, the results are similar to the findings that surgical prophylaxis for more than 3 days was the most common indication (80.6%) for surgical prophylaxis prescriptions. A similar study in Uganda also revealed that antibiotics for surgical prophylaxis were prescribed for a mean duration of 3.5 days.<sup>48</sup> The current study's findings highlight the longer-than clinically necessary use of antibiotics for surgical prophylaxis, which is common in hospitals in LMICs.<sup>49,50</sup> This is not compliant with the Uganda Clinical Guidelines<sup>29</sup> and WHO guidelines<sup>51</sup> and exposes patients to risks associated with antibiotic overuse.<sup>52</sup> Interventions must be designed to reduce the prophylactic use of antibiotics, in addition to implementing good infection control practices in hospitals, to minimise the risk of surgical site infections while mitigating the risks of overuse of antimicrobials and antimicrobial resistance (AMR).

The top two most common reasons for prescribing antimicrobials were prophylaxis in Obstetrics and Gynaecological surgery (30.4%) and prophylaxis of neonatal medical conditions (9.6%). The results are similar to those of a previous study in three African countries, although the proportions were lower than those of our present study.<sup>11</sup> A study undertaken in three hospitals in Tanzania found a near-universal use of antibiotics in obstetrics and gynaecology wards.<sup>53</sup> The high use of antimicrobials for prophylaxis in obstetrics and gynaecological surgery can be explained by a high prevalence of surgical procedures that often necessitate antibiotics to prevent postoperative infections.<sup>32</sup> Pregnancy-related complications have been shown to account for a significant proportion of the leading causes of admission to hospitals among women in Uganda, according to the annual health sector performance report FY 2023/2024.<sup>54</sup> The high rate of antibiotic prescriptions in obstetrics and gynaecology surgery requires further investigation for compliance with treatment guidelines.

Nearly all prescriptions in the three hospitals had documented reasons in notes consistent with excellent practice. However, guideline compliance was evident in approximately half (50.5%) of prescriptions, which is lower than that of previous GPPS in Uganda, which showed higher compliance with clinical guidelines (67%).<sup>11</sup> Other studies have also reported compliance with guidelines in SSA to be low.<sup>50,55</sup> Reasons for low guideline compliance could include poor awareness of the guidelines, limited availability, and lack of resources to support the implementation of the guidelines. Variations in guideline compliance among hospitals and the previous surveys can be attributed to differences in AMS interventions, availability of antibiotics in the hospital, and local hospital guidelines. This indicates that work is necessary to improve access, knowledge, use and confidence in guidelines.

The prevalence of missed doses was 16%, with the main reasons being stockouts and other unknown reasons. A large portion of missed doses was attributed to undocumented reasons, suggesting poor documentation of drug administration

records. The prevalence of missed doses could have been lower since hospitals explained that some drug administration records were omitted from the patient files but recorded in the nurses' treatment records. The reason stockouts contribute to missed doses is unsurprising, as stockouts of essential medicines are prevalent in public hospitals.<sup>56</sup> A previous similar study also revealed that the prevalence of missed doses of antibiotics ranged between 16–25.6%.<sup>12</sup> Another similar study showed that the prevalence of missed doses was as high as 44%.<sup>57</sup> The extent of missed doses could be related to the frequency of stockouts at the individual hospitals. Missed antibiotic doses reduce treatment effectiveness and can contribute to AMR because of interrupted antibiotic courses. Prescribers could consider using second-line treatment in cases of stockouts of preferred antibiotics. Reduction of inappropriate antibiotic use would also increase antibiotic availability for patients when antibiotics are indicated.

The prevalence of outpatient antimicrobial use in lower-level health facilities was 60.7%. This prevalence was lower than inpatient antimicrobial use in hospitals surveyed in the present study. Antimicrobial use in outpatients is high, as evidenced by another study conducted in eastern Uganda, which found a similar prevalence of 62.2%.<sup>58</sup> The most common indications for which antimicrobials were prescribed were URTI (45.1%), malaria (17.0%) and lower urinary tract infections (UTIs) (14.9%). This is somewhat related to the reported common conditions responsible for outpatient department (OPD) attendance in public health facilities in Uganda. This showed that malaria (30.7%), cough or cold (21.8%) and UTIs (6%) are the leading causes of admission in the financial year 2023/2024.<sup>54</sup> The finding that most antimicrobials were prescribed for URTI points to misuse of antimicrobials since the UCG emphasises the use of symptomatic management without antibiotics in cases where the suspicion of viral infection is high.<sup>29</sup> Previous studies in Uganda have also shown the irrational use of antibiotics among patients presenting with URTI in outpatient departments in health facilities.<sup>59–61</sup> URTIs are predominantly viral in aetiology, and there is no evidence that antibiotics offer clinical benefits. The practice of prescribing antibiotics to manage URTIs can contribute significantly to the development of AMR and reinforces the misconception that antibiotics can be used to treat viral infections, sending out the wrong message to patients.

Our study revealed that the most commonly prescribed antimicrobials from lower-level health centres in Wakiso District were Amoxicillin (39.1%), followed by artemether and lumefantrine (17.9%) and sulfamethoxazole and trimethoprim (13.2%). A similar outpatient study in Uganda revealed that Amoxicillin was the most prescribed antibiotic (52.2%).<sup>58</sup> High use of both antibiotics may be associated with their high availability in lower-level health facilities where only a few antibiotics are supplied. The high use of sulfamethoxazole and trimethoprim is concerning because it is only recommended in the UCG or standard treatment guidelines for prophylaxis against opportunistic infections in children with HIV.<sup>29</sup> Overuse in other settings may increase the prevalence of resistance, limiting the benefits to immunosuppressed patients taking this drug to prevent infections.

Guideline compliance for the drug selected was high (93.1%), although compliance with dosing guidelines was lower (81.8%). In this study, guideline compliance was higher in outpatient than inpatient settings. Previous similar studies indicate high non-adherence to standard treatment guidelines when prescribing antibiotics in this setting.<sup>62</sup> The findings could be due to the structural differences in healthcare services between higher- and lower-level facilities. Lower-level health facilities manage a smaller range of less complex conditions with lower patient loads, which might result in higher compliance with treatment guidelines. Addressing gaps in guideline compliance requires targeted interventions such as routine prescription audits and continuous professional development for prescribers on dosing accuracy.

The study, however, also had limitations. The findings cannot be generalised to the entire country but are important to the central region where the participating facilities are situated. The cross-sectional nature of the PPS limits the understanding of trends and seasonal variations in antimicrobial use. The inpatient GPPS tool focuses exclusively on patients receiving antimicrobials, thereby hindering data collection on patients, not on treatment, which limits comparative analysis.

The GPPS protocol supports three yearly surveys, which can help study trends and identify seasonal variations in antimicrobial prescribing.

The study had several strengths. Data collection was conducted using standardised GPPS protocols and tools. The web-based tools are user-friendly and have evidence of consistency, validity and reproducibility.<sup>11,63</sup> All participating health facilities received feedback on their findings for integration into facility-specific AMS work plans and formulation of action plans by Medicine and Therapeutics Committees (MTCs). Additionally, data were collected by trained health professionals working with the hospitals, thereby enhancing capacity for future AMU surveillance. The collected data

may generate longitudinal feedback as additional surveys are conducted, given that facilities were given GPPS accounts and can replicate the surveys. This detailed data allows targeted interventions to be developed based on areas of highest non-compliance and to consider specific focus groups, eg children with URTIs and women having obstetric and gynaecology surgeries. The GPPS allows for targeted assessment after implementing quality improvement projects to ascertain if changes to prescribing practices have been successful.

## Conclusion

This was the first study in Uganda to conduct PPS surveys in lower-level health facilities using the GPPS methodology to the best of our knowledge. There was a high prevalence of antimicrobial use among inpatients and outpatients in the three hospitals and five lower-level health facilities, respectively. Ceftriaxone and Amoxicillin were the most frequently prescribed antibiotics among inpatients and outpatients, respectively. Prophylactic use of antimicrobials exceeded recommended durations among inpatients with high rates of antimicrobial use in obstetrics and gynaecology. Both settings had high compliance with guidelines for prescribing antimicrobials.

There is an urgent need to strengthen existing AMS practices using targeted interventions to control the widespread use of broad-spectrum antimicrobials and the length of antibiotic surgical prophylaxis in hospitals. Surveillance of AMU should be made part of regular data collection activities and scaled to lower-level health facilities. Incorporating these activities into national surveillance can provide national-level results of antimicrobial use to enable better responses for reducing AMR.

## Abbreviations

AMR, Antimicrobial Resistance; AMS, Antimicrobial Stewardship; AMU, Appropriate Medicine Use; CAI, Community-Acquired Infection; CwPAMS, Commonwealth Partnerships for Antimicrobial Stewardship; FDCs, Fixed-Dose Combinations; GPPS, Global Point Prevalence Survey; HIV, Human Immunodeficiency Virus; HMIS, Health Management Information System; IPC, Infection Prevention and Control; IRB, Institutional Review Board; LMICs, Low- and Middle-Income Countries; MP, Medical Prophylaxis; MRSA, Methicillin-Resistant *Staphylococcus aureus*; MTC, Medicines and Therapeutics Committee; SF, Substandard and Falsified; SP, Surgical Prophylaxis; SSA, Sub-Saharan Africa; UCG, Uganda Clinical Guidelines; UNCST, Uganda National Council for Science and Technology; URTI, Upper Respiratory Tract Infection; UTI, Urinary Tract Infection; WASH, Water, Sanitation and Hygiene; WHO, World Health Organisation.

## Data Sharing Statement

All data used in this study are included in the article. For further information, a request can be sent to the corresponding author.

## Ethical Approval

Ethical approval was obtained from the Makerere University School of Health Sciences Institutional Review Board (IRB) (protocol code MAKSHSREC-2023-607), and the study was registered with the Uganda National Council of Science and Technology (UNCST) (registration number HS3736ES). We obtained a waiver of informed consent from patients since the study involved collecting data from patients' medical records. Patient data was handled with strict confidentiality. The data was collected and reported using an anonymised form. The study was also conducted in accordance with the principles stated in the Declaration of Helsinki.

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## Author Contributions

All authors contributed significantly to the work reported regarding conception, study design, implementation, data collection, analysis, and interpretation. All authors have contributed to the drafting and revision of the manuscript. All authors agreed to submit the manuscript to this journal and take full responsibility for the content. All authors have read and agreed to the published version of the manuscript.

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