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Surveillance of antibiotics use in inpatients at Benjamin Mkapa Zonal Referral Hospital in Dodoma, Tanzania: a point prevalence survey

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ABSTRACT

Objective To assess antibiotics prescribing and use patterns for inpatients at Benjamin Mkapa Zonal Referral Hospital (BMH) using the WHO-Point Prevalence Survey (WHO-PPS).

Design A cross-sectional survey.

Setting The Benjamin Mkapa Zonal Referral Hospital, Dodoma, Tanzania.

Participants Inpatient prescriptions, regardless of whether antibiotics were prescribed (n=286) on the day of PPS.

Outcome measures Our study analysed the prevalence of antibiotic use at BMH for inpatients, the type of antibiotics used, the indications for use and the proportion of oral and parenteral antibiotics. We also assessed prescription-prescribed antibiotics after a positive antimicrobial susceptibility testing (AST) result.

Results A survey was conducted on 286 prescriptions, which revealed that 30.07% of them included antibiotics. On average, each prescription contained at least 1.6 antibiotics. All prescriptions that included antibiotics were written in generic names, and 77.91% (67/86) of them followed the Standard Treatment Guidelines. Of the prescriptions that included antibiotics, 58.14% (50/86) had a single antibiotic, 20.93% (18/86) had parenteral antibiotics and 79.07% (68/86) had oral antibiotics. Based on AWaRe's (Access, Watch and Reserve) categorisation of antibiotics, 50% (8/16) were in the Access group, 31.25% (5/16) were in the Watch group, 12.50% (2/16) were in the Reserve group and 6.25% (1/16) were not recommended antimicrobial combinations. Out of 86 prescriptions included antibiotics, only 4.65% showed positive culture growth. However, antibiotics were still prescribed in 29.07% of prescriptions where there was no growth of bacteria, and in 66.28% of prescriptions, antibiotics were prescribed empirically without any requesting of bacteria culture and AST.

Conclusion BMH has reduced inpatient Antibiotic Use by half compared with the 2019 WHO-PPS. Adherence to National Treatment Guidelines is suboptimal. Clinicians should use AST results to guide antibiotic prescribing.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This study evaluated the prescribing and usage patterns of antibiotics among inpatients at the Benjamin Mkapa Zonal Referral Hospital (BMH) in Dodoma, using the WHO-Point Prevalence Survey (WHO-PPS) methodology.
- ⇒ Inpatient prescriptions were collected from the Integrated Health Management Information System (IHMIS) on a day of PPS before 8:00 am.
- ⇒ The PPS methodology did not involve interviewing prescribers, nurses or other medical practitioners.
- ⇒ It is essential to note that this study represents a snapshot survey and does not consider seasonal variations in antimicrobial prescribing and use in patients admitted at BMH.

BACKGROUND

Point Prevalence Surveys (PPS) tool is a standardised assessment method that is used to assess prescribing practices and the use of antimicrobials. The tool identify targets for quality improvement and assess the effectiveness of Antimicrobial Stewardship (AMS) interventions in managing infectious diseases in hospitalised patients.[1 2]

Several countries have conducted antimicrobial use (AMU) surveillance on inpatients, revealing differing trends in adult and paediatric antibiotic use. Malaysia and India have reported AMUs of 74.7% and 74.5% in adult and paediatric wards, respectively.[3 4] According to a multicentre PPS study in Nigeria, up to 80% of prescriptions surveyed included at least one antibiotic. The survey showed that the prevalence of antibiotic use ranged from 72.9% in obstetrics and gynaecology to 94.6% in the paediatric medical specialty.[5] Another sub-Saharan Africa (SSA) country revealed improvement in AMU from a series of PPS. The study found that AMU prevalence was less than 40%, with less than 50% of patients receiving single antibiotics. However, intensive care units had a higher AMU (68.6%) than medical and surgical wards.[6]

In Tanzania mainland, a comprehensive WHO-PPS was conducted in six hospitals in 2019. A cumulative AMU was 62.3%, the highest being 74.3% at Sekou Touré Regional Referral Hospital, and the lowest was 51.3% at Mbeya Zonal Referral Hospital. The AMU at BMH was reported to be 65.75% in the same survey.[7] A PPS conducted at Muhimbili National Hospital (MNH) in 2023 reported a 47% prevalence of AMU. This prevalence was lower than reported from six hospitals in 2019.[8] In Kilimanjaro, Tanzania, a study conducted at Kilimanjaro Christian Medical Centre (KCMC) showed that 51.1% of patients were on ceftriaxone during hospitalisation. Conversely, 6.9% of patients (51.1%) had been on ceftriaxone treatment without evidence of infection. Ceftriaxone use for surgical prophylaxis was 40.7%, of which 72.7% and 20.5% received ceftriaxone prophylaxis before and after surgery, respectively.[9]

The WHO-PPS conducted in six hospitals showed lower ceftriaxone use, 30.9%, and reported a commonly used metronidazole, 22.9%, for surgical prophylaxis.[7] In 2023, the most widely prescribed antibiotic combination at MNH was ceftriaxone–metronidazole, followed by ampicillin, cloxacillin and gentamicin. Ceftriaxone remained the most frequently prescribed antibiotic, accounting for 28% of prescriptions, followed by metronidazole (24%) and amoxicillin–clavulanic acid (11%), compared with studies conducted between 2019 and 2023.[8] During a PPS conducted in Northern Nigeria, the most commonly prescribed antibiotics were metronidazole (30.5%), ciprofloxacin (17.1%), ceftriaxone (16.8%), amoxicillin–clavulanate (12.5%) and gentamicin (11.8%).[5]

After the first WHO-PPS report in 2019 highlighting the high AMU at BMH,[7] antimicrobial stewardship programmes (ASPs) were strengthened to improve antibiotic prescribing and use. However, subsequent PPS assessments have yet to be carried out to gauge the effectiveness of these interventions. Various measures were taken to promote the proper use of antibiotics in hospitalised patients, such as creating a hospital formulary, conducting prescription audits, ensuring access to antimicrobial susceptibility testing (AST) services and developing a prescribing guide for empirical use and prophylaxis of antibiotics. This study uses WHO-PPS to examine antibiotic prescribing and usage patterns for inpatients at BMH. Comparing the prevalence of antibiotic use in the PPS conducted in 2019 is essential for gaining valuable insights and making informed decisions.

METHOD AND MATERIAL

Study site, designs and duration

On 8 May 2023, a cross-sectional survey was conducted at Benjamin Mkapa Hospital in Dodoma, Tanzania, to evaluate the AMU among in-patients. The survey used the WHO-PPS tool. Benjamin Mkapa Hospital is a Tertiary Referral Hospital (level S) with a capacity of up to 400 beds.

Study population inclusion and exclusion criteria

On 8 May 2023, surveillance was conducted at around 8:00 am to examine prescriptions for antibiotics administered through oral, parenteral, rectal or inhalation routes. As per the WHO PPS methodology, hospitals with less than 500 total inpatient beds, such as BMH with 400 beds, are recommended to survey all eligible patients.[1] Prescriptions of patients admitted to non-acute wards and those who started or concluded antibiotic therapy after or before 8:00 am, respectively, on the survey day were excluded.

Sampling method and sample size

The data for this study were collected directly from the wards under the guidelines provided by the WHO-PPS.[1] The entire data collection process was completed within a single day of surveillance. Out of the total bed capacity 400 at BMH, 286 beds (patients) met the inclusion criteria for the study. The remaining beds were either unoccupied or did not meet the requirements to be included in the study.

Data collection

The principal investigator and coinvestigators conducted training sessions for data collectors, who were pharmacists, at BMH over 2 days. The training focused on familiarising the participants with the WHO-PPS tool. The training emphasised critical areas such as understanding the WHO-PPS tools, collecting essential elements and highlighting the importance of maintaining the privacy and confidentiality of patients and healthcare providers. After the training, a pilot study was conducted to assess comprehension of the tool.

Relevant data were extracted from prescription order forms stored in the Integrated Health Management Information System (IHMIS) to gather information about antimicrobial medicines prescribed to inpatients before 8:00 a.m. on the days of the PPS. All prescription order forms of patients who met the eligibility criteria were reviewed, regardless of whether they received antibiotic treatment. Antibiotics were classified using the Anatomical Therapeutic Chemical (ATC) methodology and the 2019 WHO AWaRe (Access, Watch and Reserve) classification of antibiotics.[10 11]

The study focused on various aspects such as the percentage of antibiotic use, the classification of antibiotics based on the WHO AWaRe system, the wards where the antibiotics were used, the indications for prescribing antibiotics and the patients' demographic information. It is important to note that this study did not involve patient interviews, and neither clinicians nor health facility staff were interviewed. Only information technology officers and nurses were involved in retrieving the medical records from IHMIS.

Data management and analysis

All relevant data were collected and entered into a Microsoft Excel spreadsheet for thorough cleaning, a crucial step in ensuring the accuracy of our findings, before exporting it to Statistical Package for Social Sciences Software (SPSS V.20.0) for analysis. Tables were used to present the data for dissemination and publication. The critical variables collected followed the specifications outlined in the WHO-PPS methodology and WHO guidelines for investigating the rational use of medicines.[1 12] These variables included information in wards, patients and prescribed antibiotics.

Patient and public involvement statement

None. The WHO-PPS conducted at BMH was one of ASP's interventions to assess antibiotic prescribing and usage patterns following the first PPS undertaken in 2019[7] and the implementation of the Tanzania National Action Plan on AMR (2017–2022).[13]

RESULTS

Demographic description of prescriptions in inpatient antibiotics

Our research study involved gathering and analysing data from 286 patient prescriptions. The medical ward had the highest number of patients surveyed among all the wards, accounting for 116 (40.56%) of the total. In contrast, the ICU and cardiology wards had the lowest number of patients surveyed during the PPS, with only 10 (3.50%) and 15 (5.25%) prescriptions, respectively. More information can be found in online supplemental table 1.

Proportion of antibiotics prescription for inpatients

The average length of hospital stay for each patient was 4 days. Out of all the prescriptions reviewed, 86 (30.07%) included antibiotics (as given in table 1). Only 19 (22.09%) prescriptions did not follow the current Standard Treatment Guidelines/Essential Medicines List (SGT/NEMLIT). Among the 86 prescriptions that included antibiotics, 4 (4.65%) were prescribed after positive AST results, 25 (29.07%) were prescribed despite negative AST results and 57 (66.28%) were prescribed empirically. Out of prescriptions (86) containing antibiotics, 79% were oral antibiotics, and 21% were parenteral antibiotics. Notably, 14 prescriptions (16.28%) involved antibiotics prescribed for surgical prophylaxis for more than 1 day. Table 1 provides further details.

Commonly prescribed antibiotics at BMH and their respective AWaRe categorisation

A total of 137 antibiotic items were prescribed. After analysis, 16 unique and frequently prescribed antibiotics were identified. These antibiotics were categorised according to AWaRe's classification, with 50% (8/16) belonging to Access, 31.25% (5/16) to Watch, 12.50% (2/16) to Reserve and 6.25% (1/16) to the category of not-recommended antibiotics combination. The most prescribed antibiotics were metronidazole (18%), ceftriaxone (14%), amoxicillin–beta-lactamase inhibitor (13.14%) and ampicillin/cloxacillin (10.22%), as given in table 2.

Classes of antibiotics prescribed at BMH

The study results indicate that derivatives of Penicillin were prescribed the most, at 34.31%, followed by nitroimidazole at 26.28% and third-generation cephalosporin at 14.6%. On the other hand, aminoglycosides, tetracycline, first-generation cephalosporin, lincosamides and carbapenems were the least prescribed, accounting for less than 1%, as shown in online supplemental table 2.

Indication of antibiotics prescribing for inpatients at BMH

The most common reasons for prescribing antibiotics to inpatients in our study were urinary tract infections (UTIs, 24%), surgical prophylaxis (22%) and acute upper respiratory infections (17%), as given in table 3.

Antibiotic prescriptions and antimicrobial susceptibility testing

Out of the 86 total antibiotic prescriptions, 29 were prescribed after conducting an AST on the collected sample. This accounts for 33.72% of the prescriptions. Surprisingly, only 4 of the 86 prescriptions (4.65%) were tailored to the specific patient based on the positive AST results. Meanwhile, 29.07% (25/86) of the prescriptions were prescribed despite negative AST results. The remaining 57 (66.28%) of the prescriptions were prescribed empirically. For more information, refer to tables 1, 4 and 5.

DISCUSSION

At the Benjamin Mkapa Hospital (BMH), since 2019, several improvements have been aimed at optimising AMU and enhancing infection prevention. The improvements include training for healthcare providers such as prescribers, pharmacists, nurses and laboratory scientists on AMS, consumption and susceptibility testing. The institution has also emphasised its infection prevention and control programme. During the implementation of the National Antimicrobial Action Plan of Antimicrobial Resistance (NAP-AMR 2017–2022), the Hospital Medicines Therapeutics (HMT), AMS and Infection Prevention and Control (IPC) committees were revitalised, and their members were trained with the help of the Tanzania Ministry of Health and other stakeholders. The AST programme in the microbiology laboratory has been strengthened to monitor prescribing antibiotics for empirical treatment and surgical prophylaxis to ensure a definite use of antibiotics, particularly in Watch and Reserve antibiotic categories. In 2021, BMH wrote the first hospital formulary emphasising monitoring prescriptions and the use of antibiotics. Biannual clinical auditing and prescription reviews are conducted to assess the best

Table 1 Antibiotics prescribing for inpatients at BMH (n=286)

		N (%)
n=286		
Proportion (%) of prescriptions with antibiotics prescribed		86 (30.07)
Proportion (%) of prescriptions with no antibiotics prescribed		200 (69.93)
n=86		
Proportion (%) of prescriptions prescribed single antibiotics		50 (58.14)
Proportion (%) of prescriptions prescribed two antibiotics		25 (29.07)
Proportion (%) of prescriptions prescribed three antibiotics		11 (12.80)
Route of antibiotics prescribed, n=86		
Oral antibiotics		68 (79.07)
Parenteral antibiotics		18 (20.93)
Proportion (%) of prescriptions with antibiotics and indication recorded		86 (100.00)
Proportion (%) of prescriptions with antibiotics and no indication recorded		0 (0.00)
Proportion (%) of prescriptions compliant with Standard Treatment Guidelines/Essential Medicines List (SGT/NEMLIT)		67 (77.91)
Proportion (%) of prescriptions not compliant with SGT/NEMLIT		19 (22.09)
Proportion (%) of prescriptions with surgical prophylaxis with a single(stat) dose		3 (3.49)
Proportion (%) of prescriptions with surgical prophylaxis prescriptions (%) with a duration of 1 day (24 hours)		2 (2.33)
Proportion (%) of prescriptions with surgical prophylaxis prescriptions (%) with duration >1 day		14 (16.28)
Proportion (%) of prescriptions with empirical use of antibiotics		57 (66.28)
Proportion (%) of prescriptions prescribed after performing culture and AST		29 (33.72)
Proportion (%) of prescriptions with definite use of antibiotics with AST-positive results		4 (4.65)
Proportion (%) of prescriptions with the use of antibiotics with AST-negative results		25 (29.07)
Proportion (%) of prescriptions with antibiotics prescribed according towards	Medical ward	37 (43.02)
	Surgical ward	22 (25.58)
	Paediatrics ward	13 (15.12)
	Obstetrics and gynaecology ward	7 (8.14)
	Cardiology ward	4 (4.65)
	ICU ward	3 (3.88)
Drug utilisation 90% (DU90%) $\frac{\text{(number of all antibiotic items prescribed using generic names (137))}}{\text{(total number of all antibiotic items prescribed (137))}} \times 100$		N/A (100)
The average number of antibiotics per prescription $\frac{\text{(total number of all prescribed antibiotic items (137))}}{\text{(total number of all prescriptions with antibiotics (86))}}$		1.6 (N/A)

AST, antimicrobial susceptibility testing; BMH, Benjamin Mkapa Zonal Referral Hospital; ICU, intensive care unit; N, number of surveyed prescriptions; N/A, not applicable.

prescribing, dispensing and the use of antibiotics at BMH and assess adherence to clinical standards and guidelines.

In 2019, a WHO-PPS surveillance was conducted across six hospitals in mainland Tanzania, including BMH.[7] Our current surveillance found that 30.07% of admitted patients are prescribed antimicrobials, which is half the rate reported in 2019 (65.6%),[7] and it is substantially lower than the 2018 global data obtained from Global-PPS, which was 34.4%.[14] In comparison with some of the multicentre studies done in SSA and Southern Asia, the highest prevalence of AMU was reported in Northern Nigeria was 80.1% in 2020;[5] the subsequent analysis performed in Sri Lanka and two in Ghana in 2021 revealed the highest use of antibiotics in hospitalised patients 35.1%, 60.5% and 54.9%, respectively,[15–17] while a study in South Africa reported 49.7%.[18] In 2022, several studies in Africa also reported a high prevalence of AMU; for instance, Egypt, Uganda, Ghana, Zambia, Kenya and South Africa were 79%, 74%, 64%, 59.0%, 46% and 21.5%, respectively.[19–24] Compared with our study, the above point-prevalence surveys conducted in Africa in 2022 showed a higher prevalence, up to three times. Recently in 2023, Tanzania National Hospital conducted a PPS, which shows a high prevalence of antibiotic use by 47%.[8] Other surveillances

Table 2 Commonly prescribed antibiotics at BMH and their respective AWaRe categorisation (n=137)

Rank	AWaRe categories	ATC code	Antibiotics prescribed	RoA	N (%)
1	Access	J01XD01	Metronidazole 200 mg*	O	25 (18.25)
2	Watch	J01DD04	Ceftriaxone 1000 mg	P	20 (14.60)
3	Access	J01CR02	Amoxicillin–beta-lactamase inhibitor 625 mg, 375 mg, 156.25 mg/5mLs, 228 mg/5mLs*	O	18 (13.14)
4	Access	J01CA51	Ampicillin/cloxacillin 500 mg, 250 mg/5mLs	O	14 (10.22)
5	Access		Flucloxacillin–amoxicillin 500 mg	O	13 (9.49)
6	Access	J01XD01	Metronidazole 500 mg*	P	11 (8.03)
7	Watch	J01FA10	Azithromycin 250 mg, 500 mg	O	8 (5.84)
8	Watch	J01MA02	Ciprofloxacin 500 mg*	O	7 (5.11)
9	Watch	J01FA09	Clarithromycin 500 mg	O	6 (4.38)
10	Not recommended		Norfloxacin/tinidazole	O	5 (3.65)
11	Access	J01XE01	Nitrofurantoin 100 mg	O	2 (1.46)
12	Access	J01CR02	Amoxicillin–beta-lactamase inhibitor 1200 mg*	P	1 (0.73)
13	Access	J01DB01	Cephalexin 250 mg, 500 mg	O	1 (0.73)
14	Access	J01AA02	Doxycycline 100 mg	O	1 (0.73)
15	Access	J01CE02	Phenoxymethylpenicillin 250 mg	O	1 (0.73)
16	Watch	J01MA02	Ciprofloxacin 500 mg*	P	1 (0.73)
17	Watch	J01GB03	Gentamycin 40 mg/1 mL	P	1 (0.73)
18	Reserve	J01DH02	Meropenem 1000 mg	P	1 (0.73)
19	Reserve	J01FF01	Clindamycin 150 mg	O	1 (0.73)
AWaRe categorisation of antibiotics (16 antibiotics molecules, denominator)					
1	Access (A)				8 (50.00)
2	Watch (W)				5 (32.25)
3	Reserve (R)				2 (12.50)
4	Not recommended				1 (6.25)

The AWaRe categorisation is based on the Standard Treatment Guideline of the Tanzania Mainland.
*Repeated antibiotic items are counted once since they are the same molecule.
ATC, Anatomical Therapeutic Chemical; AWaRe, Access, Watch and Reserve; BMH, Benjamin Mkapa Zonal Referral Hospital; N, number of total antibiotic items from all prescriptions surveyed; O, orally; P, parenteral; RoA, route of administration.

from low-income and middle-income countries (LMICs) have discovered 78.8%,[25] 76.2%,[26] 44.0%,[27] 50.0%[28] and 35.5%[6] proportion of use of antibiotics, which were higher as reported in our study.

Our findings indicate improvements and good practices in antimicrobial prescribing at BMH. Antimicrobial use at BMH in this study is also lower compared with a single centre in a recent study in Northwest Tanzania, which reported 94.8%.[29] Compared with this research, the observed differences may be because most PPS were conducted in multiple hospitals while a few were single-centre studies. Hence, the final prevalence was an average value from individual proportions. Fortunately, only one study done in South Africa in 2022[23] has a lower value than ours, whereas the rest show a high prevalence of AMU in admitted patients. However, our finding is higher than WHO's recommended 20%–26.8% prevalence for AMU in admitted patients.[12 30–32]

Furthermore, our results are lower than the regional AMU data for East and South Asia, which is 37.5%.[7 14] Our study has found a higher prevalence of AMU than that reported in a survey conducted in England (6.3%) and one across multiple medical care facilities in Japan (1.5%).[33] The lower occurrence of AMU in developed nations significantly differs from the prevalence of antibiotics used in LMIC like Tanzania. Compared with our research and others from LMICs, higher income countries such as Japan and England have better health service regulations and guidelines supporting rational prescribing, sustainable vaccination programmes and infection prevention and control programmes. These guarantees evidence-based prescribing of empirical and surgical antibiotic prophylaxis.

The ratio of antibiotics per prescription is 1.6 at BMH, which is within the recommended threshold of 1.6–1.8 antibiotics per prescription.[30 31] This ratio is less than the one found in northwest Tanzania, which is 2 (±0.5).[29] The WHO recommends that over 90% of prescribed medicines be written in generic names (DU90%).[33] In our study, all antibiotics were prescribed in generic names,

Table 3 Indication of antibiotics prescribing for inpatients at BMH (n=86)

Rank	Indications	N (%)
1	Urinary tract infection	21 (24.42)
2	Surgical prophylaxis	19 (22.09)
3	Acute upper respiratory infection	15 (17.44)
4	Bacterial pneumonia	9 (10.47)
5	Bacteria sepsis	9 (10.47)
6	Septicaemia	3 (3.49)
7	Gastroenteritis and colitis	3 (3.49)
8	*Helicobacter pylori*	2 (2.33)
9	Cough	2 (2.33)
10	Sickle cell disease	1 (1.16)
11	Trichomoniasis	1 (1.16)
12	Acne	1 (1.16)

BMH, Benjamin Mkapa Zonal Referral Hospital; N, number of surveyed prescriptions with antibiotics.

which aligns with BMH's best practice. This is made possible by utilising the IHMIS in prescribing. Moreover, BMH has a hospital formulary that guides the forecasting, quantification, procurement, prescribing, dispensing and use of medicines, including antibiotics.[34] Our findings emphasise the importance of adopting an integrated online system and hospital formulary to assist rational prescribing.

According to the WHO, the appropriate usage rate of injected antibiotics should fall between 13.4% and 24.1%.[30 31] Our study found that parenteral antibiotic use is within range at 21%. Despite being a tertiary super-specialised zonal referral hospital, BMH had lower parenteral antibiotic use compared with regional referral hospitals in Tanzania, which was at 91.8%.[29] Physicians often prefer injections and believe parenteral antimicrobials are superior, but good evidence is lacking.[35]

For many indications and circumstances, opting for parenteral therapy may not be the most beneficial choice, and the risks are well established. Parenteral to oral antimicrobial conversion obviates these negative impacts and is recognised as a critical parameter for hospital stewardship processes.[3 35] It is generally not recommended to use parenteral medicines frequently due to their high cost, strict administration protocols and the requirement for patients to be admitted. However, there are some clinical situations where parenteral antibiotics are preferred. These include severe infections, life-threatening conditions, oral intolerance, age, type of clinical condition, microbial susceptibility and the availability of dosage forms.[36]

Metronidazole was the most commonly prescribed antibiotic in a Ghanaian hospital, consistent with previous studies.[3] Also, these findings are supported by data from

Table 4 Prescriptions with antibiotics prescribed based on positive AST results

S. no	Sample	Bacteria	Tested antibiotics	AST results	Antibiotics prescribed	Indication
1	Pus	*Escherichia coli*	amikacin, imipenem, amoxicillin–clavulanic acid, piperacillin/tazobactam, ciprofloxacin and levofloxacin	S	Amoxicillin–clavulanic acid	Bacteria sepsis
			gentamicin, cefazolin, cefuroxime, ceftazidime ceftriaxone and sulfamethoxazole/trimethoprim	R		
2	Urine	*Pseudomonas aeruginosa*	amikacin, piperacillin/tazobactam, meropenem and ciprofloxacin	S	Nitrofurantoin	Urinary tract infection
			gentamicin	I		
			sulfamethoxazole/trimethoprim, imipenem, cefotaxime, cefepime, amoxicillin–clavulanic acid and ampicillin	R		
3	Pus	*Morganella morganii*	chloramphenicol, gentamicin and piperacillin/tazobactam	S	Gentamycin	Bacteria sepsis
			amikacin, ampicillin, amoxicillin–clavulanic acid, cefotaxime, cefuroxime, ciprofloxacin, imipenem, meropenem and sulfamethoxazole/trimethoprim	R		
4	Blood	*Staphylococcus species*	chloramphenicol	S	Ampicillin/cloxacillin	Bacteria sepsis
			gentamicin	I		
			oxacillin, ciprofloxacin, erythromycin, sulfamethoxazole and trimethoprim	R		

AST, antimicrobial susceptibility test.

Table 5 Antibiotics prescribed to inpatients at BMH despite negative AST results

No.	Sample	Bacteria	Antibiotics prescribed	Indication
1	Blood	No growth	amoxicillin–clavulanic acid	Upper respiratory infection
2	Blood	No growth	amoxicillin–clavulanic acid metronidazole, ceftriaxone	Bacteria sepsis
3	Blood	No growth	ceftriaxone	Upper respiratory infection
4	Blood	No growth	amoxicillin–clavulanic acid metronidazole, ceftriaxone	Bacteria sepsis
5	Blood	No growth	metronidazole, ceftriaxone	Surgical prophylaxis
6	Blood	No growth	amoxicillin–clavulanic acid metronidazole, ceftriaxone	Bacteria sepsis
7	Blood	No growth	metronidazole, ceftriaxone	Surgical prophylaxis
8	Blood	No growth	meropenem	Bacterial sepsis
9	Blood	No growth	ceftriaxone, metronidazole	Septicaemia
10	Blood	No growth	amoxicillin–clavulanic acid	Bacteria pneumonia
11	Blood	No growth	flucloxacillin–amoxicillin	Upper respiratory infection
12	Blood	No growth	clindamycin	Bacteria sepsis
13	Urine	No growth	azithromycin	Urinary tract infection
14	Urine	No growth	ciprofloxacin	Urinary tract infection
15	Urine	No growth	amoxicillin–clavulanic acid	Urinary tract infection
16	Urine	No growth	amoxicillin–clavulanic acid	Urinary tract infection
17	Urine	No growth	azithromycin	Urinary tract infection
18	Urine	No growth	ciprofloxacin	Urinary tract infection
19	Urine	No growth	amoxicillin–clavulanic acid	Urinary tract infection
20	Urine	No growth	amoxicillin–clavulanic acid	Urinary tract infection
21	Urine	No growth	metronidazole, ceftriaxone	Bacteria pneumonia
22	Urine	No growth	amoxicillin–clavulanic acid	Urinary tract infection
23	Urine	No growth	nitrofurantoin	Urinary tract infection
24	Urine	No growth	ciprofloxacin, metronidazole flucloxacillin–amoxicillin	Urinary tract infection
25	Urine	No growth	amoxicillin–clavulanic acid	Urinary tract infection

AST, antimicrobial susceptibility test; BMH, Benjamin Mkapa Zonal Referral Hospital.

the study by Pauwels *et al* across 69 countries, where ceftriaxone was the most commonly used antibiotic for therapeutic use in adult wards worldwide.[37] Other studies reported that up to 24% of prescriptions for surgical prophylaxis in SSA were for metronidazole, followed by ceftriaxone (23%).[3] According to a report by PPS at the Korle-Bu Teaching Hospital in Ghana (2018), metronidazole was the most frequently prescribed antibiotic, followed by amoxicillin–clavulanic acid, cephalosporins (ceftriaxone, cefuroxime) and cloxacillin.[38] A PPS in Kenya also recorded a higher use of nitroimidazoles than beta-lactam antibiotics.[39] The same has been seen in three hospitals in North-Eastern Tanzania, reporting penicillin (43%) and metronidazole (10%) as the most prescribed antibiotics.[40] Data on using third-generation cephalosporin at BMH are optimal compared with the report from KCMC, Northern Zone Hospital in 2018. The use of ceftriaxone was 51.1%, especially in surgical prophylaxis.[41 42] Surgical prophylaxis and empirical treatment use of ceftriaxone are the cardinal indications; these and the most highly prevalent use of it have been revealed in previous publications in Ethiopia and Uganda and our study.[40 43] Metronidazole is commonly used in combination with other antimicrobials for surgical procedures due to its effectiveness in anaerobic infections. Additionally, it is more affordable, accessible and suitable for co-administration with other antibiotics, which could be the reason for its higher use and prescription, as observed in many studies.[44 45]

Our study found that oral antibiotics are the most prescribed form, accounting for 79% of prescriptions. Among the top 10 most prescribed antibiotics, only ceftriaxone was administered parenterally and frequently prescribed, while the rest were administered orally. The excessive use of ceftriaxone was attributed to the lack of local surgical prophylactic guidelines. Additionally, its low cost, easy availability and compatibility with other antibiotics like metronidazole could be some reasons for its frequent use. Medical wards had the highest number of patients on antibiotics, comprising 37 (43.02%) of all cases. The surgical and paediatric wards have 22 (25.58%) and 13 (15.12%) prescriptions, respectively. Our study revealed that antibiotics were used less frequently in the ICU, surgical and paediatric wards compared with medical and surgical wards. However, our findings were consistent with the overall results of antibiotic surveillance in Tanzania. The medical, surgical and paediatric wards were found to have the highest antibiotic usage rates.[3]

According to the AWaRe categorisation of antibiotics, 8 out of 16 antibiotic molecules (50%) were categorised as 'Access', which means they should be available at all times. Five antibiotic molecules (32.25%) were categorised as 'Watch', which should be used cautiously and monitored closely. Two antibiotic molecules (12.50%) were categorised as 'Reserve', which means they should only be used as a last resort. One was not recommended antibiotc combination (6.25%). A PPS study conducted in multiple centres in Tanzania revealed that 62% of prescriptions for inpatients were from the 'Access' group.[7 44 46 47] In the Maruki Memorial Welfare Medical Centre, Access prescriptions accounted for 36.0% of the antibiotics, and 58.4% were Watch antibiotics. A PPS analysis of 69 countries estimated that ~35% of patients use of Access antibiotics category, while drugs in East and South Asian hospitals and Watch antibiotics account for 60%, similar to our findings.[33 37] Hence, BMH did not meet the WHO thresholds of prescribing and using access antibiotics above 60%,[47–49] which led to the high use of Watch class. This can be explained by the fact that most BMH patients are referrals from regional referral hospitals in the Central Zone of Tanzania. Thus, most patients are have already been on treatment with Access group antibiotics as the first line when admitted.

According to the results of our PPS study, the highest prescribed antibiotics are penicillin derivatives at 47 (34.31%), followed by nitroimidazole at 36 (26.28%) and third-generation cephalosporins at 20 (14.6%). On the other hand, aminoglycosides, tetracyclines, first generation cephalosporin, lincosamides and carbapenems were the least prescribed antibiotics, accounting for less than 1% of all antibiotics. Another study by Ishibashi and colleagues found that sulfamethoxazole/trimethoprim (sulphonamides) was the most commonly prescribed antibiotic, accounting for 20% of systemic antibiotic prescriptions (ATC J01).[33] The most defined group of systemic antibiotics was non-penicillin beta-lactam antibiotics (34.4%), followed by penicillin antibiotics in combination with beta-lactamase inhibitors (25.6%) and sulphonamides with trimethoprim (20.8%). These differences were due to the high use of individual medicines, such as metronidazole and other penicillin derivatives.

In our survey, UTIs account for 24%, surgical prophylaxis for 22% and acute upper respiratory infections are the third leading indication at 17%. The least common medical conditions for antibiotic use were sickle-cell disease, acne and trichomoniasis, each representing 1%. In contrast to other studies, the most common diagnosis for systemic antibiotic prescribing was pneumonia at 49.6%.[33] Previous studies in various countries, including Tanzania, noted that antimicrobials were most often prescribed for surgical prophylaxis, making up 12%–18%.[44] Compared with the Malaysian nationwide survey, pneumonia was a common indication for antimicrobial treatment (19.6%).[50] Our study found that 20% of surveyed prescriptions for surgical prophylaxis antibiotics were used for >24 hours, less than previously reported (52.8%–77% recommended is 24%–26%).[3]

Out of 86 antibiotic prescriptions, 33.72% (29/86) of them are based on the results of an AST to guide the selection of antibiotics for treatment. Only 4.65% (4/86) of all samples taken showed a positive culture growth, and the AST was performed to aid in the selection of antibiotics for definite treatment. Surprisingly, in 29.07% (25/86) of the prescriptions, there was no growth, yet antibiotics were still prescribed to patients. In the remaining 66.28% (57/86) of the prescriptions, antibiotics were prescribed empirically, no AST was done and some were continued regardless of the microbes' resistance profile to the tested antibiotics. The majority of prescriptions, about 71%, were based on microbiologically confirmed treatments and resulted in direct and targeted prescribing (71.4%), as stated in previous evidence.[3] When it comes to septicaemia and severe UTIs, many prescribers at BMH tend to choose antibiotics and treat them empirically, even when the AST results are negative. This practice is influenced by limited resources for testing, including the availability of specific discs and prolonged turn-around time. Clinicians rely on their experience, clinical manifestation and previous medical history (medical reconciliation) to select antibiotics, regardless of outcome AST results. According to our research, only 78% of AMU and prescribing aligns with the current treatment guidelines, which should ideally be 100%.[30 31] This is due to the lack of proper institutional antimicrobial prescribing. Antibiograms are important tools in guiding appropriate antibiotic prescribing, but they are not always utilised as they should be. This can lead to antibiotics being prescribed based on the clinician's experience and the clinical presentation of the disease, rather than on more accurate and specific information. Furthermore, there is often a shortage of antibiotics in hospital pharmacies, resulting in prescribing whatever is available in stock, rather than the most appropriate and effective medication for the patient's condition.

Limitation

Our study has certain limitations. The PPS methodology did not involve interviewing prescribers, nurses or other medical practitioners. Also, the data were only collected until 8:00 a.m. on the PPS day, which is a constraint. It is important to remember that this study only represents a snapshot survey and does not consider seasonal variations in antimicrobial prescribing and use in patients admitted to the hospital.

Conclusion and recommendations

The BMH has significantly improved the AMU for inpatients, with a 30% reduction in usage compared with the previous WHO-PPS report in 2019. However, the hospital must improve adherence to the National Treatment guidelines. We recommended conducting serial WHO-PPS annually to address different seasons and ensure enough evidence is available to strengthen advanced ASPs. These findings will contribute to developing antibiotic prescribing policies for empirical treatments and surgical prophylaxis. Clinicians are advised to use AST results to foster antibiotic prescribing more effectively. Further studies are recommended to explore rational prescribing for UTIs and surgical prophylaxis, along with capacity building to improve the yield of samples for Culture and AST to tailor antibiotic selection and prescribing.

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Ethics approval This study involves human participants. The study received an ethical clearance certificate with reference number NIMR/HQ/R.8a/Vol.IX/4260 from the National Institute for Medical Research, National Health Research Ethics Review Committee (NatHREC), in Dar Es Salaam, United Republic of Tanzania. The study was also granted permission to be conducted in Benjamin Mkapa Hospital, Dodoma, United Republic of Tanzania. We reviewed written prescriptions for inpatients without interviewing patients, nurses or other medical personnel. This is based on the Point Prevalence Survey Tool.

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Supplementary Table 1: Demographic description of prescriptions in-patients (N=286)

Variable		**n (%)**
Sex	Male	129(45.11)
	Female	157(54.89)
Patients age groups The average age of patients is 40.32±20.64	<2 years	11(3.85)
	3-5 years	5(1.75)
	6-14 years	8(2.80)
	15-20 years	11(3.85)
	21-45 years	139(48.60)
	>46 years	112(39.16)
Wards	Medical	116(40.56)
	Surgical	92(32.17)
	Paediatrics	30(14.48)
	Obstetrics and gynaecology	23(8.04)
	Cardiology	15(5.25)
	ICU	10(3.50)

N- Number of surveyed prescriptions

Supplementary Table 2: Classes of antibiotics prescribed for In-patients (N=137)

Rank	**ATC CODE**	**Classes**	**N (%)**
1.	J01CR	Penicillins	47(34.31)
2.	J01XD	Nitroimidazole	36(26.28)
3.	J01DD	3rd Generation Cephalosporins	20(14.60)

4.	J01MA	Flouroquinolones	15(10.95)
5.	J01FA	Macrolides	14(10.22)
6.	J01GB	Aminoglycosides	1(0.73)
7.	J01AA	Tetracycline	1(0.73)
8.	J01DB	1st Generation Cephalosporins	1(0.73)
9.	J01FF	Lincosamides	1(0.73)
10.	J01DH	Carbapenems	1(0.73)

N-Number of total antibiotics items in each class from all surveyed prescriptions.