JAC Antimicrob Resist
https://doi.org/10.1093/jacamr/dlad093

JAC-
Antimicrobial
Resistance

WHO/INRUD prescribing indicators among tertiary regional referral hospitals in Dar es Salaam, Tanzania: a call to strengthen antibiotic stewardship programmes

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Received 22 November 2022; accepted 17 July 2023

Background: Antibiotic prescribing should be guided by national essential medicines lists (NEMLs) and treatment guidelines; however, there are inadequate data on antibiotic utilization patterns in tertiary hospitals in Tanzania. This study aimed to determine antibiotic prescribing patterns in tertiary hospitals in Dar es Salaam, Tanzania.

Methods: A retrospective cross-sectional study was conducted in three regional referral hospitals. About 200 prescription records from 2020 to 2022 were analysed at each hospital for prescribing patterns using WHO/International Network of Rational Use of Drugs (INRUD) indicators (1993) and the AWaRe 2021 classification. Factors associated with receiving an antibiotic prescription were assessed using a logistic regression model. Facilities were ranked on prescribing practices using the index of rational drug prescribing (IRDP).

Results: A total of 2239 drugs were prescribed, of which 920 (41.1%) were antibiotics. An average of 3.7 ± 1.5 (optimal: 1.6–1.8) total medicines and 1.53 ± 0.78 antibiotics were prescribed per patient. About 88.0% (528) of the prescriptions contained antibiotics (optimal: 20.0%–26.8%), while 78.2% (413) of all antibiotic prescriptions contained injections (optimal: 13.4%–24.1%). Furthermore, 87.5% (462) of the antibiotics were prescribed in generic names (optimal: 100%), while 98.7% (521) conformed to the NEML (optimal: 100%). Metronidazole was the most frequently prescribed antibiotic (39.2%; $n=134$), followed by ceftriaxone (37.1%, $n=127$) and amoxicillin/clavulanic acid (8.5%, $n=29$).

Conclusions: We found substantial empirical prescribing and overuse of antibiotics exceeding WHO recommendations. Antibiotic overuse varied across the hospitals. Being male, having underlying conditions such as diabetes mellitus, and/or being treated at Temeke hospital were associated with receiving an antibiotic prescription. We recommend strengthening antibiotic stewardship programmes in the studied facilities.

Introduction

Appropriate use of antibiotics is one of the most cost-effective interventions to curb the burden of infectious disease caused by bacteria.[1] However, misuse of antibiotics has substantially resulted in the emergence of resistant bacterial strains.[2] Consequently, resistant bacteria threaten the progress achieved over the past decade in preventing and controlling infectious diseases.[3] Resistant bacteria result in health and financial burdens due to the need for more expensive antibiotics to cure common infections and an extended hospital stay.[4]

Modelling estimates indicate a substantial rise in antibiotic consumption rates globally between the years 2000 and 2018.[5] Another report shows an increasing trend of antibiotic use in low- and middle-income countries (LMICs) compared with high income countries (HICs).[6] Regarding antibiotic classes, the same report shows an increased use of reserved antibiotics such as glycylcyclines, oxazolidinones, carbapenems and polymyxins.[6]

Despite the presence of antibiotic prescription guidelines and standards for guiding prescription practice from primary to tertiary facility levels,[7] research findings indicate significant misuse of common antibiotics across LMICs, including Tanzania,[8] though it has a National Essential Medicines List (NEML) and treatment guidelines on antibiotic use across all levels of healthcare settings.[7] A previous study among primary healthcare facilities in Dar es Salaam, Tanzania, found an average of two medicines being prescribed per consultation.[9] The same report shows that more than half (51.9%) of all prescribed medicines in primary healthcare facilities were antibiotics.[9] A recent report show an increased use of non-recommended antibiotic combinations in the country.[10]

The WHO advocates regular monitoring of antibiotic use.[11] In 1993, the WHO and the International Network of Rational Use of Drugs (INRUD) developed indicators for monitoring drug use in health settings.[12] However, there is inadequate information on antibiotic prescribing practices in Tanzania, especially from tertiary hospitals. Therefore, this study reports the status of antibiotic core prescribing indicators and utilization patterns among patients attending selected tertiary hospitals in Dar es Salaam, Tanzania. These findings may contribute to the development of effective antimicrobial stewardship (AMS) programmes.

Methods

Study design, settings and population

A retrospective cross-sectional study was conducted in three tertiary regional referral hospitals in Dar es Salaam, Tanzania in 2022. Prescription records kept from July 2020 to July 2022 were analysed to assess the antibiotic prescribing practices in the studied hospitals. The Dar es Salaam region is found along the Indian Ocean and is bordered by one administrative region (the Coast region).[13] Furthermore, Dar es Salaam is the biggest city and the former capital of Tanzania, with an approximate population of five million people (almost 10% of the country's population).[14] The Dar es Salaam region has five administrative districts with a total of three public referral regional hospitals (Amana, Temeke and Mwananyamala). In general, primary and referred patients (inpatients/outpatients) were eligible to participate in this study.

Sample size and sampling techniques

WHO recommends at least 600 encounters to be included in a cross-sectional survey of prescribing patterns.[12] This study was conducted in tertiary hospitals located in the Dar es Salaam region. Multistage sampling was employed to systematically sample patients' files (records) to obtain a minimum sample size of 600 prescriptions required for this study. A sampling interval was obtained by dividing the total proportional number of patients required for this study by the required sample size per hospital, i.e. 600 patients' files divided among three hospitals, to obtain sampling interval 'n'. The patients' files were then picked after every 'n' interval, where a maximum of 200 prescriptions were analysed from each hospital.

Data management and analysis

Data were collected using an Open Data Kit (ODK software, USA) by adapting the WHO data collection guideline,[12] and a previous study done by Mashalla *et al*.[15] Data were exported from the ODK server to a Microsoft Excel sheet (Redmond, WA, USA), then exported to a statistical package for social science (SPSS, version 25, Chicago, USA) for analysis.

Prescribing patterns

To assess prescribing patterns, we used selected indicators for monitoring drug use developed by WHO and INRUD in 1993,[12] including the average number of medicines prescribed per encounter (reference range 1.6–1.8), proportion of encounters where an antibiotic was prescribed (reference range 20.0%–26.8%), proportion of encounters where an injection was prescribed (reference range 20.0%–26.8%), proportion of medicines prescribed in generic names (reference value 100%) and proportion of medicines prescribed from the NEML (reference value 100%). Descriptive statistics such as frequency, proportion and mean (±SD) were used to summarize sociodemographic characteristics and prescribing patterns.

Overall antibiotic prescribing practices: the index of rational drug prescribing (IRDP)

To provide an overall picture of prescribing practices, we used a mathematical model for comprehensive appraisal of medical care to represent the overall prescribing practice.[16] The model has been successfully used to rank facilities based on rational use of medicines (RUM) using the WHO/INRUD indicators and has thus far been coined the IRDP.[16]

For the indices of non-polypharmacy, antibiotic prescribing and injection safety, the following formula was used:

$$Index = \frac{Optimal\ value}{Observed\ value}$$

For the generic name and essential medicine indices, the following formula was used:

$$Index = \frac{Observed\ value}{Optimal\ value}$$

And finally, the IRDP at each facility was the sum of all five indices above. The optimal IRDP is 1, such that a value close to 1 represents a good prescribing practice, while a value far away from 1 (either very small or very large) represents a poor prescribing practice. Facilities were ranked based on their IRDP.

Classification of the prescribed antibiotics: WHO AWaRe classification 2021

The prescribed antibiotics were further grouped according to the WHO AWaRe classification 2021, which classifies antibiotics into the 'access' group (first-choice group with broad activity and lower resistance potential against common pathogens), the 'watch' group (high resistance potential and key target for stewardship programmes), the 'reserve' group (last-resort antibiotics that should be reserved for confirmed or suspected infections) and the 'not recommended' group (fixed dose combinations of antibiotics with unproven efficacy).[17] The AWaRe classification is a useful tool for monitoring antibiotic consumption and setting targets for AMS programmes.

Drivers of antibiotic prescribing

Factors associated with the prescribing of antibiotics were determined using a univariate and multivariable logistic regression model for variables that had a *P* value of at least 0.2 in univariate analysis. A *P* value of <0.05 was considered statistically significant at a 95% CI.

Ethics

Ethics approval to conduct this study was sought from the Muhimbili University of Health and Allied Sciences Ethics Committee (Reference No.: MUHAS-REC-03-2022-1030). Furthermore, permission to collect data from patients' files was requested from the Medical Officers in-charge of Mwananyamala, Temeke, and Amana regional referral hospitals. The confidentiality of patients' information was ensured using codes (numbers) during data collection, analysis, interpretation and presentation.

Results

Characteristics of study participants

A total of 600 prescription records were reviewed, 200 from each hospital, with each record corresponding to one patient. The majority of the patients were inpatients (98.7%, $n=592$), female (51.5%, $n=309$) and aged between 25 and 34 years (25.5%, $n=153$). Overall, 97.7% ($n=586$) of the patients had laboratory tests such as urinalysis and full blood picture performed, but only one Gram stain was performed. Of the 600 patients, 528 (88.0%) were prescribed antibiotics, among which only 9 (1.5%) had culture and antimicrobial susceptibility test results (Table 1).

General prescribing patterns as per WHO/INRUD indicators

A total of 2239 drugs were prescribed from the analysed prescriptions, of which 920 (41.1%) were antibiotics. Generally, there was overprescribing of drugs, where an average of 3.7 ± 1.5 (optimal: 1.6–1.8) all medicines and 1.53 ± 0.78 antibiotics were prescribed per patient. Furthermore, there was overprescribing of antibiotics, where about 88.0% (528) of all prescriptions contained at least one antibiotic (optimal: 20%–26.8%), among which 78.2% (413) contained injectable antibiotics (optimal: 13.4%–24.1%). Furthermore, about 87.5% (462) of the antibiotic prescriptions were written generic names (optimal: 100%), whereas 98.7% (521) conformed to the NEML (optimal: 100%) (Table 2).

Facility-based prescribing patterns as per WHO/INRUD indicators

In all studied settings, patients received more than the recommended average number of drugs (1.6–1.8), where compared to the other facilities, patients at Mwananyamala regional referral hospital (MRRH) received the highest average number of drugs per prescription, 4.5 ± 1.9, followed by Amana regional referral hospital (ARRH) 3.6 ± 1.1 and Temeke regional referral hospital (TRRH) 3.1 ± 1.1, ($P<0.001$). Overuse of antibiotics was observed in all study facilities where there was more than optimal (20%–26.8%) percentage of prescriptions containing antibiotics: TRRH 99.0%, followed by ARRH 95.0% and MRRH 70.0%, ($P<0.001$). Contrary to optimal recommendation (13.4%–24.1%), most of the prescribed antibiotics were injectables, mostly at ARRH (87.9%) followed by TRRH (79.8%) and MRRH (62.9%) ($P<0.001$). Facilities fell short of the optimal percentage of the use of generic names in prescriptions (100%) and ARRH, TRRH and MRRH, respectively, recorded 88.9%, 87.4% and 85.7% of generic prescribing. Only TRRH conformed with 100% as recommended to the NEML, with the other facilities coming close at 98.9% (ARRH) and 96.4% (MRRH) (Table 3).

Overall antibiotic prescribing practices: the IRDP

There was overprescribing of all medicines, antibiotics and injections at the studied facilities, where the indices of non-polypharmacy, antibiotic prescribing and injection safety, respectively, ranged from 0.38 (MRRH) to 0.55 (TRRH), 0.24 (TRRH) to 0.33 (MRRH) and 0.21 (ARRH) to 0.29 (MRRH). Facilities performed well in generic prescribing and conformity to the NEML, with the respective indices ranging from 0.86 (MRRH) to 0.89 (ARRH) and 0.96 (MRRH) to 1.00 (TRRH). Overall, the studied facilities displayed poor antibiotic prescribing practices, where none of the facilities scored close to 1, with all of them having an IRDP above 2, which represents poor prescribing practices. TRRH had the highest IRDP value (2.90), followed by MRRH (2.82) and ARRH (2.81) (Table 4).

Classification of the prescribed antibiotics

The most frequently prescribed antibiotics were metronidazole ($n=335$; 36.7%) and ceftriaxone ($n=274$; 30.0%), followed by the fixed dose combination (FDC) amoxicillin/clavulanic acid ($n=82$; 9.0%) **(**Figure 1). With regard to the 2021 WHO AWaRe classification of antibiotics, most antibiotics were prescribed from the 'access' group, 53.1% (484), most notably metronidazole and amoxicillin/clavulanic acid. The 'watch' group followed in second place, with 38.4% (350), where antibiotics such as ceftriaxone, azithromycin and ciprofloxacin were commonly used. The 'not recommended' group came third, with 8.5% (77), represented mostly by ampicillin/cloxacillin and ceftriaxone/sulbactam. There were no antibiotics prescribed from the 'reserve' group (Figure 2).

Drivers of antibiotic prescribing

Male patients were 54% less likely to receive an antibiotic prescription compared with female patients [adjusted OR (aOR): 0.46, 95% CI: 0.25–0.87, *P* value: 0.017]. Patients at MRRH had a 99% lower chance of being prescribed antibiotics compared with those at TRRH (aOR: 0.01, 95% CI: 0.00–0.06, *P* value: 0.0001). Patients with underlying conditions such as hypertension and diabetes were two times more likely to receive an antibiotic prescription compared with those without underlying conditions (aOR: 2.1, 95% CI: 1.10–4.01, *P* value: 0.024) (Table 5).

Discussion

This study aimed to assess prescribing practices in three tertiary care hospitals in Dar es Salaam using five WHO/INRUD indicators (1993): (i) the average number of medicines prescribed per patient; (ii) the proportion of prescriptions where an antibiotic was prescribed; (iii) the proportion of prescriptions where injections were prescribed; (iv) the proportion of drugs prescribed by generic names; and (v) medicines prescribed per the NEML recommendation.

Table 1. Characteristics of the study participants

Variable	Category	Overall, *n* (%)	Health facility, *n* (%)		
			ARRH	MRRH	TRRH
Sex	Male	291 (48.5)	127 (63.5)	75 (37.5)	89 (44.5)
	Female	309 (51.5)	73 (36.5)	125 (62.5)	111 (55.5)
Age (years)	0–5	9 (1.5)	1 (0.5)	0 (0.0)	8 (4.0)
	6–12	5 (0.8)	1 (0.5)	2 (1.0)	2 (1.0)
	13–18	25 (4.2)	8 (4.0)	9 (4.5)	8 (4.0)
	19–24	24 (12.0)	57 (21.5)	37 (12.5)	94 (15.7)
	25–34	153 (25.5)	59 (29.5)	57 (28.5)	37 (18.5)
	35–44	108 (18.0)	44 (22.0)	35 (17.5)	29 (14.5)
	45–54	87 (14.5)	17 (8.5)	26 (13.0)	44 (22.0)
	≥55	119 (19.8)	46 (23.0)	28 (14.0)	45 (22.5)
Residence	Urban	559 (99.8)	200 (100.0)	200 (100.0)	199 (99.5)
	Rural	1 (0.2)	0 (0.0)	0 (0.0)	1 (0.5)
Marital status	Married	406 (67.7)	142 (71.0)	133 (65.5)	131 (65.5)
	Not married	180 (30.0)	56 (28.0)	65 (32.5)	59 (29.5)
	NA	14 (2.3)	2 (1.0)	2 (1.0)	10 (5.0)
Employment status	Employed	132 (22.0)	50 (25.0)	38 (19.0)	44 (22.0)
	Non-employed	157 (26.2)	37 (18.5)	57 (28.5)	63 (31.5)
	Self-employed	217 (26.2)	84 (42.0)	74 (37.0)	59 (29.5)
	Peasant	21 (3.5)	6 (3.0)	11 (5.5)	4 (2.0)
	Retired	34 (5.7)	13 (6.5)	9 (4.5)	12 (6.0)
	NA	39 (6.5)	10 (5.0)	11 (5.5)	18 (9.0)
Education level	Primary	167 (27.8)	35 (17.5)	66 (33.0)	66 (33.0)
	Secondary	266 (44.3)	89 (44.5)	101 (50.5)	76 (38.0)
	College	141 (23.5)	65 (32.5)	30 (15.0)	46 (23.0)
	Illiterate	16 (2.7)	10 (5.0)	3 (1.5)	3 (1.5)
	NA	10 (1.7)	1 (0.5)	0 (0.0)	9 (4.5)
Smoking	Yes	105 (17.5)	50 (25.0)	24 (12.0)	31 (15.5)
	No	456 (76.0)	140 (70.0)	165 (82.5)	151 (75.5)
	NA	39 (6.5)	10 (5.0)	11 (5.5)	18 (9.0)
Alcohol	Yes	128 (21.3)	50 (25.0)	26 (13.0)	52 (26.0)
	No	433 (72.2)	140 (70.0)	163 (81.5)	130 (65.0)
	NA	39 (6.5)	10 (5.0)	11 (5.5)	18 (9.0)
Admission category	Inpatient	592 (98.7)	197 (98.5)	198 (99.0)	197 (98.5)
	Outpatient	8 (1.3)	3 (1.5)	2 (1.0)	3 (1.5)
Patient category	Primary	211 (35.2)	97 (48.5)	105 (52.5)	9 (4.5)
	Referred[a]	389 (64.8)	103 (51.5)	95 (47.5)	191 (95.5)
Underlying condition	Yes	209 (34.8)	75 (37.5)	91 (45.5)	43 (21.5)
	No	391 (65.2)	125 (62.5)	109 (54.5)	157 (78.5)
Laboratory tests ordered	Yes	586 (97.7)	199 (99.5)	192 (96.0)	195 (97.5)
	No	14 (2.3)	1 (0.5)	8 (4.0)	5 (2.3)
Antibiotic prescribed	Yes	528 (88.0)	190 (95.0)	140 (70.0)	198 (99.0)
	No	72 (12.0)	10 (5.0)	60 (30.0)	2 (1.0)

NA, not applicable as children below 18 years of age.
[a]Patients from primary and secondary health facilities.

Results showed that the overall average number of medicines per prescription was 3.7, and the MRRH had the highest average value at 4.5. This figure is more than double the optimum value proposed by the WHO (1.6–1.8). Furthermore, the index of non-polypharmacy was very low, ranging from 0.38 (MRRH) to 0.55 (TRRH), indicating overprescribing of drugs. A previous study among primary healthcare facilities in Dar es Salaam, Tanzania reported a much lower (though slightly higher than the recommended optimal) average number of medicines prescribed per patient (1.99).[9] Similar values have been reported in other tertiary care settings, especially those in developing countries such as Nigeria,[18] India[19,20] and Central Nepal[21] (3.04, 3–3.62 and 3.2, respectively). Besides, the figure was relatively higher in Southwest Nigeria (6.11)[22] and Bangladesh (4.89).[23] On the contrary, lower

Table 2. General prescribing patterns as per WHO/INRUD indicators

Indicator	Observed value (mean/frequency)	Proportion (%)	Optimal value
Average number of drugs per prescription	3.7 ± 1.5		1.6–1.8
Prescriptions with an antibiotic prescribed	528	88.0	20.0%–26.8%
Prescriptions with an injectable antibiotic	413[a]	78.2	13.4%–24.1%
Antibiotics prescribed in generic names	462	87.5	100%
Antibiotics prescribed from the essential medicines list	521	98.7	100%

[a]Total = 528.

Table 3. Facility-based prescribing patterns as per WHO/INRUD indicators

WHO/INRUD indicator	ARRH	MRRH	TRRH	Optimal value	*P* value
Average number of drugs prescribed per patient[a]	3.6 ± 1.1 (720/200)	4.5 ± 1.9 (903/200)	3.1 ± 1.1 (616/200)	1.6–1.8	<0.001
Percent (*n*/*N*) prescriptions with antibiotics[a]	95.0 (190/200)	70.0 (140/200)	99.0 (198/200)	20.0–26.8	<0.001
Percent (*n*/*N*) prescriptions with injectable antibiotics[b]	87.9 (167/190)	62.9 (88/140)	79.8 (158/198)	13.4–24.1	<0.001
Percent (*n*/*N*) antibiotic prescriptions written in generic names[b]	88.9 (169/190)	85.7 (120/140)	87.4 (173/198)	100	<0.001
Percent (*n*/*N*) antibiotics prescriptions conforming to the essential medicines list or formulary[b]	98.95 (188/190)	96.4 (135/140)	100.0 (198/198)	100	<0.001

[a]Denominator is total number of prescriptions analysed at each hospital.
[b]Denominator is all prescriptions with antibiotics at the study facility.

Table 4. Overall antibiotic prescribing practices: the IRDP

Index category		ARRH	MRRH	TRRH
Non-polypharmacy[a]	Observed value	3.6	4.5	3.1
	Mean optimal value	1.7		
	Index value	0.47	0.38	0.55
Antibiotic prescribing (%)[a]	Observed value	95.0	70.0%	99.0%
	Mean optimal value	23.4		
	Index value	0.25	0.33	0.24
Injection safety (%)[a]	Observed value	87.9	62.9	79.8
	Mean optimal value	18.8		
	Index value	0.21	0.29	0.24
Generic name[b]	Observed value	88.9	85.7	87.4
	Optimal value	100		
	Index value	0.89	0.86	0.87
Essential medicines (%)[b]	Observed value	98.95	96.4	100.0
	Optimal value	100		
	Index value	0.99	0.96	1
IRDP[c]		2.81	2.82	2.90

[a]Index value = mean optimal value/observed value.
[b]Index value = observed value/optimum value.
[c]Sum of all individual indices.

values were recorded in different parts of the world, including various settings in Ethiopia (1.7, 1.76, 1.8, 1.89, 2.1 and 2.2),[24] as well as in other countries such as Pakistan (2.3)[25] and the USA (2.4).[26] The polypharmacy observed in the studied institutions could be contributed to by, but not limited to, the lack of continuous medical education for the prescribers, prescribers'

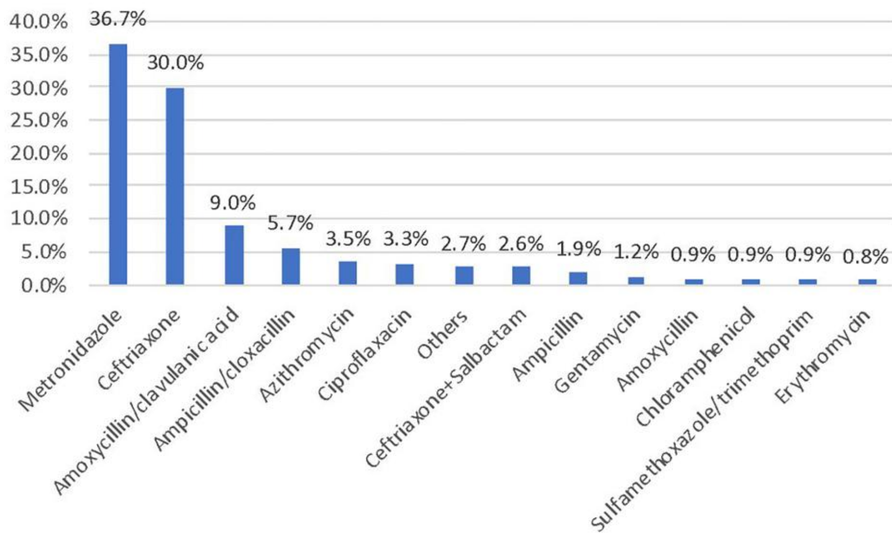

Figure 1. Proportions of prescribed antibiotics (%).

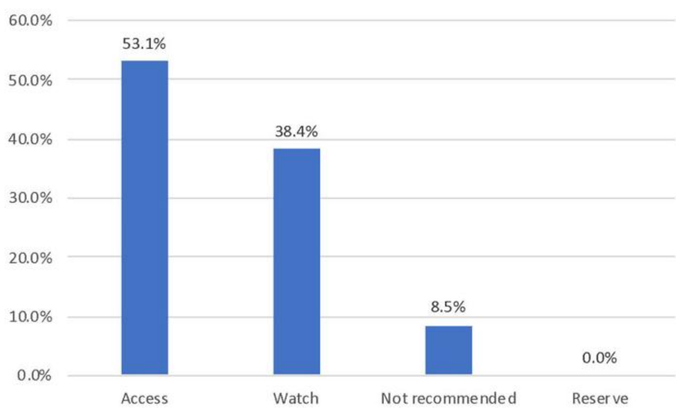

Figure 2. AWaRe classification of the prescribed antibiotics.

attitudes towards the disease, the type of healthcare system, co-morbidities and the shortage of therapeutically effective drugs, as well as influences by various pharmaceutical companies as a result of an increasing number of multiple drugs within the same therapeutic class, with claims that they are better than existing ones.[20,21] In most cases, polypharmacy is associated with a lot of serious consequences that influence treatment outcomes, hospital visits and the duration of stay in hospitals. Examples include poor adherence by patients, drug–drug interactions, and intolerable side effects that may lead to treatment failure and sometimes death.[24,25]

In this study, 88% ($n = 528$) of patients were treated with antibiotics across the three hospitals, where a total of 913 antibiotics were prescribed, averaging 1.5 antibiotics per patient. The values were even worse for individual settings, where 99% of those treated at the TRRH received antibiotic prescriptions, indicating overprescribing of antibiotics. The overuse of antibiotics is also reflected by the index of antibiotic prescribing, which ranged from 0.24 (TRRH) to 0.33 (MRRH). The proportion of antibiotic prescriptions obtained in this study is much higher compared with those reported in other studies such as 51% in Tanzania,[9] 34.4% in Nigeria,[18] 27.65% in India,[27] 52.4% in Pakistan,[28] and 46% and 78% in Bangladesh's tertiary care hospitals.[23] Nevertheless, most of the laboratory tests ordered in this study included urinalysis and a full blood count, whereas only one Gram stain was performed, and antibiotic susceptibility tests were performed for only 1.5% of the patients. This indicates that most antibiotics were prescribed empirically with no evidence of infectious aetiology. These findings support the observation that irrational antibiotic prescribing is still a major problem, posing a threat of antibiotic resistance in developing countries.[29] Antimicrobial misuse and overuse are important drivers of antimicrobial resistance (AMR), which is a huge global public health problem currently,[30] mainly in sub-Saharan Africa, where AMS initiatives are not frequently adopted.[31] For example, despite the fact that viral diseases such as colds and flu cannot be treated with antibiotics, patients are nonetheless given antibiotic prescriptions for such disorders.[32]

The study found an overuse of injections. The overall number of prescriptions where injectable antibiotics were prescribed in this study was 68.8%, which is equivalent to 78.2% of all antibiotics prescribed across the three hospitals. These values are higher than the WHO recommendation (13.4%–24.1%). In individual settings, the proportion of injection prescribing ranged from 62.9% (MRRH) to 87.9% (ARRH), whereas the indices of injection safety were very low, ranging from 0.21 (ARRH) to 0.29 (MRRH). Moreover, the individual settings and overall proportions of injection prescribing were much higher than that reported in various international tertiary care settings, such as Pakistan, where no injection antibiotics were prescribed:[16] Central Nepal, 0.7%;[21] India, 0.17%;[19] Nigeria, 4%;[18] Saudi Arabia, 15.2%;[33] Nigeria, 71.74%;[22] and North India, 85.3%.[34] Additionally, only 3.2% of patients received antibiotics in primary health facilities in Dar es Salaam, Tanzania. Since the majority of the prescriptions analysed in this study were for inpatients, this may partially explain the high percentage of injection use; however, these percentages

Table 5. Univariate and multivariable analysis of the factors associated with antibiotic prescribing (reference: not prescribed antibiotics)

		Univariate analysis			Multivariate analysis		
Variable	Category	cOR[a]	95% CI	*P* value	aOR	95% CI	*P* value
Sex	Male	0.68	0.41–1.12	0.128	0.46	0.25–0.87	**0.017**
	Female	Ref[b]					
Age category (years)	6–12	0.46	0.33–1.40	0.108	0.19	0.02–2.40	0.201
	13–18	0.46	0.16–1.33	0.149	0.56	0.14–2.28	0.418
	19–24	0.90	0.41–1.99	0.793	2.16	0.75–6.24	0.155
	25–34	0.96	0.47–1.96	0.909	1.64	0.69–3.91	0.259
	35–44	1.59	0.66–3.79	0.299	2.08	0.76–5.71	0.153
	45–54	1.65	0.64–4.23	0.299	2.32	0.76–7.11	0.141
	≥55	Ref					
Facility	ARRH	0.19	0.04–0.89	0.035	0.21	0.04–1.02	0.053
	MRRH	0.02	0.01–0.10	0.0001	0.01	0.00–0.06	**0.0001**
	TRRH	Ref					
Patient category	Primary	0.38	0.23–0.63	0.0001	0.51	0.04–5.92	0.588
	Referred	Ref					
Underlying disease condition	Yes	0.94	0.56–1.57	0.808	2.10	1.10–4.01	**0.024**
	No	Ref					
Laboratory tests ordered	Yes	1.23	0.27–5.60	0.79	0.56	0.10–3.15	0.509
	No	Ref					

Bold values indicate variable for which there was a statistically significant association with the outcome (antibiotic prescription), after a multivariate logistics analysis.
[a]Crude OR.
[b]Reference category.

may still be considered inappropriate for non-emergency in-patient settings too.

The WHO recommends that all medications (100%) should be prescribed in generic names. However, this study highlights the lower use of generic names when prescribing antibiotics (87.5%), with values in individual settings ranging from 85.7% (MRRH) to 88.9% (ARRH). An approximately similar percentage of generic prescribing was observed among primary healthcare facilities in Dar es Salaam, Tanzania (84.4%).[9] In comparison, studies conducted elsewhere have reported even lower use of generic names in prescriptions. In north India, no generic names were mentioned in any prescription.[34] In south India 1.42%,[20] central Nepal 2.9%[21] and Maharashtra-India 25.76%,[19] to name a few. In contrast, higher proportions of generic prescribing have been observed among Ethiopian national and regional referral hospitals, with 98.86% of prescriptions written in generic names, and in Maharashtra-India, where generic names were mentioned in 100% of the prescriptions.[19]

The study found fairly good conformity to the NEML, with 98.7% of the prescribed antibiotics being recommended in the NEML.[7] This is close to the WHO optimal value of 100%. TRRH conformed to the NEML 100%, while other facilities came close at 98.9% (ARRH) and 96.4% (MRRH). These values are approximately similar to what was observed among primary healthcare facilities in the Ilala district, Tanzania (97.6%).[9] On the other hand, the values were higher than the previously reported figures in various international tertiary care settings, such as in Ethiopia (93.04%),[24] Central Nepal (21.3%),[21] Nigeria (94%),[18,22] India (81.6%[19] and 52.9%[34]) and Pakistan (81.5%).[25] For many countries, essential medicines are those recommended in their standard treatment guidelines (STG).[35,36] The Tanzanian essential medicines list is attached to the STG, thus retaining its purpose of identifying medicines considered essential for treating common disease conditions in Tanzania, and it is in line with the WHO recommendations under Tanzania's conditions.[7] Conforming to the NEML may imply good conformity to the STG as well.

In this study, the commonly prescribed classes of antibiotics included nitroimidazole antibiotics (metronidazole 36.7%), followed by cephalosporins (ceftriaxone, 30.0%) and antimicrobial FDCs (amoxicillin/clavulanic acid, 9%; and ampicillin/cloxacillin, 5.7%). This is different from a previous study in Dar es Salaam, Tanzania, where amoxicillin constituted the highest percentage, followed by ciprofloxacin and metronidazole.[9] Another study focusing on prescribing antibiotics to insured patients in Dar es Salaam reported that penicillins were the most preferred group of antibiotics, followed by nitroimidazoles.[32] The findings are further different from what was observed in tertiary care hospitals in India, where cephalosporins[37] and β-lactam antibiotics[27] were the most frequently prescribed antibiotics. Also in Pakistan, where cephalosporins were the most commonly prescribed class of antibiotics, followed by penicillins and fluoroquinolones.[25] On the other hand, a study carried out in the emergency department of a tertiary care hospital in Saudi Arabia reported that penicillins were the most frequently prescribed class of antibiotics, followed by cephalosporins and macrolides[33], while amoxicillin/clavulanic acid was most preferred agent among insured patients in Tanzania,[9] while piperacillin/tazobactam was in one of the tertiary care hospitals in Oman.[38]

Regarding the 2021 WHO AWaRe classification,[17] this study found 53% of antibiotics prescribed from the 'access' group, with metronidazole and amoxicillin/clavulanic acid constituting the highest percentage. The 'watch' group followed (38.4%), with ceftriaxone, azithromycin and ciprofloxacin being commonly prescribed. The 'not recommended' group constituted 8.5%, represented most prominently by ampicillin/cloxacillin and ceftriaxone/sulbactam, and there were no antibiotics prescribed from the 'reserve' group. Results from this study are contrary to those reported from five healthcare settings in Zambia, where ceftriaxone, a 'watch group' antibiotic, was mostly prescribed, followed by metronidazole, an 'access group' antibiotic.[39] Also, another study done in Bangladesh reported on the use of 'watch group' antibiotics followed by 'access group' antibiotics.[40] The prescribing of antibiotics in the studied settings largely followed the WHO AWaRe classification, except for the minor use of medicines that are not recommended. These 'not recommended' antibiotics are normally FDCs with no evidence of added benefit over the individual drugs and increased potential for causing AMR. Three of the non-recommended FDCs (ampicillin/cloxacillin, flucloxacillin/amoxicillin and ceftriaxone/sulbactam) are listed in the NEML[7] and their frequent use may have been contributed to by the notion that they are more effective. According to the results of the global point prevalence survey on antimicrobial use, antibiotic prescribing patterns are generally associated with accessibility and affordability, with broad-spectrum antibiotics in the access category being more readily available and affordable than antibiotics in the other categories;[28,30] however, a recent review has noted an increased use of these non-recommended FDCs in Tanzania.[10]

This study highlights two factors that influence antibiotic prescribing in the studied settings, whereby being treated at TRRH and having underlying medical conditions such as diabetes and hypertension contributed to high chances of receiving an antibiotic prescription. The populations receiving care in the study facilities are fairly identical in many sociodemographic and clinical characteristics, therefore the observed difference could be a result of the overprescribing tendency of the healthcare workers at TRRH. As shown in the results, 99.0% of patients at TRRH received antibiotic prescriptions, while the facility had the highest IRDP value, indicating an inappropriate antibiotic prescribing practice. Overprescribing of antibiotics in some facilities has been reported in previous studies where factors included a lack of insight into local resistance patterns, a lack of awareness of prescribing guidelines, clinical situations, patients' medical histories, physicians' perceived risks, diagnostic uncertainty, and limited diagnostic resources.[41] On the other hand, the influence of peers and the environment in certain healthcare institutions may lead to antibiotic prescription, and many junior doctors consider senior doctors' practices 'much more important than the minimal reputational stake of overprescribing.'[42] Previous studies have reported underlying medical conditions such as diabetes mellitus (DM) being among the main drivers of receiving an antibiotic prescription. Studies report that patients with DM, especially type 1, are at a higher risk of developing infections than normal people. They are therefore prone to receiving antimicrobial agents, especially antibiotics.[43] For example, 'up to one-third of people with diabetes develop diabetic foot ulceration (DFU) during their lifetime, and over 50% of these ulcerations become infected'.[44] Other issues include amputation,[45] and urinary tract infections (UTIs), which are significantly common in DM patients, increasing the susceptibility to receiving antibiotics in this group of patients.[46]

This study has generally highlighted inappropriate antibiotic prescribing practices in the studied facilities. However, several limitations can be stated for this study. These may include, but are not limited to: (i) Findings may have been limited by data shortcomings in the prescription records. The studied records may have been incomplete, thus missing some data, or may have contained misleading information; (2) The retrieved records were predominantly for inpatients, thus limiting our understanding of the outpatient picture. Therefore, the investigators made use of the best available data in the studied settings.

Conclusions

The study found overuse of medicines, including antibiotics. Generally, the number of medicines per patient exceeded that recommended by the WHO, and most antibiotics were prescribed empirically and in injectable forms. The most frequently prescribed classes of antibiotics were nitroimidazoles and cephalosporins. Furthermore, according to the WHO 2021 AWaRe classification of antibiotics, the 'access' group constituted the highest proportion, followed by the 'watch' group, while patients received antibiotic combinations that are not recommended in practice. Having DM, especially type 1, was found to be one of the drivers of receiving an antibiotic prescription in this study. Most of the prescriptions conformed to the NEML, while a lower use of generic names was observed in several prescriptions. Therefore, following the inappropriate prescribing of antibiotics observed in this study, we recommend implementing AMS programmes and adhering to the national treatment guidelines, the NEML and the 2021 WHO AWaRe classification of antibiotics. Furthermore, since the conclusion of this study is limited to tertiary care hospitals, further studies are recommended across a wide range of healthcare settings.

Acknowledgments

We thank the medical officers in charge of the studied hospitals for granting permission to collect data in their facilities. Furthermore, we acknowledge the support from the medical staff working in the studied settings.

Funding

This study was funded by the Swedish International Development Agency (Sida), through the Muhimbili University of Health and Allied Sciences (MUHAS). The funder did not participate in the design of the study, data collection, analysis, interpretation, or manuscript preparation.

Transparency declarations

None to declare.

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