Original Article

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Evaluation of Rational Drug Use in Outpatients with Urinary Tract Infection at a Rural Indian Hospital: A Cross-sectional Study

Pharmacology Section

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ABSTRACT

Introduction: Urinary Tract Infections (UTIs) in outpatients are frequently treated empirically with antibiotics. It is essential to assess prescribing patterns to address irrational drug use and prevent the development of antimicrobial resistance.

Aim: To evaluate rational drug use in outpatients with UTIs.

Materials and Methods: The present cross-sectional study was conducted in the Medicine Outpatient Department (OPD) at Swami Ramanand Tirth Rural Government Medical College, Ambajogai, Maharashtra, India. A total of 1,000 prescriptions from patients diagnosed with UTIs between December 2018 and June 2020 were evaluated for demographic characteristics, co-morbidities, and medication profiles. The World Health Organisation (WHO) Anatomical Therapeutic Chemical/Defined Daily Dose (ATC/DDD) methodology was used to assess prescriptions using metrics such as Prescribed Daily Dose (PDD), DDD, PDD:DDD ratio, and DDD per 1,000 Inhabitants per Day (DID). Rationality was evaluated using WHO prescribing indicators and the Index of Rational Drug Prescribing (IRDP). Categorical data were analysed using the Chi-square test and Pearson's correlation.

Results: The UTIs were more common in females, 682 (68.2%), than in males, 318 (31.8%). The most frequent co-morbidities were diabetes mellitus 360 (36%), urolithiasis 190 (19%), and Benign Prostatic Hypertrophy (BPH) 104 (10.4%). A total of 2,550 drugs were prescribed, most commonly nitrofurantoin 256 (25.6%), paracetamol 280 (28.0%), norfloxacin 113 (11.3%), pantoprazole 149 (14.9%), levofloxacin 118 (11.8%), amoxicillin 55 (5.5%), cefpodoxime 29 (2.9%), and disodium hydrogen citrate 1,000 (100%). The mean PDD was 675.71±607.29 mg, mean DDD was 0.92±1.03 mg, the PDD:DDD ratio was 1.0±0.5, and DID was 0.0492±0.0452. The average number of drugs per encounter was 2.55. Of all drugs prescribed, 42.03% were written by generic name and 53.05% were from the Essential Medicines List (EML). Antibiotics were prescribed in all encounters; no injections or Fixed-Dose Combinations (FDCs) were used. The overall IRDP index was 2.03.

Conclusion: Low DID values indicate limited antibiotic utilisation. Minimal polypharmacy and the absence of injections or Fixed-Dose Combinations (FDCs) demonstrate rational prescribing practices. However, universal antibiotic prescribing and a low IRDP index suggest considerable scope for improvement.

Keywords: Benign prostatic hypertrophy, Drug utilisation, Index of rational drug prescribing, World health organisation

INTRODUCTION

The UTI is most common in women (50-80%), owing to the unique anatomy of the lower urinary tract and its close proximity to reproductive organs [1,2]. Clinically, UTIs are classified as uncomplicated and complicated. Uncomplicated UTIs are usually diagnosed based on clinical symptoms and treated empirically with antibiotics, often without urine culture or susceptibility testing, which may lead to irrational antibiotic use [3]. Outpatient management of uncomplicated UTIs in rural Indian populations requires focused attention because of high prevalence and the increasing threat of antimicrobial resistance. Factors such as malnutrition, poor hygiene, and low socioeconomic status are more prevalent in rural areas and are associated with higher UTI incidence [4]. Irrational antimicrobial use is common in developing countries, including India [5].

Monitoring resistance patterns and prescribing behaviour is essential to ensure appropriate treatment of uncomplicated UTIs. Drug Utilisation Studies (DUS) provide a structured approach to assess prescribing trends and identify irrational practices. Drug use evaluation is a structured and methodological drug assessment system used to study the actual trend of drug use in a particular setting, so that necessary changes can be made accordingly, if inappropriate drug prescription practices are seen. The findings of such evaluation can shed light on irrational drug use. It is important to evaluate drug use in uncomplicated UTIs in rural areas to resolve irrational prescribing. For these studies, the WHO developed ATC/DDD Classification System, wherein the medicines are classified into five levels, such as Anatomical, Therapeutic, Pharmacological, Chemical and Chemical substance groups. The key parameters employed in this study were PDD, DDD, PDD: DDD ratio, DID (DDDs of drugs per thousand inhabitants per day) to measure antibiotic use on outpatient basis [6]. WHO core prescribing indicators and the ATC/DDD system were employed in this study to evaluate rational drug utilisation [6,7].

The primary objective was to assess the rationality of drug use among outpatients with UTIs in a rural hospital. Previous studies from India and other countries have evaluated prescribing patterns using either WHO indicators or ATC/DDD methodology, often revealing irrational antibiotic use and poor guideline adherence [8,9]. However, few studies have applied a combined approach incorporating ATC/DDD metrics, WHO prescribing indicators, and the IRDP [10-12].

This integrated methodology offers both quantitative and qualitative insights into prescribing behaviour. The present study addresses this gap by comprehensively analysing a large number of UTI prescriptions from a rural Indian hospital to identify opportunities for improving rational drug use and antibiotic stewardship. Secondary objectives included evaluating demographic characteristics (age and gender), clinical profiles (comorbidities), correlation between utilisation measures, prescribing trends, and healthcare facility performance using IRDP. The findings aimed to support practical recommendations for rational prescribing tailored to rural healthcare settings.

Null Hypothesis (H_0): There is no significant difference between prescribing indicators, IRDP indices, and ATC/DDD metrics and the standard values used to assess rational drug use among outpatients with uncomplicated UTIs in the rural hospital.

Alternative Hypothesis (H_1): There is a significant difference between prescribing indicators, IRDP indices, and ATC/DDD metrics and the standard values used to assess rational drug use among outpatients with uncomplicated UTIs in the rural hospital.

MATERIALS AND METHODS

The present cross-sectional study was conducted in the Medicine OPD at Swami Ramanand Tirth Rural Government Medical College, Ambajogai, Maharashtra, India. A total of 1,000 prescriptions were collected from patients with a clinical diagnosis of uncomplicated UTI between December 2018 and June 2020. Written informed consent was obtained from all patients prior to inclusion in the study. Ethical approval was secured from the Institutional Ethics Committee before commencement of the study (Ref. No. SRTR/GMC/Pharma/IEC/43/22.10.18) Institutional Ethics Committee prior to study initiation, in accordance with institutional guidelines and the Declaration of Helsinki (1975, revised 2013).

Inclusion criteria:

- Prescriptions from patients with a clinical diagnosis of UTI based on symptoms such as painful or burning micturition with increased frequency and urgency, suprapubic or lower abdominal pain, cloudy or foul-smelling urine, and haematuria.
- Patients willing to participate in the study.
- Adult patients aged ≥18 years of either gender.

Exclusion criteria:

- Prescriptions from patients presenting with systemic symptoms indicative of upper or complicated UTI, such as high-grade fever, flank pain, nausea, and vomiting.
- Inpatients with complicated UTIs.
- Pregnant women.
- Children.

Sample size calculation: Prescriptions were selected using a simple random sampling method to obtain unbiased data reflecting prescribing practices. Based on WHO recommendations, a minimum of 600 prescriptions is required to achieve statistically significant results [7]. Therefore, a larger sample size of 1,000 prescriptions was analysed in the present study.

Study Procedure

Demographic information including age, gender, education, marital status, occupation, OPD number, and date of visit was extracted from prescriptions, along with clinical details such as co-morbidities. Medication data included the number of drugs prescribed and individual drug details such as formulation, name (generic or brand), strength, dosage frequency, treatment duration, and reported adverse effects at follow-up visits. Patients were provided contact numbers and advised to report any side effects and revisit the OPD for appropriate management.

Information obtained through prescriptions was recorded on the basis of age, gender, and pattern of individual drug use. Drug use indicators were evaluated using the WHO core drug use indicators methodology described in the manual "How to Investigate Drug Use in Health Facilities: Selected Drug Use Indicators" (WHO/DAP/93.1;1993) [7]. This WHO document defines and standardises the methodology for assessing various indicators but does not specify numerical optimal or reference values. The commonly cited benchmark or reference values for these indicators were subsequently derived from a WHO- Essential Drugs and Medicines policy/ International Network for Rational Use of Drugs. (WHO-EDM/INRUD) supported study by Isah A et al., (2001), which developed these reference values based on empirical data and expert consensus in Nigeria reviewed by multidisciplinary expert panel [13]. These have since been widely adopted in the literature as WHO/INRUD reference values. This has become the de facto standard citation for the numeric prescribing indicator benchmarks often referenced in WHO/INRUD-related research, audits and widely cited in WHO-supported research articles, systematic reviews and academic publications applying WHO/INRUD prescribing indicators as empirical benchmark source for optimal prescribing values. The reference values for these prescribing indicators reported and further commonly quoted in later literature were derived from Isah A et al., (2001) [13-16].

The WHO drug prescribing indicators methodology and reference values derived from Isah A et al., (2001) were employed in the present study, to measure the rationality of drug prescribing [7,13].

- Average number of medicines per encounter=Total number of medicines prescribed÷Total number of encounters. (WHO reference value: 1.6-1.8)
- Percentage of medicines prescribed by generic name=(Number of medicines prescribed by generic name÷Total number of medicines prescribed)×100. (WHO reference value: 100%)
- Percentage of encounters with antibiotics prescribed=(Number of encounters with antibiotics÷Total number of encounters)×100. (WHO reference value: 20.0-25.4%)
- Percentage of encounters with injections prescribed=(Number of encounters with injections÷Total number of encounters)×100. (WHO reference value: 10.1–17.0%)
- Percentage of medicines prescribed from the Essential Medicines List (EML)=(Number of medicines prescribed from EML÷Total number of medicines prescribed)×100. (WHO reference value: 100%)

Index of Rational Drug Prescribing (IRDP): The IRDP was calculated using a validated method developed by Zhang and Zhi and applied by Dong L et al., [17]. It consists of five indices derived from WHO prescribing indicators.

For indicators such as non-polypharmacy, rational antibiotic use, and injection use, the index was calculated as:

Index=Observed value÷WHO optimal value

Similarly, indices for generic prescribing and EML use were calculated using the same formula.

An optimal index value of 1 indicates rational prescribing. The maximum possible IRDP score is 5, obtained by summing the five indices.

ATC/DDD Methodology: Drug utilisation was assessed using the WHO-recommended ATC/DDD system [6]. The PDD was calculated as the average daily dose for each drug, and the final PDD was derived as the mean of individual PDDs.

The PDD:DDD ratio was computed to evaluate dosing adequacy:

Ratio=1 indicates appropriate dosing

Ratio <1 indicates underdosing

Ratio >1 indicates overdosing

The DDD per 1,000 inhabitants per day (DID) was calculated using the formula:

DID=(Total amount of drug used in one year (mg)×1,000)÷(WHO DDD (mg)×365×Study population) [18]

For population-based calculations, the population of Ambajogai town was taken as 73,975 based on Municipal Council census data (2011-2020) [19].

STATISTICAL ANALYSIS

Data were recorded using Microsoft Excel 2007. Categorical variables such as age, gender, and co-morbidities were analysed using the two-way Chi-square (χ^2) test for independence to determine associations between variables. Contingency tables were constructed using observed frequencies to perform the χ^2 test. Expected frequencies and χ^2 components were calculated, and degrees of freedom were used to obtain p-values from the χ^2 distribution table. The χ^2 statistics were cross-validated for accuracy using Python software version 3.x with the SciPy library version 1.6.0. Descriptive statistics were used to analyse continuous variables, including PDD, DDD, PDD:DDD ratio, and DID. Pearson's correlation coefficient (r) was applied to assess relationships between these variables, and the correlation matrix was presented using a heatmap.

RESULTS

A highly significant association was observed between age and gender. Female predominance was particularly marked in the 18-30 year age group, with 312 patients (31.2%) indicating a higher incidence of UTIs among younger women. Male predominance was observed in individuals above 70 years of age, accounting for 187 patients (18.7%). In the 31-50-year age group, the gender difference was not statistically significant [Table/Fig-1].

Age group (years)	Males N (%)	Females N (%)
18-30	23 (2.3)	312 (31.2)
31-50	32 (3.2)	75 (7.5)
51-70	76 (7.6)	209 (20.9)
>70	187 (18.7)	86 (8.6)
Total (N=1000)	318 (31.8)	682 (68.2) ***

[Table/Fig-1]: Demographic characteristics.
(χ^2)=269.20, df=3; p-value: 4.59×10^{-58}; p<0.001*** (highly significant)

There was also a highly significant association between gender and type of comorbidity. Benign Prostatic Hyperplasia (BPH) occurred exclusively in males and contributed substantially to the Chi-square value. Diabetes Mellitus, with or without hypertension, and urolithiasis were present in both genders but with significant distribution differences [Table/Fig-2].

it as the preferred first-line agent. Levofloxacin and norfloxacin were prescribed at moderate frequencies. Levofloxacin showed a PDD:DDD ratio greater than 1 (2.0), suggesting overdosing, whereas norfloxacin demonstrated adequate dosing but lower utilisation, reflecting restricted fluoroquinolone use.

Cefpodoxime and amoxicillin were infrequently prescribed, with DID values below 1. Amoxicillin displayed a PDD:DDD ratio less than 1, indicating underdosing. Among supportive medications, paracetamol was frequently prescribed but showed low DID and underdosing (PDD:DDD <1). Pantoprazole demonstrated a high PDD:DDD ratio (~2) and relatively higher DID (0.077), suggesting potential over-prescription. Disodium hydrogen citrate was prescribed in all cases. Overall, all DID values were less than 1 [Table/Fig-4].

The correlation matrix illustrated Pearson's correlation coefficients among PDD, DDD, PDD:DDD ratio, and DID. A strong, statistically significant positive correlation was observed between PDD and DDD (r=0.89, p<0.05), indicating proportional increases between these measures. A statistically significant moderate negative correlation was found between DDD and PDD:DDD ratio (r=-0.55, p<0.05).

A moderate positive but non-significant correlation was observed between PDD:DDD ratio and DID (r=0.49, p>0.05). Other correlations (PDD-PDD:DDD ratio, PDD-DID, and DDD-DID) were moderate and non-significant (p>0.05) [Table/Fig-5].

DISCUSSION

The present study evaluated drug utilisation patterns, rationality of prescribing, and treatment practices for uncomplicated UTIs in a rural tertiary care hospital in India. The association between age and gender was highly significant, with marked female predominance in the 18-30-year age group, reflecting increased susceptibility among young women. Conversely, male predominance in patients above 70 years was likely attributable to prostatic enlargement or obstructive uropathy.

Similar trends were reported by Sharma A et al., who observed higher incidence in women of childbearing age and older adults [20]. Prakash D et al., and Al-Badr A et al., also documented comparable

Co-morbidities observed	Males (*Of*)	Females (*Of*)	Total	Males (*Ef*)	Females (*Ef*)	X2={∑(O−E)2/ E} Components		
						Males	Females	p-value
BPH	104	0*	104	57.9	46.1	36.87	46.09	<0.0001***
DM with/without HT	134	226	360	200.4	159.6	22.04	27.6	<0.0001***
Urolithiasis	126	64	190	105.7	84.3	3.9	4.89	0.003*
Total	364	290	654	-	-	-	-	-

[Table/Fig-2]: Commonly observed co-morbidities.
BPH: Benign prostatic hyperplasia; DM: Diabetes mellitus; HT: Hypertension; *Of*: Observed frequency; *Ef*: Expected frequency; *BPH occurs only in males; (χ^2)=141.39, df=2; p-value: 2.21×10-31; p<0.0001*** (highly significant)

The WHO prescribing indicators revealed that the average number of medicines per encounter (2.55) was within the optimal range (1.6-1.8). However, the percentage of medicines prescribed by generic name (42.03%) and encounters with antibiotics prescribed (100%) deviated markedly from optimal values (100% and 20.0-25.4%, respectively). Similarly, medicines prescribed from the Essential Medicines List (53.05%) were below the optimal value of 100%. No injections or fixed-dose combinations were prescribed. The overall IRDP score (2.03) was lower than the optimal level [Table/Fig-3] [5].

The most frequently prescribed drugs were disodium hydrogen citrate (1,000; 100%), nitrofurantoin (256; 25.6%), paracetamol (280; 28.0%), norfloxacin (113; 11.3%), pantoprazole (149; 14.9%), levofloxacin (118; 11.8%), amoxicillin (55; 5.5%), and cefpodoxime (29; 2.9%).

Nitrofurantoin was the most commonly prescribed antibiotic and exhibited a PDD:DDD ratio of 1.0, indicating appropriate dosing. Its DID value (~0.066) was the highest among antibiotics, confirming

patterns [21,22]. Schrier RW reported that acute cystitis commonly affects sexually active young women due to coital exposure and during pregnancy owing to mucosal invasion by Escherichia coli [23]. Stamm WE et al., and Najar MS al., suggested that proximity of the anus to the periurethral region facilitates migration of intestinal flora in females [24,25].

The most frequent co-morbidities were diabetes mellitus, urolithiasis, and BPH, with significant gender associations. BPH was confined to elderly males, while diabetes and urolithiasis were observed in both genders. UTIs can occur across all age groups in the presence of risk factors such as renal calculi, obstructive uropathy, and prostatic hypertrophy.

Wang T et al., highlighted increased UTI prevalence in diabetic patients due to glucose-rich urine promoting bacterial growth [26]. Diabetes also causes genitourinary structural changes, predisposing to pyelonephritis. Prajapati AK attributed recurrent UTIs in diabetics to leukocyte dysfunction affecting chemotaxis and phagocytosis

Prescribing indicators	Observed values	WHO Standard values WHO Reference values††	IRDP observed values	IRDP optimum values
Average number of medicines per encounter	2.55	1.6-1.8	0.78	1
Percentage of medicines with generic name prescribed	42.03	100%	0.42	1
Percentage of medicines with antibiotics prescribed	100	20.0 - 25.4	0.3	1
Percentage of medicines with injections prescribed	0	10.1 - 17.0	0	1
Percentage of encounters prescribed from EML	53.05	100%	0.53	1
Total IRDP	-	-	2.03	5

[Table/Fig-3]: WHO Drug Prescribing Indicators and IRDP indices.
†=WHO Prescribing indicators methodology: WHO/DAP/93.1;1993 [7], ††=WHO Reference values from WHO-EDM/INRUD-supported study by Isah et al., (2001) [13].
EML: Essential medicine list, IRDP: Index of rational drug prescribing, WHO-EDM/INRUD: World health organisation- essential drugs and medicines policy/international network for rational use of drugs.

studies by Bhamare AB et al., and Ussai S et al., [34,35]. Disodium hydrogen citrate was prescribed universally for symptomatic relief, though O'Kane DB et al., noted a lack of evidence supporting its use and its exclusion from National Institute for Health and Care Excellence (NICE) recommendations [36].

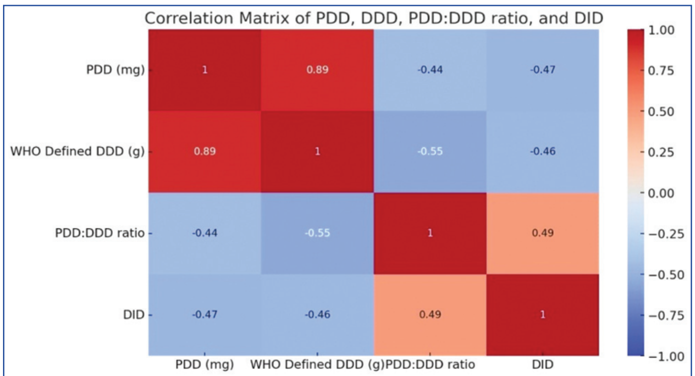
The choice and duration of antibiotic therapy aligned closely with international guidelines on urological infections [37-39]. Narrow-spectrum oral antibiotics with low collateral damage were preferred, with fluoroquinolones used sparingly due to their association with serious adverse effects, as highlighted by Walker E et al., [40].

All patients received a single antibiotic without the use of FDCs, taking into consideration age and comorbid conditions. Paracetamol was prescribed for pyrexia, and pantoprazole was used to manage gastric side effects associated with oral antimicrobials.

The average number of drugs per prescription was 2.55 (optimal value: 1.6-1.8), indicating a moderate level of polypharmacy, consistent with findings reported by Akunne AA et al., and Banerjee I et al., [41,42]. Ofori-Asenso R et al., noted that symptomatic

Prescribed drugs	Total prescriptions N (%)	ATC code	PDD (mg)	WHO defined DDD (g)	PDD: DDD ratio	DID with prescribing trends
Nitrofurantoin	256 (25.6)	J01XE01	200	0.2	1.0	0.066 †
Norfloxacin	113 (11.3)	J01MA06	800	0.8	1.0	0.029 §
Levofloxacin*	118 (11.8)	J01MA12	1000	0.5	2.0	0.061 §
Cefpodoxime	29 (2.9)	J01DD13	400	0.4	1.0	0.008 ‡
Amoxycillin**	55 (5.5)	J01CA04	1000	1.5	0.67	0.010 ‡
Paracetamol**	280 (28.0)	N02BE01	1000	3.0	0.33	0.024††
Pantoprazole*	149 (14.9)	A02BC02	80	0.04	2.0	0.077 ‖
Total	1000	-	-	-	-	

[Table/Fig-4]: Commonly prescribed drugs, ATC/DDD metrics, DID and prescribing trends.
Disodium hydrogen citrate (ATC= B05CB02): WHO defined DDD is not available, hence not included.
Central tendency showed as mean and variability as standard deviation for each variable.
ATC: Anatomical Therapeutic Chemical classification code, Prescribed Daily Dose: PDD, DDD: Defined Daily Dose, DID=DDD/1000 inhabitants /day [6].
*=over dosing, **=under dosing,
Prescribing trends: †=Commonly used, ‡=Less used, §=Moderately used, ‖=Highly used, ††=Symptomatic use



[Table/Fig-5]: Heatmap for correlation Matrix of PDD, DDD, PDD: DDD ratio and DID:
Numerical values in cells= Pearson correlation coefficients (r): No linear correlations (r=0)
Color gradients (r): Red shades= Positive correlations(r=+1), Blue shades= Negative correlations (r=-1), Darker colors= Stronger correlations, Lighter colours= Weaker correlations.
PDD: Prescribed Daily Dose, DDD: Defined Daily Dose, DID=DDD/1000 inhabitants /day.

[27]. Sewify M et al., noted that hyperglycaemia induces nerve damage, impairs bladder sensation, and promotes urinary retention, increasing infection risk [28].

Li X et al., reported frequent UTIs in patients with urolithiasis, consistent with present findings [29]. Bichler KH et al., demonstrated that chronic infections with urease-producing bacteria lead to infection stone formation and severe pyelonephritis [30]. Ng M et al., described age-related BPH causing increased bladder pressure and reduced urinary flow [31]. Leslie SW et al., and Muruganandham K et al., found that UTIs contribute to acute urinary retention in BPH due to incomplete voiding and urinary stasis [32,33].

Commonly prescribed antibiotics included nitrofurantoin, fluoroquinolones, β-lactams, and cefpodoxime, consistent with earlier

management and a high burden of comorbidities often lead to increased medicine use per patient [14].

Prescribing by generic name reflects good prescribing practice; however, although WHO recommends 100% generic prescribing, the proportion observed in this study was below optimal levels, possibly due to preference for branded medicines [43].

The high proportion of prescriptions containing antibiotics likely reflects their free availability in the hospital, similar to findings by Vyas N et al., and Wadhwa M et al., [44,45]. The absence of injectable drugs (optimal <10%) indicates rational practice in the outpatient setting, where oral therapy is appropriate.

Although WHO recommends 100% prescribing from the EML, the lower adherence observed may result from limited availability or lack of awareness. Shortages of essential medicines can compel prescribers to use alternative agents, sometimes contributing to polypharmacy [46]. Other Indian studies have reported mixed levels of EML utilisation [47,48].

The absence of FDC use reflects rational prescribing, as irrational FDCs are often costly and potentially harmful [49]. In contrast to several Indian studies reporting widespread FDC antibiotic use, none were prescribed in this study, suggesting improved prescribing behaviour. The observed IRDP score of 2.03 (optimal=5) indicated suboptimal rational prescribing, similar to findings by Akunne AA et al., [41].

Drug utilisation was further assessed using the ATC/DDD methodology, with reference values provided by the WHO Collaborating Centre for Drug Statistics Methodology [50]. Variations between PDD and WHO-defined DDD were expected due to differences in patient characteristics and disease severity.

Nitrofurantoin was the most frequently prescribed first-line antibiotic and was appropriately dosed, reflecting adherence to treatment guidelines. Fluoroquinolones and β-lactam antibiotics were used less frequently, while supportive medications such as pantoprazole and paracetamol were commonly co-prescribed.

The low overall DID values (<1) indicate limited antibiotic exposure in the population, consistent with short-course treatment of uncomplicated UTIs. However, relatively higher DID values for levofloxacin and pantoprazole suggest the need for prescribing rationalisation [51].

Although the ATC code for disodium hydrogen citrate (B05CB02) exists, it was excluded from evaluation due to the absence of a WHO-defined DDD and lack of recommendation in NICE guidelines for UTI management. These findings align with those reported by Hooton TM et al., [52]. Empirical use of nitrofurantoin remains appropriate as it has minimal cross-resistance with commonly used antibiotics. Short courses of fluoroquinolones may be reasonable for mild-to-moderate UTIs, while β-lactams should be reserved as second-line agents, as observed in this study [52].

Only a small proportion of patients reported mild adverse effects, including diarrhoea (3.5%), dizziness (3%), abdominal pain (2.2%), and nausea or vomiting (2%), none of which necessitated treatment discontinuation. Appropriate drug selection, correct dosing, and shortest effective treatment duration are essential for preventing antimicrobial resistance and achieving optimal antimicrobial stewardship. Despite availability of effective narrow-spectrum agents, costly broad-spectrum antibiotics are often overused in uncomplicated UTIs-a practice that should be discouraged.

Current UTI treatment guidelines rarely emphasise antimicrobial stewardship implementation. The development of novel oral antimicrobials with new mechanisms of action is anticipated; however, their success will depend on sustained global efforts to promote rational antimicrobial use [53].

The comparison of observed prescribing indicators with WHO reference values and IRDP scores revealed statistically significant deviations in the average number of drugs per encounter and the proportion of antibiotic prescriptions ($p<0.05$). Therefore, the null hypothesis was rejected and the alternative hypothesis accepted, indicating deviations from rational prescribing practices.

However, indicators such as generic prescribing and injection use did not differ significantly from reference values ($p>0.05$), supporting the null hypothesis for these parameters. A major strength of this study is the combined application of the ATC/DDD system, WHO prescribing indicators, and IRDP using a large sample size, providing a comprehensive and unbiased evaluation of drug use patterns.

Limitation(s)

The present study was a single-centre outpatient study and did not compare treatment efficacy across different antibiotic regimens.

CONCLUSION(S)

Nitrofurantoin and norfloxacin were appropriately dosed, whereas amoxicillin was underdosed and levofloxacin and cefpodoxime were overdosed. Overall antibiotic consumption, as reflected by DID values, was low. Minimal polypharmacy and absence of injections or FDCs indicate rational prescribing practices. However, the high rate of antibiotic prescribing, moderate adherence to EML and generic prescribing, and low IRDP scores highlight the need for strengthened antibiotic stewardship initiatives in outpatient settings. Regular drug utilisation reviews, adherence to WHO and national treatment guidelines, and integration of ATC/DDD monitoring into hospital systems are essential to promote rational prescribing and reduce inappropriate antibiotic use. Prescribing indicators reflect facility-level practices and do not capture individual prescriber behaviour; therefore, targeted interventions such as prescriber education, audit-feedback mechanisms, and formulary control are necessary to optimise antibiotic use and curb resistance.

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