

Antibiotic prescription practices and stewardship readiness among private practitioners in India: A cross sectional study

Ninu P Mathew

Kasturba Medical College, Manipal

Vandana Kalwaje Eshwara

Kasturba Medical College, Manipal

Robert A. C. Ruiter

Maastricht University

Unnikrishnan Bhaskaran

Manipal Academy of Higher Education

Muralidhar D Varma

Kasturba Medical College, Manipal

Girish Thunga

Manipal Academy of Higher Education

Asha Kamath

Manipal Academy of Higher Education

Chiranjay Mukhopadhyay

`chiranjay.m@manipal.edu`

Kasturba Medical College, Manipal

Research Article

Keywords: Antimicrobial resistance, Antibiotic stewardship, Antibiotic Prescription, AWaRe classification

Posted Date: April 8th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-9027476/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

Background

In the majority of the LMICs, the private sector accounts for a substantial proportion of antibiotic use but remains weakly integrated into antimicrobial stewardship and surveillance systems. Understanding the stewardship practices in this sector requires examination of both provider behaviour and system level enablers.

Methods

This is a cross-sectional study conducted among private medical practitioners in the Udupi district of South India, using a validated knowledge, attitude, and practice questionnaire, assessing prescribing behaviour for common infectious syndromes, and evaluating the availability of stewardship-enabling infrastructure. Antibiotic prescriptions are assessed using the WHO Access, Watch, Reserve (AWaRe) classification. Descriptive and comparative analysis is conducted.

Results

A total of 141 practitioners participated in the survey (response rate 65.2%). KAP scores were generally favourable for antimicrobial resistance and stewardship. However, watch category antibiotics were commonly prescribed for self-limiting infections and community-acquired infections, whereas Access category antibiotics remained low. Despite access to a microbiology laboratory, there was limited utilisation of culture and sensitivity tests. Formal stewardship structures, training and resistance patterns were uncommon. Overall, KAP scores did not differ significantly across individual practitioner level characteristics, suggesting systemic drivers for inappropriate use rather than individual factors.

Conclusion

In private health care settings, antibiotic prescription practices are shaped less by knowledge deficits and more by the structural gaps, such as the absence of guidelines, limited diagnostic stewardship, and weak stewardship governance. Effective AMS strategies should extend beyond education to address system-level enablers and accountability in the private health care.

Trial Registration:

The study was registered in the Clinical Trial Registry of India (CTRI/2021/01/030448) on 14th January, 2021 URL:<https://ctri.nic.in/Clinicaltrials/regtrial.php?trialid=50974&EncHid=24540.89288&modid=1&compid=19>

1. Background

Antimicrobial resistance (AMR) is a global public health concern primarily driven by the inappropriate use of antibiotics across healthcare settings. Lower- and Middle-Income Countries (LMICs) face a disproportionate burden of AMR due to the high burden of infectious diseases, limited diagnostic capacity, and weak regulatory oversight on antimicrobial prescribing [1, 2, 3, 4]. Frequent antibiotic prescription for self-limiting and viral infections, particularly in outpatients and secondary care facilities, contributes to unnecessary exposure to broad-spectrum agents and fuels the development of resistance [2, 5, 6]. In the majority of the LMICs, private sector provides the majority of first contact and hospital based care, however antibiotic stewardship interventions are primarily focused on public hospitals and tertiary care institutions [1, 7, 8, 9, 10, 11]. Evidence consistently shows a higher antibiotic prescription rates in private hospitals compared to public hospitals, with higher reliance on empirical therapy, demand-driven, incentive influenced prescriptions and lower adherence to antibiotic guidelines [12, 13]. However, they are frequently underrepresented in the national surveillance systems, stewardship initiatives and continuing professional education activities [14–19].

Knowledge- attitude – practice (KAP) is widely used to understand the prescriber behaviour related to AMR [12, 20]. Evidence suggests that awareness and a favourable attitude do not guarantee stewardship practices in the private sector - highlighting a knowledge - practice gap. In such contexts, understanding the prescriber behaviour not only requires an understanding of their current knowledge and attitude, but also an examination of structural and system - level factors influencing the everyday prescription practice [21–24].

India represents one such setting for examining stewardship gaps in the private sector, as the private sector caters to the majority of outpatient visits and a substantial proportion of healthcare [25, 26]. While national policies, such as the National Action Plan for AMR [27] and (AMS), prioritise rational antibiotic use and surveillance, empirical evidence from the community and private healthcare sector remains limited [5]. Antibiotic prescribing decisions in these settings are influenced not only by clinical knowledge but also by organisational structures, availability of diagnostics, institutional guidelines, workflow pressures, and accountability mechanisms. Examining antibiotic use through a health services lens allows assessment of how service-level inputs and governance structures shape prescribing behaviour.[20, 28, 29].

This study aimed to assess antibiotic-related knowledge, attitudes (KAP) and prescribing practices among private medical practitioners in a mixed healthcare district in southern India. In addition, we examined syndrome-specific antibiotic choices using the WHO AWaRe classification and explored system-level factors, including diagnostic access, stewardship governance, and training, that may facilitate or hinder the appropriate use of antibiotics. By identifying both behavioural and structural gaps, this study seeks to inform context-specific antimicrobial stewardship strategies applicable to private healthcare settings in LMICs.

2. Materials and methods

2.1 Study design and setting

This cross-sectional survey was conducted in Udupi district, Karnataka, located in the southwestern coastal region of India. Udupi has a mixed healthcare system comprising public hospitals at the primary, secondary, and tertiary levels, alongside a substantial private healthcare sector that includes large and medium private hospitals, nursing homes, and standalone private clinics. This setting represents a pluralistic healthcare system typical of many districts in India and other LMICs, where outpatient and secondary care services are predominantly delivered by private providers [9–11; 30–32].

2.2 Study population and eligibility criteria

The study population included private practitioners (PPs) holding a minimum qualification of Bachelor of Medicine and Bachelor of Surgery (MBBS) or higher, who were actively involved in patient care within private clinical establishments lacking a formal academic teaching structure. Private clinical establishments were defined according to India's Clinical Establishments Act, 2010, as facilities operated by non-governmental entities, including private hospitals, nursing homes, and clinics.

Practitioners working exclusively in government facilities, those not directly involved in patient care, and those affiliated with academic institutions were excluded. Of the 445 PPs identified in the district, 253 met the eligibility criteria, and 141 consented to participate in the survey.

2.3 Sample size calculation

The sample size was calculated based on the estimated prevalence of PPs with good knowledge of AMR and AMS. A pilot study conducted in the same setting indicated an assumed prevalence of 53%. Using a 95% confidence interval, 5% absolute precision, and applying a finite population correction for the eligible population ($N = 253$), the minimum required sample size was 151. A total of 141 PPs participated, achieving 93% of the target sample size, which is considered adequate for AMS-related surveys among physicians in similar settings.

2.4 Study tool and scoring

A semi-structured questionnaire in English was developed to assess KAP, along with contextual and environmental barriers related to AMR and AMS. Items were adapted from standard textbooks, published literature, and national and international guidelines, supplemented by informal discussions with experts in Clinical Microbiology and Infectious Diseases to ensure contextual relevance.

The final questionnaire comprised four sections (Provided as Supplementary file 1):

1. Demographic and professional characteristics
2. Knowledge items assessing antibiotic pharmacology, AMR mechanisms, and AMS awareness

3. Attitude items exploring perceptions of antibiotic misuse, AMR threat, prescribing pressures, and stewardship
4. Practice items assessing self-reported prescribing behaviour, case-based decisions, diagnostic use, stewardship infrastructure, confidence, and patient education

Content validity was established through expert review by a multidisciplinary panel of five experts using a four-point ordinal scale. The Item Content Validity Index (ICVI) and Scale Content Validity Index (SCVI) were calculated. Three items with ICVI < 0.7 were removed, and the final SCVI was 0.98, indicating excellent content validity. Based on pilot testing and expert suggestions, additional items addressing external influences and prescribing drivers were included.

Construct validity of the attitude scale was assessed using exploratory factor analysis, which demonstrated adequate factorability (Kaiser-Meyer-Olkin ≥ 0.5). The questionnaire also included clinical case scenarios - acute bronchitis, acute infectious diarrhoea, and rhinosinusitis - as sentinel conditions to differentiate appropriate non-prescribing or watchful waiting from inappropriate antibiotic use, in line with ICMR guidelines.

Internal consistency of knowledge items was assessed using the Kuder–Richardson formula (KR-20), while Cronbach’s alpha was used for attitude items. Knowledge items showed good to excellent reliability (KR-20 ≥ 0.90). A test–retest reliability assessment conducted among 17 participants over a two-week interval demonstrated moderate reliability for KAP domains (ICC 0.51–0.72).

2.5 Data collection method

Data were collected between April 2021 and July 2023 using both online and in-person approaches. For online participation, a secure Google Form link was shared via email or WhatsApp, mirroring the paper questionnaire to minimise mode-related bias. For offline participation, the researcher personally distributed the self-administered questionnaires. Participation was voluntary, following informed consent.

2.6 Data management and analysis

Questionnaires were reviewed for completeness, and online responses included mandatory fields. Data were cleaned, coded, and analysed using Jamovi (version 2.6.3). Knowledge and practice items were scored dichotomously (correct/right = 1; incorrect/wrong = 0). Attitude items were scored on a five-point Likert scale, with reverse scoring applied where appropriate. Composite scores were generated for each domain, with higher scores indicating better KAP. Antibiotic prescribing choices were categorised using the WHO AWaRe classification. Normality was assessed using the Shapiro - Wilk test. Appropriate parametric or non-parametric tests were applied based on data distribution.

2.7 Ethical considerations

Ethical approval

was obtained from the Kasturba Medical College and Kasturba Hospital Institutional Ethics Committee (Ref No: IEC 624–2020). The study was registered with the Clinical Trial Registry of India (CTRI/2021/01/030448). Participants were informed of their right to withdraw at any stage, and written informed consent was obtained from all participants.

3. Results

Out of the 308 private practitioners identified, 92 were excluded (recruitment details are provided in Fig. 1), leaving 216 eligible practitioners. Among these, 141 participated in the survey, with a response rate of 65.2%.

The majority of participants were males (72.3%), with a median age of 45–64 years (52.4%). Most PPs were postgraduate specialists (83.6%) who practised at private hospitals (61.7%). PPs in the survey practised at primary, secondary, and tertiary care levels, with the majority (64.5%) being from secondary care. A detailed demographic and professional profile of the participants is provided in Table 1

Table 1
Demographic and professional profile of the participating private practitioners

Demographic Variables	Frequency	Percentage (%)
Gender		
Male	102	72.3%
Female	39	27.7%
Age		
25–44 years	38	26.95%
45–64 years	74	52.48%
> 64 years	29	20.57%
Type of Health Facility		
Primary Care	36	25.50%
Secondary care	91	64.50%
Tertiary care	14	9.90%
Professional status*		
General Practitioners/ primary care physicians	23	16.4%
Specialist (postgraduate specialist)	118	83.6%
Type of clinical practice*		
Private Hospitals (Includes medium/ large private hospitals, multispecialty, tertiary care hospitals)	87	61.7%
Private outpatient clinics	45	31.19%
Small private inpatient facility (Nursing or Maternity homes)	9	6.90%

*Professional Status has been classified according to the WHO international standard definitions; the types of clinical practices - In the Indian context, "nursing homes" and "maternity homes" are small, privately owned hospitals with limited inpatient facilities. For generalizability, (Hospitals Level 1–3) were grouped under "Private hospitals" according to the Clinical Establishments Act, 2010. Type of health facility - Primary care facilities include private general practices or clinics functioning as first-contact services; secondary care facilities are private hospitals providing specialist services; tertiary care facilities include large super-speciality hospitals.

Analysis of antibiotic prescriptions for clinical syndromes demonstrates a strong tendency towards the choice of Watch category antibiotics, with comparatively less use of Access category agents and a non-

negligible use of reserve antibiotics in certain conditions. For self-limiting infections such as acute pharyngitis and community-acquired respiratory infections, approximately one-third to two-fifths were Watch category antibiotics, including macrolides, fluoroquinolones, and oral cephalosporins. Over one-fifth of the prescriptions for Acute otitis media and skin and soft tissue infections were Watch agents – suggesting a frequent escalation beyond first-line agents.

For Urinary tract infections and acute infectious diarrhoea, Watch agents were predominantly used, such as fluoroquinolones and cephalosporins. In severe infections, including bloodstream infections and ventilator-associated pneumonia, the predominant use was the Watch category, with 6–19% of the PPs using reserve category antibiotics. Overall, there is limited alignment with AWaRe recommendations, characterised by frequent escalation to Watch and Reserve agents, with relatively lower use of Access antibiotics in the private sector. A detailed analysis of the antibiotic usage in comparison to the AWaRe classification is provided in Table 2:

Table 2
Most common antibiotics prescribed for common clinical conditions

Antibiotics	Percentage	AWaRe
Acute Pharyngitis		
Amoxicillin	36.26%	Access
Azithromycin	34.07%	Watch
Amoxicillin with clavulanic acid	17.58%	Access
Levofloxacin	4.40%	Watch
Community-acquired Respiratory Tract Infections		
Amoxicillin	38.30%	Access
Azithromycin	21.28%	Watch
Amoxicillin with clavulanic acid	18.09%	Access
Cefixime	5.32%	Watch
Ceftriaxone	5.32%	Watch
Acute Otitis Media		
Amoxicillin with clavulanic acid	45.83%	Access
Amoxicillin	20.83%	Access
Cefpodoxime	6.94%	Watch
Cefixime	6.94%	Watch
Azithromycin	6.94%	Watch
Urinary Tract Infection		
Nitrofurantoin	24.77%	Access
Norfloxacin	12.84%	Watch
Cefixime	12.84%	Watch
Ciprofloxacin	10.09%	Watch
Levofloxacin	8.26%	Watch
Amoxicillin	6.42%	Access
Ventilator-Associated Pneumonia		
Piperacillin+ Tazobactam	25.00%	Watch

Antibiotics	Percentage	AWaRe
Acute Pharyngitis		
Meropenem	19.44%	Reserve
Vancomycin	16.67%	Watch
Cefaperazone+Sulbactam	13.89%	Watch
Ceftriaxone	13.89%	Watch
Skin and Soft Tissue Infections		
Amoxicillin + clavulanic acid	31.73%	Access
Azithromycin	8.65%	Watch
Cefixime	7.69%	Watch
Amoxicillin	6.73%	Access
Ceftriaxone	5.77%	Watch
Blood Stream Infections		
Ceftriaxone	46.77%	Watch
Piperacillin Tazobactam	9.68%	Watch
Cefixime	6.45%	Watch
Amoxicillin + clavulanic acid	6.45%	Access
Meropenem	6.45%	Reserve
Acute Infectious Diarrhoea		
Ofloxacin	20.00%	Watch
Metronidazole	10.59%	Access
Cefixime	10.59%	Watch
Ofloxacin+Ornidazole	10.59%	Watch
Ciprofloxacin	9.41%	Watch

Knowledge regarding antibiotics and antimicrobial resistance

The majority of private practitioners (PPs) demonstrated good overall knowledge of antibiotics and antimicrobial resistance (median score: 23; IQR: 22–25). Over 90% could correctly distinguish between antibiotics and antimicrobials, and 96.1% identified the safest antibiotic for use during pregnancy. While most PPs (96.1%) recognised that bacteria develop resistance to antibiotics, nearly one-fifth (19.9%)

incorrectly believed that the human body becomes resistant. Knowledge of resistance transmission was suboptimal, with 35.5% unaware of animal-to-human transmission pathways.

PPs showed strong awareness of key AMR drivers, including self-medication (97.8%), broad-spectrum antibiotic use (80.1%), non-adherence (92.2%), inappropriate empiric therapy (86.4%), and incorrect dosing (89.6%). However, awareness of antibiotic use in animals (51.8%) and environmental contributors to AMR, such as poor infection control (20.6%) and environmental contamination (23.4%), was limited.

Notable gaps were observed in clinical pharmacology, particularly regarding azithromycin dosing (36.2%) and aminoglycoside administration (36.9%).

The detailed knowledge response by private practitioners for the antibiotic resistance mechanism and the causes or drivers for AMR and antibiotic use is summarised in Table 3.

Table 3
Knowledge response by Private Practitioners

Knowledge items	Right	Wrong
Antibiotic resistance (M = 7; IQR:1 (6,7))		
Antibiotic resistance develops when the human body grows resistant to antibiotics	80.1%	19.9%
Antibiotic resistance develops when bacteria grow resistant to antibiotics	96.5%	3.5%
Resistant bacteria are transmitted from animals to humans	64.5%	35.5%
Causes of AMR (M = 11; IQR:3 (9, 12))		
Using more broad-spectrum antibiotics is a driver for AMR	80.1%	19.9%
Self-medication by the patient is a driver for AMR	97.8%	2.2%
Patients not adhering to the course of antibiotic therapy is a driver for AMR	92.2%	7.8%
Lack of infection control practices in hospitals is a driver for AMR	79.4%	20.6%
The use of antibiotics in animals is a driver for AMR	51.8%	48.2%
A contaminated hospital environment due to a lack of proper hygiene and sanitation is a driver for AMR	76.5%	23.4%
Inappropriate empirical choices are a driver for AMR	86.4%	13.6%
Inappropriate dose prescription is a driver for AMR	89.6%	10.4%
Inappropriate duration of antibiotic is a driver for AMR		
Clinical knowledge on antibiotic use (M = 9;IQR:2 (8,10))		
For an adult patient with Group A Streptococcus Pharyngitis, Is treatment with Azithromycin 500mg for 3 days justified?	36.2%	63.8%
Ceftriaxone is an empiric treatment choice for acute Bacterial Meningitis	83%	17%
Which antibiotics more effectively cross blood brain barrier	68.1%	31.9%
Which among the following antibiotics show best activity against anaerobic organisms	92.2%	7.8%
The most effective way of administering an aminoglycoside antibiotic like gentamicin	36.9%	63.1%
Should erythromycin be used to treat upper respiratory tract infections	9.2%	76.5%
Methicillin resistant Staphylococcus aureus is sensitive to	51.7%	48.2%
Gut commensal flora is an important reservoir of resistant genes both in the hospital and community settings	60.2%	39.7%
An antibiotic will always be effective in treating the same infection again in the	16.3%	83.6%

Knowledge items	Right	Wrong
Antibiotic resistance (M = 7; IQR:1 (6,7))		
future		

Descriptive statistics of KAP scores among Private Practitioners are provided in Table 4. The median knowledge score was 24 (IQR = 4), ranging from 8 to 29. Attitude scores were normally distributed with a mean score of 41 ± 4.02 (range: 28–50). The practice scores had a mean of 52.3 ± 7.35 (range:28–66). The results show that the knowledge and practice levels have substantial variability, while MPs had a favourable attitude towards AMR and AMS

Table 4
Descriptive statistics of KAP scores among Private Practitioners

Score	Mean $\pm$ SD/Median (IQR)	Range
Total Knowledge	24(4)	8–29
Total attitude	41 ± 4.02	28–50
Total practice	52.3 ± 7.35	28–66

Attitude towards AMR and AMS

The majority of the PPs (80–90%) had a favourable attitude towards AMS and IPC. More than 90% of the MPs recognise AMR as a global and national problem. The PPs strongly prefer context-specific solutions, 95% of them preferring a local guideline than an international one. PPs had a strong inclination towards evidence-based prescription, as reflected by approximately 80% rejecting cost and expiry date as primary selection criteria for antibiotics, and 91.5% disagreeing with complying with patient demand for antibiotic prescriptions.

Despite the favourable attitude, an ambiguous stance is noted. While PPs clearly recognise the overuse of antibiotics in community general practice (97% agreed), they have mixed views (only 75% agreed) over hospital misuse. Most recognise the external drivers of antibiotic misuse, such as OTC availability (90.8% agree) and industry pressure (54% agree). However, there is a disagreement on when to use reserve antibiotics, with 27.7% agreeing and the same proportion (27.7%) disagreeing on the preference for reserve antibiotics. It is important to note the neutrality of a small proportion (27.7%) regarding antibiotic guidelines and the committee's suggestion of reluctance in AMS uptake in real-world practice. Table 5 provides a detailed description of the attitude scores.

Table 5
Attitude towards AMR and AMS

Attitude Items	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree
Guidelines and AMS strategies (M = 16 (IQR:3; 15,18))					
Antibiotic guidelines and the Committee on antibiotics are more of an obstacle to clinical care than an aid	7(5.00%)	18(12.80%)	39(27.70%)	55(39.00%)	22(15.60%)
Prescribing fewer antibiotics can reduce the risk of antibiotic-resistant infections	16 (11.30%)	62 (44.00%)	16 (11.30%)	16 (11.30%)	0
It would be more useful to develop local guidelines than international ones.	76 (53.90%)	58 (41.10%)	5 (3.50%)	2 (1.40%)	0
Infection control programs and antimicrobial stewardship programs are necessary for reducing antibiotic resistance	71 (50.40%)	59 (41.80%)	7 (5.00%)	0	4 (2.80%)
Attitude towards AMR (M = 10 (IQR:2; 8,10))					
Antimicrobial resistance is a serious worldwide problem	88 (62.40%)	47 (33.30%)	6 (4.30%)	0	0
Antimicrobial resistance is a serious problem in community setting of India	90(63.8%)	43 (30.50%)	4 (2.80%)	3 (2.10%)	1 (0.70%)
Attitude on prescribing practices (M = 11 (IQR: 3; 10, 13))					
The selection of an antibiotic must be based on the expiry date, cost and availability of the drug rather than the cause of the infection	9 (6.40%)	5 (3.50%)	13 (9.20%)	72 (51.10%)	42 (29.80%)
We should consider the patient's demand for antibiotics even if it is not necessary to prescribe an antibiotic	1 (0.70%)	4 (2.80%)	7 (5.00%)	66 (46.80%)	63 (44.70%)

Attitude Items	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree
Guidelines and AMS strategies (M = 16 (IQR:3; 15,18))					
I would prefer a restricted/ reserve antibiotic rather than looking for an alternative	15 (10.60%)	38 (27.00%)	29 (20.60%)	39 (27.70%)	20 (14.20%)
Attitude on antibiotic overuse (M = 9 (IQR:2; 7.9))					
I think antibiotics are overused in Community General Practice	89 (63.10%)	48 (34.00%)	3 (2.10%)	1 (0.70%)	0
Antibiotics are overused in hospitals	56 (39.70%)	50 (35.50%)	28 (19.90%)	7 (5.00%)	0
Attitude toward external influence on antibiotic use (M = 8 (IQR: 2; 7, 9))					
In general, the promotion of drugs by pharmaceutical companies plays an important role in antibiotic prescription	17 (12.10%)	59 (41.80%)	34 (24.10%)	22 (15.60%)	9 (6.40%)
Over-the-counter availability of antibiotics in pharmacies DOES NOT contribute to antibiotic resistance	5 (3.50%)	4 (2.80%)	4 (2.80%)	62 (44.00%)	66 (46.80%)

Antibiotic prescription practice

We also assessed antibiotic prescription practices in cases of acute bronchitis, watery diarrhoea, and colds; a detailed summary is provided in Table 6. For fever and sore throat, the majority (77.3%) of the PPs would resort to empirical therapy with amoxicillin (55.6%), while a considerable proportion (29.2%) would opt for azithromycin and broad-spectrum cephalosporins (8.4%), demonstrating an overuse of Watch and Reserve antibiotics. A small proportion preferred a watch-and-wait approach (22.6%), reflecting some awareness of viral aetiology and self-limiting illness. PPs tend to align towards treating purulent sputum as bacterial, despite a viral presentation in Case 1. In the case of watery diarrhoea (case 2), 81.48% would not prescribe antibiotics, demonstrating alignment with guidelines. For a likely viral rhinosinusitis, a significant proportion (40.6%) would recommend antibiotics. There are significant gaps in diagnostic differentiation and antibiotic spectrum choice in prescription practice. Overall, the antibiotic prescription demonstrates a misalignment with WHO AWaRe recommendations and ICMR treatment guidelines for common infectious syndromes [33, 34]

Table 6
Antibiotic Prescription Practice in different clinical scenarios

SI No	Case scenario	Correct	Incorrect
1	A patient with Acute bronchitis/cough for 5 days; no fever; lung examination shows normal; presence of purulent sputum; would you recommend antibiotics?	30%	70%
2	Watery diarrhoea for 3 days; no foul-smelling; no fever; Stool examination and other examinations are regular; would you recommend antibiotics?	81.48%	18.52%
3	Would you recommend an antibiotic for a patient with purulent nasal discharge for 5 days; no fever reported; no cough, and an otherwise routine examination?	49.62%	50.37%

Stewardship infrastructure, diagnostic and training

The majority of the PPs (92.1%) antibiotic prescription decision-making relied on previous experience and knowledge, 53.1% relied on national guidelines, 36.8% relied on advice from colleagues, 43.2% relied on advice from a microbiologist 43.2%, and very few (1.41%) were influenced by culture and sensitivity test -reflecting a significant gap in evidence-based prescription. Limited microbiological data and patterns are evident, with 76.5% not having local antimicrobial resistance patterns available in their facility, and 56% of the PPs not receiving any frequent and periodic updates on the resistance pattern in their practice. A vast proportion (78.7%) of the PPs had access to a referral microbiology laboratory, and only 51% recommended culture and antibiotic sensitivity testing results before prescribing definitive antibiotic therapy, which suggests underutilization of the laboratory facility. Structural deficiencies are evident from the fact that 75.2% of the PPs have not received or attended any formal training on antimicrobial prescribing in the last year of their practice. Few (42.8%) of the MPs had antibiotic or IPC guidelines, and 83.1% did not have an AMS committee in their hospitals. These findings collectively reveal a substantial deficit in diagnostic and governance support for stewardship in private healthcare settings.

Patient education during antibiotic therapy

At the provider–patient interface, 58.2% of doctors reported constantly educating patients on the correct daily dose and duration of antibiotics, and 44% of PPs explained the rationale behind not giving an antibiotic when it is not indicated. About half of the PPs (52.5%) always educated patients not to share antibiotics, and fewer than half (46.1%) of the doctors routinely advised the patients to assess the adherence to therapy. On average, 50% of PPs consistently engage in patient education while prescribing antimicrobial treatment, whereas the other half miss the stewardship opportunity in patient education.

Decision-making in antibiotic therapy

Most doctors reported high confidence in their antibiotic decision-making, such as planning the duration of antibiotic treatment (89.4%), diagnosing infections (61.7%), and antibiotic selection (62.1%). However, diagnostic dependent stewardship decision making lacked confidence; with on 41.1% expressed full confidence in diagnostic differentiation, using a combination antibiotic therapy (53.9%) and just over half (57.4%) confident in interpretation of the microbiological results (57.4%), streamlining /stopping the antibiotic treatment based the clinical evolution (58.9%) and in choosing between Intra Venous route and oral administration (57.4%) – suggesting a limited confidence in diagnostics and evidence based decision making among the PPs

KAP scores across demographic variables

Our bivariate analysis shows that there is no statistically significant difference in KAP scores observed across gender, age, clinical practice, qualification, year of professional experience, type of health facility and professional status based on appropriate non-parametric tests (Mann-Whitney U, Kruskal-Wallis) or Parametric tests (Independent sample tests or ANOVA) analysis. The detailed analysis is described in Table 7

Table 7
Comparison of KAP scores and demographic variables

Demographic variable	Categories	KAP score (Mean $\pm$ SD /Median &IQR)	P values	Test used
Gender	Male	116 $\pm$ 10.7	0.777	Independent T-test
	Female	116 $\pm$ 10.7		
Age	25–44	116 $\pm$ 10.8	0.814	One-way ANNOVA
	45–64	116 $\pm$ 10.4		
	> 65	117 $\pm$ 11.4		
Clinical practice	Nursing homes	106 $\pm$ 7.9	*0.001	One-way ANNOVA (Welch's)
	Private hospitals	117 $\pm$ 10.66		
	Private clinics	116 $\pm$ 10.33		
Type of Health facility	Primary care	115 $\pm$ 11.99	0.449	One-way ANNOVA
	secondary care	116 $\pm$ 9.75		
	Tertiary care	120 $\pm$ 12.67		
Professional Status	Consultant	114 $\pm$ 10.41	0.200	One-way ANNOVA
	General practitioners	115 $\pm$ 12.11		
	Specialist	116 $\pm$ 10.59		
	Specialist and consultant	121 $\pm$ 8.75		
Qualification	MBBS	115 $\pm$ 11.3	0.868	Independent sample T test
	Post graduate	117 $\pm$ 10.5		
Years of professional experience	0–5 years	118 $\pm$ 8.44	0.636	One way ANOVA (Welch's)
	6–10 years	118 $\pm$ 9.31		
	11–20 years	116 $\pm$ 14.93		
	> 20 years	116 $\pm$ 10.52		

*Significant difference in KAP score across clinical practice settings (Welch's annova, $p = 0.001$) was observed; post hoc Games – Howell comparisons showed that PPs working in nursing homes had significantly different KAP scores compared to private hospitals ($p = 0.003$) and private clinics ($p =$

0.006). No other statistically significant difference in KAP score was observed in all the other demographic variables.

4. Discussion

This study assessed knowledge, attitudes, and practices related to AMS in a mixed healthcare district in South India. The findings reveal a clear knowledge -attitude-practice paradox, wherein generally good knowledge of AMR)and favourable attitudes towards stewardship do not consistently translate into optimal prescribing behaviour. Inappropriate antibiotic use, particularly the overuse of Watch category agents and antibiotics for self-limiting infections, suggests that suboptimal prescribing in private healthcare settings is driven primarily by structural, diagnostic, and contextual barriers rather than individual knowledge deficits.

Although most practitioners recognised the seriousness of AMR and expressed support for AMS and IPC, prescribing practices often deviated from national and global guidelines. Antibiotics were routinely used for community-acquired and self-limiting infections, and reserve antibiotics were prescribed for multiple indications. This disconnect between intent and practice mirrors findings from other LMICs, including India. Importantly, no significant association was observed between individual practitioner characteristics (age, experience, or qualifications) and KAP scores, underscoring that prescribing behaviour is shaped more by practice context than by individual attributes.

A key finding is the diagnostic utilisation gap. Despite access to microbiology laboratories, many practitioners did not recommend diagnostic testing, indicating barriers beyond access, such as cost, patient affordability, consent, lack of standardised reporting, and delayed results. Furthermore, the absence of local antibiograms and limited confidence in interpreting microbiological results weaken diagnostic stewardship. These findings emphasise that laboratory availability alone is insufficient; effective stewardship requires functional diagnostic integration supported by timely reporting, standardised formats, local resistance data, affordable diagnostics, and patient engagement. In their absence, empirical therapy becomes the default, even among AMR-aware prescribers.

Missed stewardship opportunities were evident at the provider–patient interface. Practitioners frequently relied on clinical experience rather than diagnostic input, particularly in private practice settings characterised by time constraints, patient expectations, and financial considerations. Inadequate patient education on adherence and non-prescribing decisions further compounds inappropriate antibiotic use.

Case-based assessments showed guideline-concordant prescribing for acute infectious diarrhoea, but inappropriate antibiotic use persisted for acute bronchitis and viral upper respiratory tract infections. Misinterpretation of purulent sputum as bacterial infection contributed to unnecessary antibiotic exposure and AWaRe misalignment.

These findings have direct implications for AMS interventions in private healthcare. Education alone is insufficient unless complemented by system-level enablers. From a health services perspective, integrating private providers into surveillance systems, strengthening diagnostic stewardship, and embedding locally relevant prescribing guidance within routine workflows may support improved antibiotic use.

This study provides practice-oriented evidence from the underrepresented private healthcare sector and employs syndrome-based prescription assessment aligned with AWARe and national guidelines. However, self-reported practices may be subject to social desirability bias, the cross-sectional design limits causal inference, and findings from a single district may not be universally generalisable. Nonetheless, the observed patterns are consistent with reports from other regions in India and LMICs, supporting the broader relevance of the findings [35–40].

5. Conclusion

This study demonstrates that inappropriate antibiotic prescribing persists despite good awareness of antimicrobial resistance and a favourable attitude towards AMS. These findings suggest that educational interventions alone may be insufficient in private healthcare settings without parallel strengthening of diagnostic integration, guideline availability, and institutional stewardship governance. Without these enabling structures, empirical prescribing remains the default, even among well-informed practitioners. Strengthening AMS in the private sector, therefore, demands addressing these structural issues for improving antibiotic use in pluralistic health systems

Abbreviations

AMR – Antimicrobial Resistance

AMS – Antimicrobial Stewardship

KAP – Knowledge, Attitude and Practice

WHO – World Health Organisation

PPs – Private Practitioners

ICVI – Item Content Validity Index

SCVI - Scale Content Validity Index

ICMR – Indian Council of Medical Research

IPC – Infection Prevention and Control

Declarations

Statement regarding Ethical approval and consent to participate: Ethical approval for the study was obtained from Kasturba Medical College and Kasturba Hospital (KMC & KH) Institutional Ethics Committee (Ref No: IEC 624–2020). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Informed consent was obtained from all individual participants included in the study.

Consent for publication:

The authors confirm that the participants were informed and provided their informed consent for the publication of these findings in academic journals and forums.

Competing interests:

None to declare

Funding:

This study was supported by the Indian Council of Medical Research (ICMR) through the award of a fellowship – Reference number: SRF/08/2022/SBHSR.

Author Contribution

All authors contributed to the conception and design of the study. NM collected the data. NM and RAC performed the data analyses and interpreted the results. NM prepared the initial manuscript draft. CM, VKE, RAC, UB, MV, GT, and AK critically revised the manuscript for important intellectual content. CM, VKE, MV, and UB provided supervision and senior oversight. All authors approved the final version of the manuscript.

Data Availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

References

1. Sulis G, Adam P, Nafade V, Gore G, Daniels B, Daftary A, Das J, Gandra S, Pai M. Antibiotic prescription practices in primary care in low- and middle-income countries: a systematic review and meta-analysis. *PLoS Med.* 2020;17(6):e1003139.

2. Chalotra R, Khajuria N, Zaffer I, Singh JP, Sr. Pattern in the antibiotic prescribing practices at primary health settings in India: a systematic review and meta-analysis. *Cureus*. 2025;17(10):e93812.
3. Nepal G, Bhatta S. Self-medication with antibiotics in WHO Southeast Asian region: a systematic review. *Cureus*. 2018;10(4):e2428. 10.7759/cureus.2428.
4. Hossain MJ, Jabin N, Ahmmed F, Sultana A, Abdur Rahman SM, Islam MR. Irrational use of antibiotics and factors associated with antibiotic resistance: findings from a cross-sectional study in Bangladesh. *Health Sci Rep*. 2023;6(8):e1465. 10.1002/hsr2.1465.
5. Modgil V, Shafiq N, Gondara A, Surial R, Singh H, Karol V, Kaur M, Lambert H, Taneja N. An evaluation of antibiotic prescription pattern and drug rationality analysis among outpatients at public health setting, India. *Indian J Med Microbiol*. 2025;55:100829. 10.1016/j.ijmmb.2025.100829.
6. Bansal A, Gupta M, Shafiq N, Saroch A, Muralidharan J, Arora N, Kumar M, Tripathi S. Rational use of antibiotics at primary & secondary healthcare facilities in district Panchkula, Haryana, North India: a cross-sectional study. *Indian J Med Res*. 2025.
7. Sharma M, Damlin AL, Sharma A, Stålsby Lundborg C. Antibiotic prescribing in medical intensive care units: a comparison between two private sector hospitals in central India. *Infect Dis*. 2015;47(5):302–9.
8. Koya SF, Ganesh S, Selvaraj S, Wirtz VJ, Galea S, Rockers PC. Consumption of systemic antibiotics in India in 2019. *Lancet Reg Health Southeast Asia* 2022;4.
9. Sarwar MR, Saqib A, Iftikhar S, Sadiq T. Antimicrobial use by WHO methodology at primary health care centers: a cross-sectional study in Punjab, Pakistan. *BMC Infect Dis*. 2018;18:492.
10. Tekleab AM, Asfaw YM, Weldetsadik AY, Amaru GM. Antibiotic prescribing practice in the management of cough or diarrhea among children attending hospitals in Addis Ababa: a cross-sectional study. *Pediatr Health Med Ther*. 2017;8:93–8.
11. Admassie E, Begashaw B, Hailu W. Assessment of drug use practices and completeness of prescriptions in Gondar University Teaching Referral Hospital. *Int J Pharm Sci Res*. 2013;4:265.
12. Kotwani A, Chaudhury RR, Holloway K. Antibiotic-prescribing practices of primary care prescribers for acute diarrhea in New Delhi, India. *Value Health*. 2012;15:S116–9.
13. Sarkar S, Saha S, Dutta S. Antimicrobial stewardship implementation in primary and secondary tier hospitals in India. *Sci Rep*. 2024;14:78111.
14. Ab Rahman N, Teng CL, Sivasampu S. Antibiotic prescribing in public and private practice: a cross-sectional study in primary care clinics in Malaysia. *BMC Infect Dis*. 2016;16:9459.
15. Lam TT, Le H, Tran HH, Do DV, Nguyen TA, Jan S, et al. What are the most effective community-based antimicrobial stewardship interventions in low- and middle-income countries? A narrative review. *J Antimicrob Chemother*. 2021;76(5):1117–29.
16. Raju R, Gharat M, Vaidya R, Siddalingegowda SM, Kumar TMP, Srinivas SC. Community pharmacists as antimicrobial resistance stewards: a narrative review on their contributions and challenges in low- and middle-income countries. *J Pharm Pharm Sci* 2024;27.

17. Rolfe R, Kwobah C, Kussin P, Ali S, Bollinger J, Bodinayake C et al. Barriers to implementing antimicrobial stewardship programs in three low- and middle-income country tertiary care settings: findings from a multi-site qualitative study. *Antimicrob Resist Infect Control* 2021;10(1).
18. Singh S, Jaykrishnan AV, Charani E, Ellangovan K, Kumar A, Sharma A et al. A road-map for addressing antimicrobial resistance in low- and middle-income countries: lessons learnt from the public private participation and co-designed antimicrobial stewardship programme in the State of Kerala, India. *Antimicrob Resist Infect Control* 2021;10(1).
19. Sriram V, Yilmaz V, Kaur S, Andres C, Cheng M, Meessen B. The role of private healthcare sector actors in health service delivery and financing policy processes in low- and middle-income countries: a scoping review. *BMJ Glob Health*. 2024;8(Suppl 5):e013408.
20. World Health Organization. Antimicrobial stewardship programmes in healthcare facilities in low- and middle-income countries: a WHO practical toolkit. Geneva: World Health Organization; 2019.
21. Bosley H, Henshall C, Appleton JV, Jackson D. A systematic review to explore influences on parental attitudes towards antibiotic prescribing in children. *J Clin Nurs*. 2017;27(5–6):892–905.
22. Yates TD, Davis ME, Taylor YJ, Davidson L, Connor CD, Buehler K et al. Not a magic pill: a qualitative exploration of provider perspectives on antibiotic prescribing in the outpatient setting. *BMC Fam Pract* 2018;19(1).
23. Guo H, Chow A, Ibrahim MAB, Hildon ZJL, Tang WE, Loh VWK et al. Exploring antibiotic prescribing in public and private primary care settings in Singapore: a qualitative analysis informing theory and evidence-based planning for value-driven intervention design. *BMC Fam Pract* 2021;22(1).
24. Bartholomew Eldredge LK, Markham CM, Ruiter RAC, Fernández ME, Kok G, Parcel GS. Planning health promotion programs: an intervention mapping approach. 4th ed. San Francisco (CA): Jossey-Bass; 2016.
25. Institut Montaigne. Private healthcare in India: boons and banes 2020 [cited 2025 Mar 5]. Available from: <https://www.institutmontaigne.org/en/expressions/private-healthcare-india-boons-and-banes>
26. Swain S, et al. Human resources for health in India: need to go beyond numbers. *Indian J Community Med*. 2020;45(3):266.
27. World Health Organization. India: national action plan on antimicrobial resistance (NAP-AMR) 2017–2021. New Delhi: WHO Regional Office for South-East Asia; 2017.
28. Resman F. Antimicrobial stewardship programs; a two-part narrative review of step-wise design and issues of controversy. Part II: ten questions reflecting knowledge gaps and issues of controversy in the field of antimicrobial stewardship. *Ther Adv Infect Dis*. 2020;7:2049936120945083. 10.1177/2049936120945083.
29. Pierce J, Apisarnthanarak A, Schellack N, et al. Global antimicrobial stewardship with a focus on low- and middle-income countries. *Int J Infect Dis*. 2020;96:621–9. 10.1016/j.ijid.2020.05.126.
30. Sengupta A, Mukhopadhyaya I, Weerasinghe MC, Karki A. The rise of private medicine in South Asia. *BMJ*. 2017;357:j1482. 10.1136/bmj.j1482.

31. Sundararajan R, Mwanga-Amumpaire J, King R, et al. Conceptual model for pluralistic healthcare behaviour: results from a qualitative study in southwestern Uganda. *BMJ Open*. 2020;10:e033410. 10.1136/bmjopen-2019-033410.
32. Carruth L. Camel milk, amoxicillin, and a prayer: medical pluralism and medical humanitarian aid in the Somali Region of Ethiopia. *Soc Sci Med*. 2014;120:405–12.
33. Indian Council of Medical Research. Treatment guidelines for antimicrobial use in common syndromes. 2nd ed. New Delhi: Indian Council of Medical Research; 2019.
34. World Health Organization. AWaRe classification of antibiotics for evaluation and monitoring of use. Geneva: World Health Organization; 2023 Jul. p. 26.
35. Alhosni H, Alahdab F, Zakaria W, Kejah A, Shibani M, Alameer MB, Hawat A, Torbey A, Karah N, Alhajmoussa A, Ezkazyez A, Abbara A. A cross-sectional survey of knowledge, attitudes, and practices regarding antimicrobial resistance among Syrian health care professionals. *IJID Reg*. 2025;17:100789. 10.1016/j.ijregi.2025.100789.
36. Ma Y, Xia Y, Zhang X, et al. Knowledge, attitude, and practice of clinicians regarding antimicrobial stewardship: a cross-sectional study in a tertiary hospital of East China. *Antimicrob Resist Infect Control*. 2025;14(1):148. 10.1186/s13756-025-01665-9.
37. Badar V, Parulekar VV, Garate P. Study of knowledge, attitude and practice amongst medical professionals about antimicrobial stewardship in tertiary care teaching hospital in India: a questionnaire based study. *Int J Basic Clin Pharmacol*. 2018;7:511–7.
38. Maksane N, Langfeld K, Bhaskar JP, Sadhu S, van Hasselt J. Attitudes and practices for antibiotic prescription and antimicrobial resistance among general physicians: findings from a multi-country survey. *PLOS Glob Public Health*. 2025;5(5):e0004558. 10.1371/journal.pgph.0004558.
39. Aniyozova I, Akilov H, Kasimova M, Favaretti C, Sadyrova M, Egamberdieva Z, Botirova L, Deckert A. Antimicrobial resistance related knowledge, attitude and practice of general practitioners, patients and farmers: a cross-sectional study in Uzbekistan. *Heliyon*. 2024;10(19):e37566. 10.1016/j.heliyon.2024.e37566.
40. Otaigbe CII, Elikwu CJ. Drivers of inappropriate antibiotic use in low- and middle-income countries. *JAC Antimicrob Resist*. 2023;5(3):dlad062. 10.1093/jacamr/dlad062.

Figures

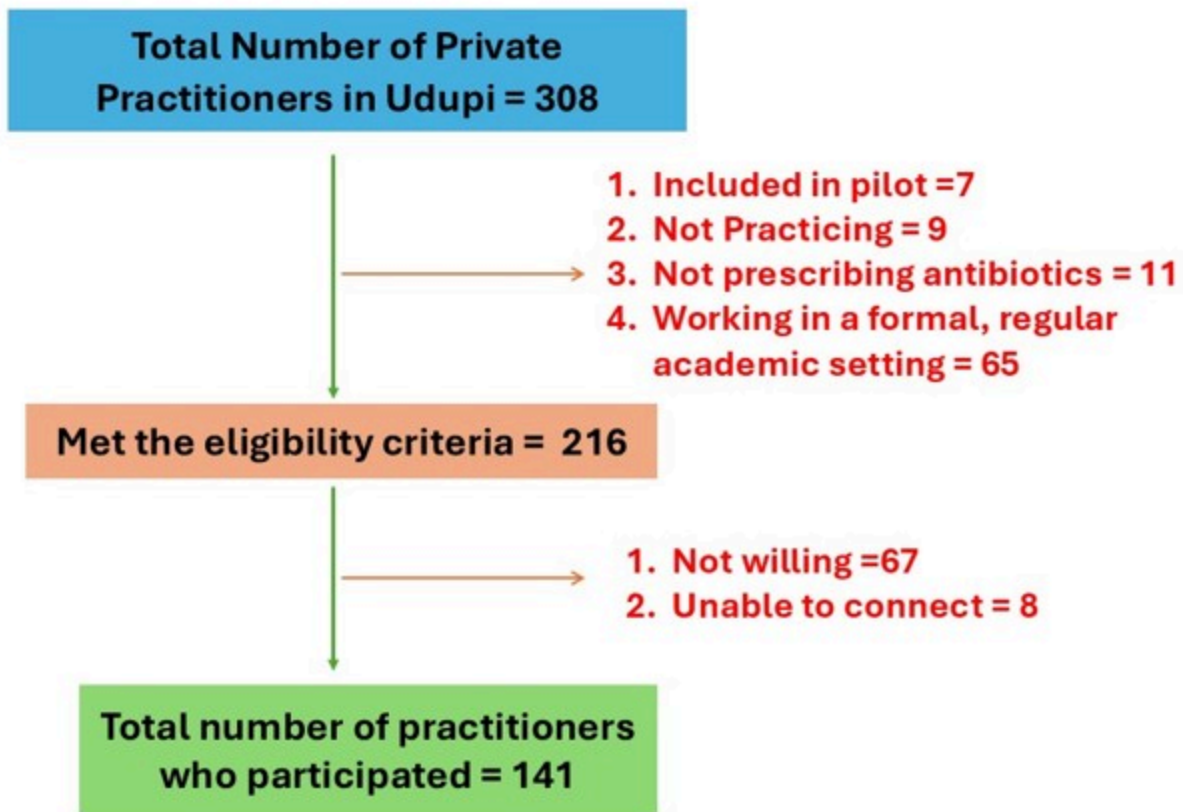


Figure 1

Recruitment details of the private practitioners

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Supplementaryfile1.pdf](#)