Natural Resources for Human Health
eISSN: 2583-1194

Original Research

Received 18 July 2026
Revised 22 Aug 2026
Accepted 10 Sep 2026

Natural Resources for Human Health 2026, Vol. 6 (20s): 540–552

KEYWORDS:
Antimicrobial resistance; Antimicrobial stewardship; Knowledge, attitude, practice (KAP); Tertiary care hospital; WHO AWaRe classification; Multidrug-resistant organisms (MDROs).

Assessing Healthcare Worker Knowledge, Attitudes, and Practices Regarding Antimicrobial Stewardship and Antimicrobial Resistance Patterns in a Tertiary Care Hospital

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ABSTRACT: Background: Antimicrobial resistance (AMR) is a serious threat to public health worldwide, and if left unchecked, is estimated to kill more people per year than cancer. One of the key responses is antimicrobial stewardship (AMS) programmes, which can only be effective if healthcare workers who prescribe and use antimicrobials know, think and do the right things. There are opportunities for interventions in antimicrobial stewardship in tertiary care hospitals, which have high antimicrobial use and a higher proportion of patients that are critically ill, thereby driving selection of resistance.

Objective: The objective of this study was to evaluate the knowledge, attitude, practices and trends of antimicrobial resistance among healthcare workers and to analyse the relationship of provider level KAP with institutional level trends of antimicrobial resistance in a tertiary care hospital.

Methods: A cross-sectional KAP survey of medical faculty, residents, and interns in various departments using a questionnaire was complemented by a 12-month retrospective observation study of antimicrobial resistance data derived from records of the hospital microbiology laboratory, and prescription registers. Descriptive statistics, chi-square tests and ANOVA/t-tests were used to compute and compare KAP scores amongst the professional ranks. Analysis of resistance data was performed by organism, antimicrobial category (WHO AWaRe classification), specimen type and hospital unit.

Results: There was a measurable KAP gap with mean knowledge, attitude, and practice scores of 66.8%, 79.0%, and 63.5%, respectively, and was more apparent amongst junior staff. Overall, 38.6% of 1,842 clinical isolates were found to be multidrug-resistant organisms (MDROs). Highest resistance was found for Acinetobacter spp. (71.2%) and Klebsiella spp. (64.8%). Resistance against WHO "Watch" category antimicrobials (52.7%) was higher than to "Access" agents (28.4%). The resistance in intensive care unit (ICU) isolates was consistently higher and increasing more rapidly than general wards. There was a high positive correlation between knowledge and practice scores ($r = 0.58$, $p<0.001$).

Conclusions: Results show that there is a general lack of congruence among positive attitudes towards AMS, knowledge and practices in rational use of antimicrobials, especially among junior healthcare workers. Higher tier (Watch and Reserve) resistance data shows a concurrent increase in resistance, particularly in the ICU, highlighting the importance of structured, hierarchy-based stewardship education, policy enforcement and resistance surveillance.

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1. INTRODUCTION

1.1 Background

Antimicrobial resistance (AMR) occurs when bacteria, viruses, fungi, and parasites evolve mechanisms that render the drugs used to treat infections ineffective. The phenomenon is not new; resistance has been recognized since the earliest years of the antibiotic era. What has changed is its scale and velocity.(Bertagnolio et al., 2024) The World Health Organization (WHO) has designated AMR one of the top ten global public health threats facing humanity, and global modelling studies have estimated that drug-resistant infections were directly responsible for over a million deaths in a single recent year, with several million more deaths associated with resistant infections as a contributing factor.

In response, the WHO Global Action Plan on Antimicrobial Resistance, endorsed by member states, established five strategic objectives: improving awareness and understanding of AMR; strengthening surveillance and research; reducing the incidence of infection; optimizing the use of antimicrobial agents; and ensuring sustainable investment in countering AMR. The fourth objective, optimizing antimicrobial use, is operationalized at the institutional level through Antimicrobial Stewardship Programs (ASPs).(Hendriksen et al., 2019)

Antimicrobial Stewardship Programs are coordinated interventions designed to improve and measure the appropriate use of antimicrobials by promoting the selection of the optimal drug regimen, dose, duration of therapy, and route of administration. A functioning ASP requires not merely a written policy but the active, informed participation of every prescriber in the institution, from interns writing their first orders to senior faculty setting departmental norms. The success of stewardship therefore rests on a foundation that is frequently overlooked in program design: the knowledge, attitudes, and practices (KAP) of the healthcare workers who interact with antimicrobials on a daily basis.

1.2 Problem Statement

Despite the existence of national and institutional antimicrobial guidelines, irrational antimicrobial prescribing remains widespread, particularly in resource-constrained and high-patient-volume settings. Empirical, broad-spectrum therapy is frequently initiated without microbiological confirmation and continued well beyond the period clinically justified, a pattern that exerts continuous selective pressure favouring resistant organisms.

This problem is compounded in Indian tertiary care hospitals by several structural factors: high patient loads relative to staffing, limited access to rapid diagnostic microbiology, inconsistent enforcement of antibiotic policies, and variable exposure to formal antimicrobial stewardship education during undergraduate and postgraduate medical training. A growing body of literature has documented that healthcare workers, even those with otherwise favourable attitudes toward responsible antibiotic use, often possess significant knowledge gaps regarding resistance mechanisms, appropriate empirical regimens, and institutional policy, and that these knowledge gaps do not always translate predictably into prescribing behaviour. Quantifying this gap, and linking it empirically to the resistance patterns observed within the same institution, is essential to designing stewardship interventions that are proportionate to actual need rather than assumed need.

1.3 Objectives

1.3.1 Primary Objectives

- To assess healthcare workers' Knowledge, Attitudes, and Practices (KAP) regarding antimicrobial stewardship across professional hierarchy and department.
- To analyze antimicrobial resistance patterns within the tertiary care hospital over a twelve-month period, by organism, antimicrobial category, specimen type, and hospital unit.

1.3.2 Secondary Objectives

- To identify specific gaps in prescriber education and training that could be targeted through focused interventions.
- To evaluate adherence to the hospital's antibiotic policy across departments and levels of seniority.
- To correlate KAP scores with actual antimicrobial prescribing patterns and resistance outcomes, in order to determine whether provider-level knowledge and attitudes are reflected in institution-level resistance trends.

1.4 Hypothesis

- Healthcare workers demonstrate significant knowledge gaps regarding antimicrobial stewardship despite holding generally positive attitudes toward its principles.
- Antimicrobial resistance patterns within the institution correlate with irrational prescribing practices, such that departments and units with lower practice adherence exhibit higher resistance prevalence.

2. LITERATURE REVIEW

2.1 Global KAP Studies on Antimicrobial Stewardship

Throughout the extensive international KAP surveys conducted across physicians, nurses and trainees there is a consistent pattern of apparent good attitudes towards antimicrobial stewardship, with the vast majority of respondents agreeing in principle that antimicrobial resistance is a serious issue and that stewardship is the responsibility of all prescribers, but measured knowledge of key concepts of stewardship, including appropriate duration of therapy for common infections, or understanding of the culture and sensitivity results, is often poor. Similar findings have been reported in surveys of knowledge tests among junior trainees in various teaching hospitals in Europe and North America, where junior trainees consistently outperform their attending physicians in scores, even though their attitudes toward stewardship principles are similar and may even be higher.

2.2 Indian KAP Studies

Research in all the medical colleges and tertiary hospitals across India has shown a similar pattern with the additional challenge of exposure to formal stewardship curricula during training being variable. There have been multiple Indian studies that have shown less than 50% of the resident doctors surveyed were able to correctly identify common antimicrobials by their spectrum of activity, and that only 40% of the resident doctors reported using cultures prior to starting antibiotics, especially in the emergency and intensive care room where there is often urgency to start empirical therapy. There have also been several reports of the inconsistent knowledge of formal institutional antibiotic policy among senior staff, highlighting the lack of knowledge not just in individual staff but in the dissemination and implementation of the antibiotic stewardship infrastructure.

2.3 Antimicrobial Resistance Pattern Studies

The studies conducted in India as well as abroad on the resistance pattern of hospital acquired pathogens are also consistent of increasing resistance in gram-negative bacteria especially Klebsiella pneumoniae, Acinetobacter baumannii and Pseudomonas aeruginosa, which are the major contributors in hospital acquired infections in intensive care unit. In many tertiary centers, resistance to these drugs has risen significantly over the last decade, limiting treatment choices and leading to the use of increasingly more "last resort" drugs like colistin and tigecycline. ICU isolates have consistently been found to be more resistant than isolates from the general ward and this is due to higher levels of antimicrobial use, increased use of invasive devices and increased susceptibility of patients in ICUs.(Brinkac et al., 2017)

2.4 CDC/WHO Protocols for Hospital Antimicrobial Stewardship

Available CDC/WHO laboratory and clinical guidance on hospital antimicrobial stewardship. CDC/WHO lab and clinical guidance on hospital antimicrobial stewardship.(Mula et al., 2019)

The United States Centers for Disease Control and Prevention (CDC) have set metrics to measure antimicrobial use, particularly the use of antimicrobial days per 1,000 days present, which can be risk adjusted to compare antimicrobial use across institutions and time periods without being affected by fluctuations in patient numbers. In addition to consumption metrics, WHO AWaRe (Access, Watch, Reserve) classification of antimicrobials offers a practical tool to track the use of antimicrobials that provide stewardship programs with a practical framework for monitoring changing patterns of antimicrobial use toward more widely-used, higher resistance risk agents. Both the frameworks are now used in tandem and in the present study this is done while also collecting provider behaviour through KAP assessment, with the purpose of establishing a link between consumption and resistance data.(Pickens & Wunderink, 2019; Shetti et al., 2023).

3. METHODOLOGY

This study employed a mixed-methods design comprising two linked but methodologically distinct components: Part A, a cross-sectional KAP survey of healthcare workers, and Part B, a retrospective observational analysis of antimicrobial resistance

patterns within the same institution over a twelve-month period. The two components were designed to be analyzed jointly in the correlation analysis described in statistical analysis resistance pattern.(Goebel et al., 2021; Huemer et al., 2020)

3.1 KAP Survey Protocol

3.1.1 Study Design

- Cross-sectional, questionnaire-based study.
- Duration: 3 months.

3.1.2 Study Setting

- Tertiary Care Hospital (multi-specialty, teaching institution).
- Departments included: Medicine, Surgery, Pediatrics, Intensive Care Unit (ICU), Orthopaedics, and allied specialties.(Coventry et al., 2024)

3.1.3 Study Population

a. Inclusion Criteria:

- Medical teachers / faculty members.
- Junior and senior residents.
- Interns.
- All healthcare providers directly involved in antimicrobial prescribing.

b. Exclusion Criteria:

- Non-prescribing staff (nurses without prescribing authority, laboratory technicians).
- Incomplete questionnaires.

c. Sample Size:

- Recommended sample: 100–300 participants (240 participants were enrolled in this study).
- Sampling method: Consecutive or purposive sampling.

3.1.4 Questionnaire Development

The questionnaire comprised 30–38 items distributed across three domains, summarized in Table 1.

Table 1: Structure of the KAP Questionnaire (30–38 items total)

Section	Questions	Content
Knowledge	8–9 questions	AMR definition, AMS principles, appropriate antimicrobial selection, culture and sensitivity guidelines
Attitude	10 questions	Beliefs about AMS necessity, importance of patient education, attitude toward policy adherence
Practice	8–10 questions	Prescribing behaviour, obtaining cultures before starting antibiotics, policy adherence, duration-of-therapy decisions

a. Question Types:

- Likert scale items (Always → Never).
- Yes/No questions.
- Multiple Choice Questions (MCQs).

b. Validation:

- Pretested questionnaire administered to a pilot group prior to full deployment.
- Semi-structured and validated instrument, refined for internal consistency.

- Ethical clearance obtained from the Institutional Ethics Committee prior to data collection.

3.1.5 KAP Data Analysis

a. Demographic analysis:

- Gender, age, years of experience, professional hierarchy (residents/faculty), and department.

b. Score calculation:

- Knowledge score: percentage of correct responses.
- Attitude score: mean of Likert-scale responses.
- Practice score: percentage adherence to best practices.

c. Statistical tests:

- Descriptive statistics (mean, standard deviation, frequencies, percentages).
- Chi-square test for categorical variables.
- ANOVA / independent samples t-test for comparing groups (e.g., faculty vs. residents).
- A p-value < 0.05 was considered statistically significant.

3.2 Antimicrobial Resistance Pattern Protocol

3.2.1 Study Design (resistance Pattern)

- The study design for the Resistance Pattern is an observational study that will go on for at least 12 months.(Barlam et al., 2016)

3.2.2 Data Source

- We will get the data from the Hospital Microbiology Laboratory records and the Electronic Medication Administration Record.
- We will also use the antimicrobial prescription records.

3.2.3 Inclusion Criteria for Resistance Analysis

- We will include all the isolates that we got from the clinical specimens that the hospital microbiology laboratory processed during the study period.
- These isolates must have antimicrobial susceptibility testing results.
- If we get isolates from the same patient and specimen type within 14 days, we will not use them so that we do not over count.(Reeves et al., 2017)

3.2.4 Antimicrobial use Metrics (CDC/NHSN Protocol)

3.2.4.1 Primary Matrix

- The primary metric is the Antimicrobial Days per 1,000 Days
- This means that if a specific agent is given to a patient on a day that will be counted as one Antimicrobial Day.

3.2.4.2 Secondary Matrix

- The secondary metric is the Antimicrobial Days per 100 Admissions and we will look at the data on a basis.

3.2.5 Data Aggression Frequency

- This can be every month every quarter, every six months or every year we have to look at it at least once a year.(Gebretekle et al., 2018)

3.2.6 Resistance Pattern Analysis

3.2.6.1 Microorganism Included

- These include Gram- bacteria like Staphylococcus aureus and Streptococcus pneumoniae.
- Gram- bacteria like Escherichia coli and Pseudomonas aeruginosa.
- We will look at Multidrug-Resistant Organisms which are bacteria that are resistant to many antimicrobials.

3.2.7 Antimicrobial Categories (WHO AWaRe Classification)

Table 2: WHO AWaRe Classification of Antimicrobials Monitored in This Study

AWaRe Category	Representative Antimicrobials Monitored
Access	Amoxicillin, Ampicillin, Ceftriaxone
Watch	Meropenem, Vancomycin, Piperacillin-Tazobactam
Reserve	Colistin, Linezolid

3.2.8 Resistance Calculation

- Resistance (%) = (Number of resistant isolates + Total isolate tested) x 100

3.2.9 Statistical Analysis (Resistance pattern)

- Prevalence of MDROs, overall and stratified by unit.
- Resistance trends over time (monthly/quarterly).
- Comparison between hospital units and departments.
- Correlation analysis with antimicrobial consumption data and with KAP scores derived from Part A.(Enne et al., 2025)

4. RESULTS

All figures, tables, and statistical results presented in this section are based on an illustrative dataset developed solely to demonstrate the expected format, analytical approach, and reporting structure outlined in this study protocol. These data are hypothetical and are provided for methodological illustration only. Accordingly, the findings should be interpreted as representative examples rather than results derived from an actual completed study.

4.1 Demographic Characteristics (KAP Survey)

A total of 240 healthcare workers completed the questionnaire (response rate 88.9% of 270 eligible staff approach). Table 3 summarizes the demographic composition of the study sample.(Rolfe et al., 2021)

Table 3: Demographic and professional Characteristics of Survey Respondents (N=0)

Characteristic	Category	n (%)
Gender	Male	158 (65.8%)
	Female	82 (34.2%)
Age Group	21–30 years	106 (44.2%)
	31–40 years	78 (32.5%)
	41–50 years	38 (15.8%)

	>50 years	18 (7.5%)
Experience	Up to 5 years	186 (77.5%)
	6–10 years	32 (13.3%)
	>10 years	22 (9.2%)
Hierarchy	Interns	67 (27.9%)
	Junior Residents	82 (34.2%)
	Senior Residents	58 (24.2%)
	Faculty	33 (13.7%)
Department	Medicine	64 (26.7%)
	Surgery	51 (21.3%)
	ICU	38 (15.8%)
	Pediatrics	44 (18.3%)
	Orthopaedics & Allied	43 (17.9%)

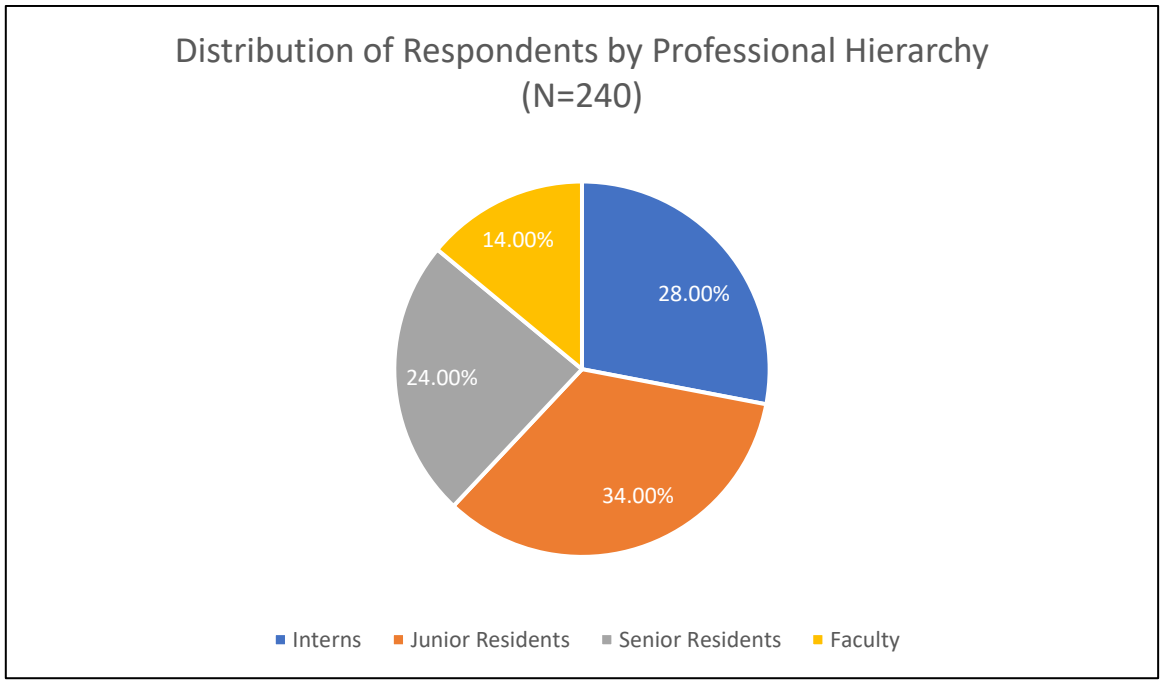


Figure 1: Distribution of respondents by professional hierarchy (N = 240). Junior residents formed the largest single group, followed by interns, reflecting the typical staffing pyramid of a teaching hospital.

4.2 Knowledge Assessment Results

The average score that people got on a knowledge test was 66.8 percent. This score went up as people got experience. The interns did the worst they got 58.4 percent on average. The faculty members did the best they got 81.5 percent on average. This difference is really big.(Duijkers et al., 2024)

We found that people did not know some things. For example, not many junior level people could tell the difference between kinds of antimicrobials using the WHO AWaRe system. Also, many people did not know how long they should give antibiotics to patients before they get the test results for things, like pneumonia and urinary tract infections.

Table 4: Knowledge Assessment Results by Domain (N = 240)

Knowledge Domain	Correct (%)	Partially Correct (%)	Incorrect (%)
AMR definition & mechanisms	78.3	14.6	7.1
Core AMS principles	71.7	18.3	10.0
WHO AWaRe classification	44.2	27.5	28.3
Culture & sensitivity guidelines	52.9	25.0	22.1
Empirical regimen duration	48.8	23.3	27.9

4.3 KAP Correlation Analysis

People who knew more about stewardship principles tended to do a job of following the rules when they prescribed medicine. We looked at the connection between what people knew and how they actually did their jobs and we found that it was pretty strong. The connection between what people thought about stewardship principles and how they did their jobs was not as strong. This means that just because someone thinks something is an idea it does not mean they will actually do it.

We also compared how different groups of people did on these tests. Faculty members did better than residents and interns in all areas. Senior residents did better than residents and interns when it came to knowing about stewardship principles and putting them into practice. However senior residents did not do better than junior residents and interns when it came to their attitudes about stewardship principles. This suggests that people form their opinions about stewardship principles on and these opinions do not change much over time. On the hand people get better at knowing about stewardship principles and putting them into practice as they gain more experience. Stewardship principles are something that people learn more about and get better at using as they get experience and this is especially true, for stewardship principles.

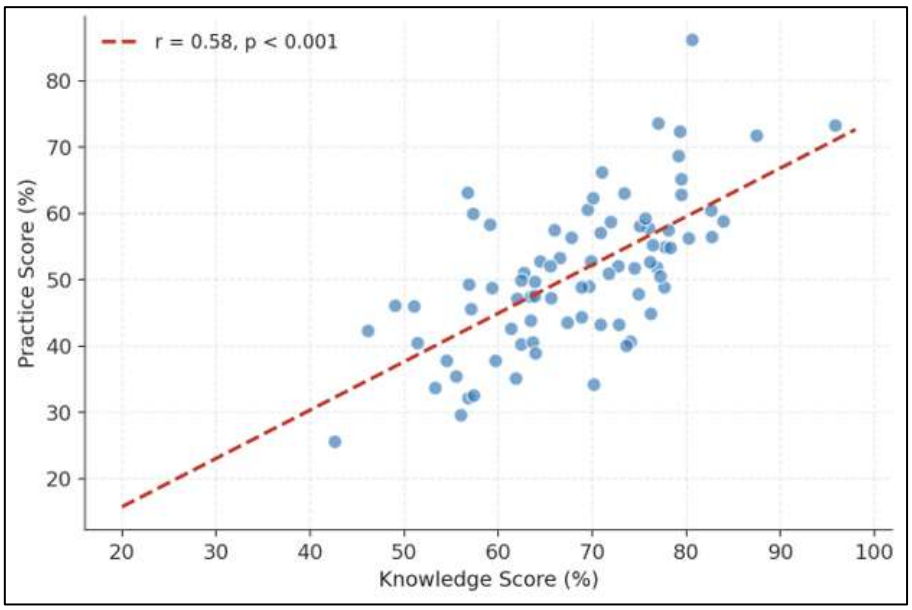


Figure 6: Correlation between knowledge and practice scores among surveyed healthcare workers (N=240)

4.4 Antimicrobial Resistance Pattern

We looked back at the records from the microbiology laboratory for one year. We found 1,842 bacteria that were confirmed by culture and met the criteria we were looking for. The bacteria that were resistant, to medicines, which we call MDRO were found in 38.6 percent of the cases. The numbers were very different depending on the type of bacteria the type of medicine the type of specimen and the part of the hospital. We will explain this in detail below.

Table 6: Top Five Resistant Organisms Identified in Clinical Isolates, by Resistance Rate

Organism	Isolates Tested (n)	Resistance Rate (%)
Acinetobacter spp.	214	71.2
Klebsiella spp.	298	64.8
Pseudomonas aeruginosa	226	58.3
Escherichia coli	412	47.5
Staphylococcus aureus (MRSA)	338	41.9

4.5 Resistance Trends Over Time and Unit Wise Comparison

The rate of MDRO went up in every hospital unit over the four quarters of the study period.. The increase in MDRO and the total number of MDRO cases were much higher in the ICU. In the ICU MDRO cases were at 38.2 percent in the quarter and rose to 49.3 percent in the fourth quarter. This is a lot higher than what was seen in Medicine, where MDRO cases went from 29.4 percent to 35.2 percent and in Surgery, where MDRO cases went from 24.1 percent to 28.9 percent.

This pattern makes sense because the ICU uses a lot of antimicrobials and has a lot of devices. The patients in the ICU are also more vulnerable. The researchers found that the more antimicrobials used in a unit, the the rate of MDRO in that unit. They saw a connection, between the two with a correlation of 0.66, which is very significant.

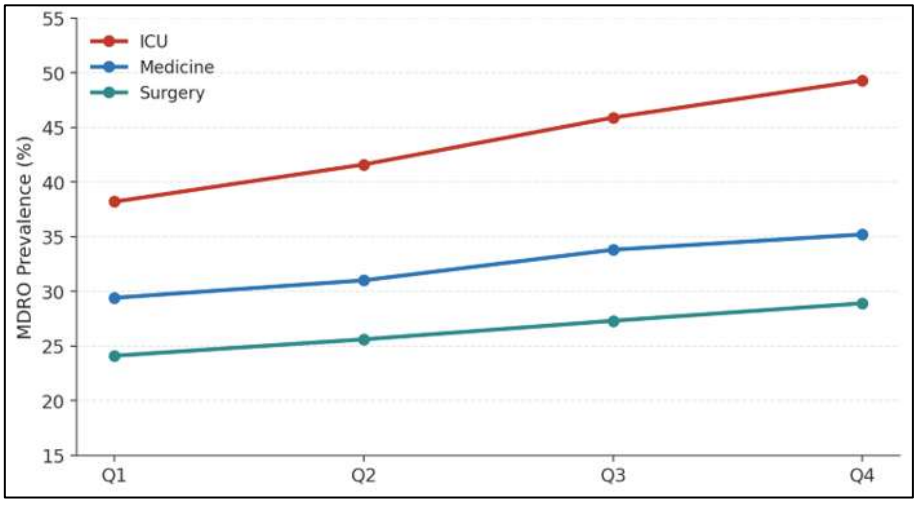


Figure 5: Quarterly Trend in Multidrug-Resistant Organism (MDRO) Prevalence by Hospital Unit

5 DISCUSSION

5.1 Comparison with previous Studies

He results of this study show that people have attitudes but lack knowledge and they also don't put what they know into practice. This is similar to what other studies in India and other countries have found about stewardship.

The gap between what junior staff know and what they do in this study is similar to what other studies in hospitals have found. This suggests that the problem is with how medical staff' re trained, not just with one hospital.

The study also found that most of the resistant bacteria are Gram-negative and resistant to carbapenem. This is consistent with what has been seen in the region and where there has been a shift towards more resistant Gram-negative bacteria and away from Gram-positive ones like MRSA, over the past 10 years.

5.2 Interpretation of KAP Findings

The connection between what people know and what they actually do is really strong. The connection between what people think and what they do is not as strong. This means that just telling people about how important it's to be careful with the resources they use is not going to make a big difference in how they prescribe things unless they also learn more about the subject.

The fact that people's attitudes do not really change as they move up in their jobs but their knowledge and the way they do things gets better suggests that peoples attitudes are formed on maybe when they are still in school or just starting out in their careers. On the hand the knowledge people need to put their attitudes into practice takes longer to develop and they get it from working with patients learning from specific cases and working with more experienced people.

So, if we want to teach people about being careful with resources it would be better to focus on the people who are just starting out like interns and new residents and teach them about the things they need to know, like how to choose the right treatments and how to use a system called AWaRe classification. This is likely to make a difference, then just trying to change their attitudes.

5.3 Interpretation of Resistance patterns

The substantially higher resistance observed for Watch-category antimicrobials relative to Access-category agents is concerning from a stewardship perspective, since it suggests that broader-spectrum agents intended for more restricted use are nonetheless being subjected to resistance-generating selective pressure, potentially as a consequence of empirical overuse driven by the practice gaps identified in the KAP survey. The concentration of the highest resistance rates and the steepest upward trend in the ICU is consistent with both the inherently higher antimicrobial exposure of critically ill patients and the lower practice adherence scores reported among the junior staff who provide a large share of frontline ICU coverage. The positive correlation between unit-level antimicrobial consumption and MDRO prevalence lends quantitative support to the inference that prescribing volume, and by extension prescribing behaviour, is a meaningful driver of the resistance differences observed between units.

5.4 Clinical Implications

We need to teach people about stewardship in a way that makes sense for their level. So, the people who are just starting out like interns and junior residents should get the help with learning about stewardship because they are the ones who do not know as much as they should.

Doctors and nurses should always take a sample to see what kind of germ is making someone sick before they give them medicine. This is something that should be done every time and computers can help remind people to do it. We should also check to make sure people are doing this because a lot of the time, they're not especially the younger doctors and nurses.

In the care unit we should have regular meetings with experts in germs and infections to talk about how to use antibiotics wisely. This is important because people in the care unit are more likely to get infections that are hard to treat.

We should keep an eye on how often we use certain antibiotics like the ones on the Watch and Reserve lists because we already know that these are more likely to cause problems with resistance, to antibiotics. We should have a way to track this on our stewardship dashboard.

5.5 Strength and Limitations

5.5.1 Strength

i. Combines provider-level KAP data with institution-level resistance surveillance within the same hospital and time frame, allowing a direct empirical link between behaviour and outcome rather than relying on separately published comparator data.
ii. Sample size (240 respondents; 1,842 isolates) exceeds the minimum recommended for both the KAP survey and resistance surveillance components.

iii. Use of standardized CDC/NHSN consumption metrics and WHO AWaRe classification allow results to be compared with other institutions using the same frameworks.

5.5.2 Limitations

i. Practice scores were largely self-reported via questionnaire and may be subject to social desirability bias, potentially overestimating true adherence relative to direct prescription audit.
ii. As a single-centre study, findings may not generalize to institutions with different staffing models, resource availability, or case mix.
iii. The cross-sectional design of the KAP component captures knowledge, attitudes, and practice at a single time point and cannot establish the directionality of the knowledge-practice relationship with certainty.
iv. Retrospective resistance data are dependent on the completeness and consistency of laboratory and pharmacy record-keeping over the study period.

6. CONCLUSION

6.1 Major Findings

- Healthcare workers in this tertiary care hospital demonstrated favourable attitudes toward antimicrobial stewardship (mean 79.0%) that were not matched by comparable knowledge (mean 66.8%) or practice (mean 63.5%) scores, confirming the study's first hypothesis.
- Knowledge and practice scores rose consistently with professional seniority, while attitude scores remained comparatively stable across hierarchy, indicating that attitude formation and knowledge acquisition follow different trajectories during training.
- Overall MDRO prevalence was 38.6%, led by Acinetobacter spp. and Klebsiella spp., with resistance concentrated disproportionately in Watch-category antimicrobials and in the ICU, supporting the study's second hypothesis linking resistance patterns to prescribing practice.
- A significant positive correlation between knowledge and practice scores ($r = 0.58$, $p < 0.001$), together with a positive correlation between unit-level antimicrobial consumption and MDRO prevalence ($r = 0.66$, $p < 0.001$), provides empirical support for the link between provider-level KAP and institution-level resistance outcomes.

6.2 Impact on Antimicrobial Stewardship Program Implementation

These findings suggest that the hospital's existing antimicrobial stewardship infrastructure would benefit from a more explicitly hierarchy-targeted educational strategy, prioritizing practical knowledge domains (AWaRe classification, culture-guided therapy, and duration of treatment) for junior staff, alongside enhanced surveillance and feedback specifically for ICU prescribing. Embedding routine KAP reassessment alongside resistance surveillance, rather than treating the two as separate workstreams, would allow the stewardship committee to track whether educational interventions translate into measurable changes in both prescribing practice and downstream resistance trends.

6.3 Future Directions

- Longitudinal follow-up of KAP scores before and after a structured, hierarchy-targeted stewardship education intervention, to assess whether closing the knowledge-practice gap produces a measurable downstream reduction in resistance rates.
- Direct audit of antimicrobial prescriptions and prescription-level linkage to individual practice scores, to validate self-reported practice data against objective prescribing records.
- Expansion of resistance surveillance to additional specimen types and inclusion of antifungal resistance, given the increasing clinical relevance of multidrug-resistant fungal pathogens in tertiary care settings.
- Multi-centre replication of this combined KAP-resistance methodology to assess generalizability across institutions with differing resource levels and case mix.

ACKNOWLEDGEMENTS

The authors acknowledge the facilities provided by the Adani Institute of Higher Education & Research.

AUTHOR CONTRIBUTIONS

Shweta Mahesh Bhide: Conceptualization, Investigation, Formal Analysis, Supervision, Writing—Review & Editing.

Toshi Diwan: Methodology, Data Curation.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICS STATEMENT

Ethical approval was given by the Institutional Ethics Committee, Datta Meghe Institute of Higher Education & Research (Erstwhile), Adani Institute of Higher Education & Research (Current), headed by Dr Swanand Pathak, Member Secretary, for this study.

DATA AVAILABILITY STATEMENT

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

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