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ANTIMICROBIAL RESISTANCE PATTERNS AND INFECTION CONTROL PRACTICES IN HOSPITAL-BASED CLINICAL SETTINGS

Dr. Pradeep Kumar Singh[1], Dr. Aarti Saxena[2], Dr. Mohd. Arif Khan[3], Dr. Lata Krishnan[4], Dr. Vinayak Patwardhan[5]

[1] Department of Microbiology, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India
[2] Department of Infectious Diseases,Sir Ganga Ram Hospital, New Delhi, India
[3] Department of Clinical Microbiology, Jawaharlal Nehru Medical College, Aligarh Muslim University, Aligarh, Uttar Pradesh, India
[4] Department of Infection Control and Hospital Epidemiology, Sri Ramachandra Institute of Higher Education and Research, Chennai, Tamil Nadu, India
[5] Department of Pharmacology, B. J. Government Medical College, Pune, Maharashtra, India Email: pradeep.singh@aiimsjodhpur.edu.in

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Abstract
Antimicrobial resistance is a major threat to hospital-based healthcare because it increases treatment failure, prolongs hospitalization, and limits therapeutic options. Infection prevention and antimicrobial stewardship are essential for controlling the spread of multidrug-resistant organisms in clinical settings. This study aimed to assess antimicrobial resistance patterns and infection control practices in hospital-based clinical settings. A hospital-based cross-sectional descriptive study was conducted using two components: laboratory record review and healthcare worker assessment. Clinical specimens were reviewed to identify bacterial isolates and antimicrobial susceptibility patterns. Infection control practices were assessed among healthcare workers using a structured questionnaire and observation checklist. Data were analyzed using descriptive statistics, and resistance patterns were summarized by organism type, antibiotic class, and multidrug resistance status. A total of 420 clinical specimens were reviewed, of which 276 showed bacterial growth, giving a culture positivity rate of 65.7%. Gram-negative bacteria accounted for 71.7% of isolates. Escherichia coli was the most common pathogen, followed by Klebsiella pneumoniae, Staphylococcus aureus, Pseudomonas aeruginosa, and Acinetobacter baumannii. High resistance was observed against ampicillin, ceftriaxone, ciprofloxacin, and cotrimoxazole. Overall multidrug resistance prevalence was 50.0%, with the highest rate among A. baumannii. Infection control compliance was variable, with lower compliance for hand hygiene before patient contact and regular infection control training. The findings highlight a substantial burden of antimicrobial resistance and persistent infection control gaps. Continuous surveillance, hospital-specific antibiograms, improved hand hygiene, regular staff training, and integrated antimicrobial stewardship are recommended.

Keywords: Antimicrobial resistance; multidrug-resistant organisms; infection control practices; antimicrobial stewardship.

1. Introduction

The problem of antimicrobial resistance is currently one of the gravest challenges to the contemporary healthcare due to the diminished impact of antibiotics, complicated clinical conditions, and the likelihood of prolonged morbidity, therapeutic failure, and fatality. The economic cost of bacterial antimicrobial resistance is enormous, and in 2019, it was reported that bacterial infections with resistance caused many deaths in various regions and income levels (Antimicrobial Resistance Collaborators, 2022). Recent estimates and projections worldwide indicate that AMR will remain a significant health burden until 2050, unless the coordination of prevention, surveillance, and stewardship measures are reinforced (Naghavi et al., 2024). This causes AMR to be not only a microbiological issue, but also a clinical, epidemiological and health system issue.

Hospitals are especially significant environments where the emergence and transmission of antimicrobial resistance happen. Patients who are severely ill, have invasive devices, have long hospital stays, have acute exposure repeatedly to antibiotics, and are more susceptible to infection are common in healthcare facilities. These circumstances provide a platform where the resistant organisms will develop, continue and propagate among the patients, staffs, equipment and surfaces of the hospital. Healthcare environments can thus act as the sources, reservoirs, and amplifiers of AMR, particularly in cases where infection prevention and antimicrobial stewardship systems are not robust (Cocker et al., 2024). This issue is further exacerbated by hospital-acquired infections since they are commonly linked with late diagnosis, the use of broad-spectrum antibiotics without evidence, and lack of treatment options when dealing with resistant organisms (Avershina et al., 2021).

Clinical significance of AMR is particularly apparent in infections with multidrug-resistant organisms, such as resistant strains of Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, Pseudomonas aeruginosa and Acinetobacter baumannii. These organisms are normally related to urinary tract infections, bloodstream infections, wound infections, respiratory infections, and device-associated infections. An up-to-date review of AMR suggests that numerous factors are intertwined to cause resistance, such as improper use of antibiotics, lack of diagnostic ability, inadequate surveillance, transmission, and lack of access to effective antimicrobials (Ho et al., 2024). Hence, the local resistance patterns are paramount to clarify the direction of empirical therapy, acquisition of hospital antibiograms, and enhanced patient outcomes.

Antimicrobial stewardship has become a well-known fundamental public health approach to maintaining the efficacy of antibiotics and minimizing unnecessary exposure to antimicrobials. The stewardship programs encourage sound antibiotic choices, dose reduction, de-escalation, monitoring prescribing habits, and compliance with clinical practice guidelines (Majumder et al., 2020). Stewardship in the hospital setting is conceptually significant as it bridges the gap between microbiological evidence and clinical decision-making and aids in reducing the selective pressure that leads to the development of resistant organisms (Giamarellou et al., 2023). Stewardship, however, cannot operate efficiently alone. It should be in place with effective infection prevention and control schemes to minimize the selection as well as spread of resistant pathogens.

Prevention and control of infection has been the focus in the fight against healthcare-associated infections and AMR. Priorities consist of hand hygiene, personal protective equipment, sterilization and disinfection, environmental cleaning, waste management, isolation precautions, safe injection practices, and monitoring of healthcare-associated infections (Lacotte et al., 2020). The synergistic effect of antimicrobial stewardship and infection prevention measures is especially significant since antibiotic misuse leads to an increase in resistance pressure, whereas poor infection control promotes the spread of resistant organisms in hospitals (Okeah et al., 2021). Therefore, the combined strategies are likely to decrease AMR compared to disjointed solutions.

Healthcare workers are the key to infection prevention since their knowledge, attitudes, and practices directly reflect the adherence to standard precautions. Research has revealed that the levels of compliance with infection prevention can be influenced by training, workload, supply availability, institutional policies, risk perception, and professional category (Alhumaid et al., 2021). The available information on the compliance with standard precautions also suggests that lapses in hand hygiene, wearing protective equipment, and routine infection control activities are still widespread in healthcare facilities (Bahegwa et al., 2022). In the same way, the knowledge, attitudes, and practices of healthcare workers regarding prevention of multidrug-resistant organisms are critical factors in defining the effectiveness of hospital in preventing cross-transmission (Zhou and Chen, 2022).

Based on these issues, it is necessary to have hospital-based research studies that can investigate the trends of antimicrobial resistance along with infection control measures. These studies are used to give evidence about the most commonly isolated organisms, the highest rates of resistance to antibiotics, the burden of multidrug resistance and the practical gaps in the prevention of infections in healthcare workers. The current research, which is entitled Antimicrobial Resistance Patterns and Infection Control Practices in Hospital-Based Clinical Settings, will be conducted to determine the patterns of bacterial resistance and infection control practices in a hospital setting. The study aims to produce evidence, which could be used to support local antibiotic policies,

enhance infection prevention programs, advance antimicrobial stewardship, and help deliver safer patient care by connecting microbiological findings to the practices of healthcare workers.

2. Methodology

2.1 Study Design

This research design assumed a cross-sectional descriptive design with a hospital-based approach to evaluate the patterns of antimicrobial resistance and infection control practices in clinical settings. The research was divided into two interconnected parts. The former comprised laboratory-based testing of bacterial isolates and antimicrobial susceptibility data acquired using clinical samples. The second element evaluated infection prevention and control measures of healthcare workers in the chosen hospital departments.
This design was suitable since it enabled the study to characterize the distribution of bacterial pathogens, identify patterns of antimicrobial resistance, estimate the burden of the multidrug-resistant organisms, and investigate the practice of infection control in the same hospital-based setting.

2.2 Study Setting

It was carried out within a hospital-based health facility in the selected clinical departments. The units were medical wards, surgical wards, intensive care units, emergency unit, outpatient unit and the microbiology lab. The microbiology lab was the main source of information about bacterial isolates and antimicrobial susceptibility data, and the chosen clinical departments offered data about the infection prevention and control behaviors among healthcare staff.

2.3 Study Population

There were two groups of participants in the study. There was the first group which involved clinical specimens that were sent to the microbiology laboratory to undergo bacterial culture and antimicrobial susceptibility tests in the course of the study. These samples comprised of urine, wound swabs, blood, sputum, pus, body fluids and catheter tips.
The second population was the healthcare workers engaged in the patient care, clinical support, specimen handling, and infection prevention work. This sample consisted of nurses, physicians, lab staff, and infection control staff members, and other health care workers operating in the chosen departments.

2.4 Sample Size

The laboratory part of the study included 420 clinical specimens. Among them 276 specimens were positive to grow bacteria and were categorized in the final analysis of antimicrobial resistance. The primary dataset to identify the bacterial pathogens, determine antimicrobial resistance patterns, and estimate multidrug resistance was the culture-positive isolates.
In the case of the infection control element, 120 healthcare workers were involved in the evaluation of the infection prevention and control practices. These respondents were chosen based on various professional categories and departments to give a general picture of the compliance in infection control in hospital environment.

2.5 Sampling Technique

A consecutive sampling technique was used in the selection of clinical specimens. Every specimen that was fit into the microbiology lab throughout the study period was to be included. The final analysis involved culture-positive specimens that had full bacterial identification, and antimicrobial susceptibility testing outcome.
A purposive sampling method was used in choosing healthcare workers. The sample size was established based on the departments that practiced patient care, handling of specimens, and infection prevention activities on a regular basis. This methodology had the advantage of making the infection control assessment concentrate on the healthcare workers directly involved in practices that affect the prevention of hospital-acquired infections and control of antimicrobial resistance.

2.6 Inclusion Criteria

For the laboratory component, the study included clinical specimens submitted for bacterial culture and antimicrobial susceptibility testing during the study period. Only culture-positive specimens with complete bacterial identification and antimicrobial susceptibility records were included. Both Gram-negative and Gram-positive bacterial isolates were considered.
For the healthcare worker component, the study included healthcare workers who were directly involved in patient care, specimen handling, infection control, or clinical support activities. Participants were required to

be working in the selected hospital departments during the data collection period and to provide informed consent before participation.

2.7 Exclusion Criteria
Duplicate isolates obtained from the same patient and same infection episode were excluded to avoid overrepresentation of particular organisms or resistance patterns. Contaminated samples, improperly collected specimens, culture-negative specimens, and records with incomplete antimicrobial susceptibility results were excluded from the final laboratory analysis.
Healthcare workers who were not directly involved in patient care or infection prevention activities were excluded. Participants who declined consent or submitted incomplete questionnaires were also excluded from the final analysis.

2.8 Data Collection Methods
Data were collected using two structured tools: a laboratory record review form and an infection control practice assessment tool.
For the laboratory component, data were extracted from microbiology laboratory records. The extracted information included specimen type, bacterial organism isolated, hospital department, antibiotics tested, and antimicrobial susceptibility results. The clinical specimens reviewed included urine, wound swabs, blood, sputum, pus, body fluids, and catheter tips.
For the infection control component, data were collected from healthcare workers using a structured questionnaire and, where feasible, an observation checklist. The tool assessed selected infection prevention and control practices, including hand hygiene before and after patient contact, use of gloves during invasive procedures, use of masks when indicated, sterilization of reusable instruments, environmental surface disinfection, biomedical waste segregation, and participation in regular infection control training.

2.9 Microbiological Procedures
Clinical specimens were processed according to standard microbiological procedures followed by the hospital laboratory. Specimens were cultured on appropriate media based on specimen type and suspected infection. After incubation, bacterial isolates were identified using colony morphology, Gram staining, biochemical tests, and other routine laboratory identification methods available in the hospital laboratory.
Antimicrobial susceptibility testing was performed using standard laboratory procedures such as the Kirby-Bauer disk diffusion method or automated susceptibility testing systems, depending on laboratory availability. The interpretation of antimicrobial susceptibility results was based on recognized clinical laboratory guidelines followed by the hospital.
The bacterial isolates assessed in the study included Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, Pseudomonas aeruginosa, Acinetobacter baumannii, Enterococcus species, Proteus species, and coagulase-negative Staphylococcus. Antibiotics assessed included ampicillin, ceftriaxone, ceftazidime, ciprofloxacin, gentamicin, amikacin, meropenem, cotrimoxazole, penicillin, erythromycin, cefoxitin, and vancomycin, depending on the organism and routine testing protocol.

2.10 Assessment of Antimicrobial Resistance Patterns
Antimicrobial resistance patterns were assessed by calculating the number and percentage of resistant isolates for each antibiotic tested. Resistance was analyzed according to bacterial species, antibiotic category, and clinical relevance.
For Gram-negative bacteria, resistance was assessed against commonly used antibiotics including ampicillin, ceftriaxone, ceftazidime, ciprofloxacin, gentamicin, amikacin, meropenem, and cotrimoxazole where applicable. For Gram-positive organisms, resistance was assessed against antibiotics such as penicillin, erythromycin, ciprofloxacin, gentamicin, cotrimoxazole, cefoxitin, and vancomycin, depending on the organism.
Cefoxitin resistance among Staphylococcus aureus isolates was used as an indicator of methicillin-resistant Staphylococcus aureus where applicable. Carbapenem resistance among Gram-negative isolates was assessed using meropenem resistance results.

2.11 Assessment of Infection Control Practices
Infection control practices were assessed among 120 healthcare workers. The assessment focused on selected practices relevant to preventing healthcare-associated infections and limiting the spread of antimicrobial-resistant organisms.
The major practice areas assessed were:

1. Use of gloves during invasive procedures.
2. Proper biomedical waste segregation.
3. Use of masks when indicated.
4. Hand hygiene after patient contact.
5. Environmental surface disinfection.
6. Sterilization of reusable instruments.
7. Hand hygiene before patient contact.
8. Regular participation in infection control training.

Responses were summarized as compliance percentages for each infection control practice. Higher percentages indicated better reported or observed compliance, while lower percentages indicated areas requiring improvement.

2.12 Study Variables

The main outcome variable was antimicrobial resistance among bacterial isolates. This included resistance to individual antibiotics, resistance by bacterial species, and multidrug resistance status.

The independent variables included type of clinical specimen, bacterial species, hospital department, antibiotic tested, and infection control practice indicators. For the healthcare worker component, variables included professional category, department, hand hygiene practice, personal protective equipment use, waste segregation, sterilization practices, environmental disinfection, and infection control training.

2.13 Data Analysis

Data were entered, cleaned, and analyzed using appropriate statistical software. Descriptive statistics were used to summarize laboratory and healthcare worker data. Frequencies and percentages were calculated for specimen distribution, culture positivity, bacterial isolate distribution, antimicrobial resistance patterns, multidrug resistance prevalence, and infection control compliance.

The culture positivity rate was calculated by dividing the number of culture-positive specimens by the total number of clinical specimens processed. The percentage distribution of bacterial isolates was calculated using the total number of culture-positive isolates as the denominator. Antimicrobial resistance percentages were calculated for each bacterial species and antibiotic tested. Multidrug resistance prevalence was calculated for each organism and for all isolates combined.

For infection control practices, compliance percentages were calculated based on the number of healthcare workers who reported or demonstrated adherence to each practice. Results were presented using frequency tables, percentage distributions, and graphical summaries.

Where applicable, associations between infection control practices and antimicrobial resistance patterns were explored descriptively across hospital departments. Because the study used a cross-sectional design, the findings were interpreted as associations rather than causal relationships.

2.14 Quality Control

Several measures were applied to ensure data quality. The laboratory data extraction form was designed to capture only relevant variables, including specimen type, bacterial isolate, antibiotic tested, and susceptibility result. Incomplete records, contaminated specimens, and duplicate isolates from the same patient and infection episode were excluded.

The infection control questionnaire and checklist were reviewed before data collection to ensure clarity and relevance. Data were checked for completeness before analysis. Laboratory results were obtained from official microbiology records to reduce reporting errors. Data entry was reviewed to identify inconsistencies, missing values, and duplicate entries.

3. Results

3.1 Characteristics of Clinical Specimens

The study included 420 clinical specimens in the data collection period. Among them, 276 specimens were positive with bacteria, which resulted in an overall culture positivity rate of 65.7%. Urine samples yielded the greatest number of positive bacterial isolates followed by wound swabs and blood samples. Urine had a positive rate of 34.1% with wound swabs being 22.5%. Table 1 illustrates distribution of clinical specimens and culture-positive isolates.

Table 1. Distribution of Clinical Specimens and Culture-Positive Isolates

Type of Clinical Specimen	Number of Specimens Collected	Culture-Positive Isolates	Percentage of Positive Isolates (%)
Urine	130	94	34.1

Wound swab	85	62	22.5
Blood	72	38	13.8
Sputum	58	35	12.7
Pus	45	29	10.5
Body fluids	18	10	3.6
Catheter tips	12	8	2.9
Total	**420**	**276**	**100.0**

Urinary tract specimens were found as the primary source of bacterial isolates as seen in Table 1 which indicates a high number of patients in the selected hospital departments with a burden of urinary tract infections. Wound swabs and blood samples were also significant contributors of the total bacterial profile of the isolates.

3.2 Distribution of Bacterial Pathogens

Out of 276 bacteria isolates detected, Gram-negative bacteria were more prevalent than Gram-positive bacteria. There were 198 Gram-negative organisms, which comprised of 71.7 percent of the total bacterial isolates, and 78 Gram-positive organisms, which comprised of 28.3 percent.

Isolates of Escherichia coli were the most often isolated with 78 isolates, Klebsiella pneumoniae with 52 isolates, Staphylococcus aureus with 46 isolates, Pseudomonas aeruginosa with 34 isolates, and Acinetobacter baumannii with 28 isolates. Table 2 indicates the distribution of bacteria pathogens and Figure 1 graphically illustrates it.

Table 2. Frequency Distribution of Bacterial Pathogens

Bacterial Isolate	Number of Isolates	Percentage (%)
Escherichia coli	78	28.3
Klebsiella pneumoniae	52	18.8
Staphylococcus aureus	46	16.7
Pseudomonas aeruginosa	34	12.3
Acinetobacter baumannii	28	10.1
Enterococcus spp.	20	7.2
Proteus spp.	12	4.3
Coagulase-negative Staphylococcus	6	2.2
Total	**276**	**100.0**

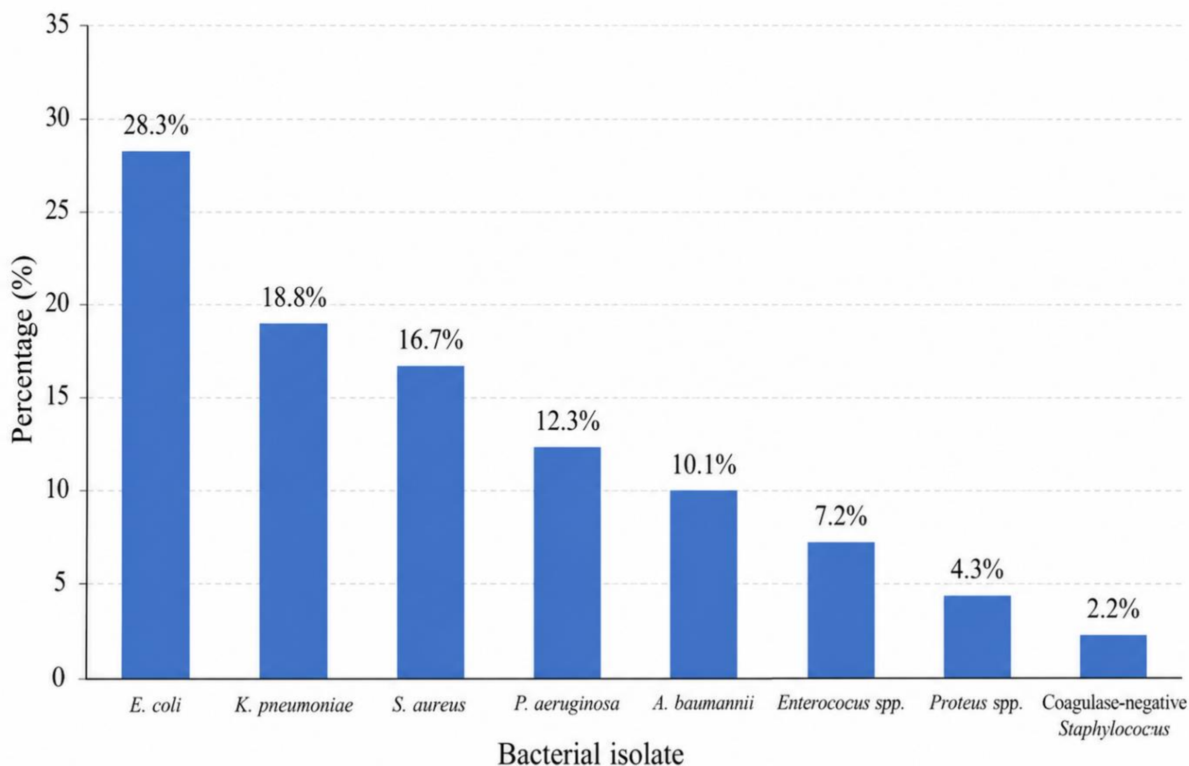

Figure 1. Percentage Distribution of Major Bacterial Isolates

As shown in Figure 1, E. coli was the most prevalent pathogen detected during the study especially in the urine samples whereas S. aureus was more commonly detected in wound and pus samples. The pre-eminence of Gram-negative organisms indicates their significant role in hospital-related infections and antimicrobial resistance.

3.3 Antimicrobial Resistance Patterns

The antimicrobial susceptibility findings were significantly resistant to both Gram-negative and Gram-positive bacterial isolates. High resistance was also seen towards the commonly used antibiotics like ampicillin, ceftriaxone, ciprofloxacin, and cotrimoxazole among Gram-negative organisms. Resistance to meropenem and amikacin was found to be lower, but the resistance to carbapenem remained in isolates of K. pneumoniae, P. aeruginosa and A. baumannii.

Out of Gram-positive isolates, Staphylococcus aureus exhibited resistance to penicillin and erythromycin. A significant percentage of S. aureus isolates were seen to be resistant to methicillin. S. aureus isolates did not show any vancomycin resistance but Enterococcus species showed some resistance.

Table 3 shows the antimicrobial resistance pattern of the key bacterial isolates.

Table 3. Antimicrobial Resistance Pattern of Major Bacterial Isolates

Antibiotic	E. coli n = 78	K. pneumoniae n = 52	P. aeruginosa n = 34	A. baumannii n = 28	S. aureus n = 46
Ampicillin	66 (84.6%)	44 (84.6%)	NT	NT	NT
Ceftriaxone	51 (65.4%)	37 (71.2%)	NT	NT	NT
Ceftazidime	43 (55.1%)	35 (67.3%)	21 (61.8%)	20 (71.4%)	NT
Ciprofloxacin	48 (61.5%)	33 (63.5%)	19 (55.9%)	18 (64.3%)	22 (47.8%)
Gentamicin	36 (46.2%)	28 (53.8%)	17 (50.0%)	16 (57.1%)	18 (39.1%)
Amikacin	19 (24.4%)	16 (30.8%)	10 (29.4%)	11 (39.3%)	NT
Meropenem	8 (10.3%)	9 (17.3%)	7 (20.6%)	8 (28.6%)	NT
Cotrimoxazole	52 (66.7%)	36 (69.2%)	NT	NT	20 (43.5%)
Penicillin	NT	NT	NT	NT	40 (87.0%)
Erythromycin	NT	NT	NT	NT	27 (58.7%)
Cefoxitin	NT	NT	NT	NT	16 (34.8%)
Vancomycin	NT	NT	NT	NT	0 (0.0%)

Note. NT = not tested or not routinely applicable for the organism.

According to Table 3, the resistance to third-generation cephalosporins was especially high in K. pneumoniae and E. coli. The rates of resistance to ceftriaxone were 71.2% of K. pneumoniae isolates and 65.4% of E. coli isolates. Meropenem resistance was less than that of other antibiotics, but the occurrence of carbapenem-resistant isolates is still clinically significant. Cefoxitin resistance was found in 34.8% of S. aureus isolates, which showed that there was methicillin-resistant Staphylococcus aureus.

3.4 Multidrug-Resistant Organisms

A significant percentage of bacterial isolates were found to be multidrug resistant. The prevalence of MDR was 50.0 because 138 of 276 isolates were multidrug resistant. Gram-negative isolates were more common in MDR compared to Gram-positive isolates.

The largest MDR rate was found in Acinetobacter baumannii with 20/28 isolates being multidrug-resistant. This was then succeeded by Klebsiella pneumoniae and Pseudomonas aeruginosa. Table 4 indicates the prevalence of multidrug-resistant organisms..

Table 4. Prevalence of Multidrug-Resistant Bacterial Isolates

Bacterial Isolate	Total Isolates	MDR Isolates	MDR Prevalence (%)
Escherichia coli	78	39	50.0
Klebsiella pneumoniae	52	31	59.6
Staphylococcus aureus	46	20	43.5
Pseudomonas aeruginosa	34	18	52.9
Acinetobacter baumannii	28	20	71.4
Enterococcus spp.	20	6	30.0
Proteus spp.	12	3	25.0

Coagulase-negative Staphylococcus	6	1	16.7
Total	**276**	**138**	**50.0**

As shown in **Table 4**, A. baumannii had the highest MDR prevalence at **71.4%**, followed by K. pneumoniae at **59.6%** and P. aeruginosa at **52.9%**. These findings indicate that multidrug-resistant Gram-negative bacteria represent a major therapeutic challenge in the hospital setting.

3.5 Infection Control Practices among Healthcare Workers

The infection control practice assessment involved 120 healthcare workers. The participants comprised of nurses, physicians, laboratory staff, and other clinical staff. All in all, adherence to infection prevention and control practices differed among various areas of practice.
Maximum reported compliance was reported during the use of gloves during invasive procedures, and the lowest compliance was during hand hygiene prior to contact with the patient and involvement in regular infection control training. The results are summarized in Figure 2.

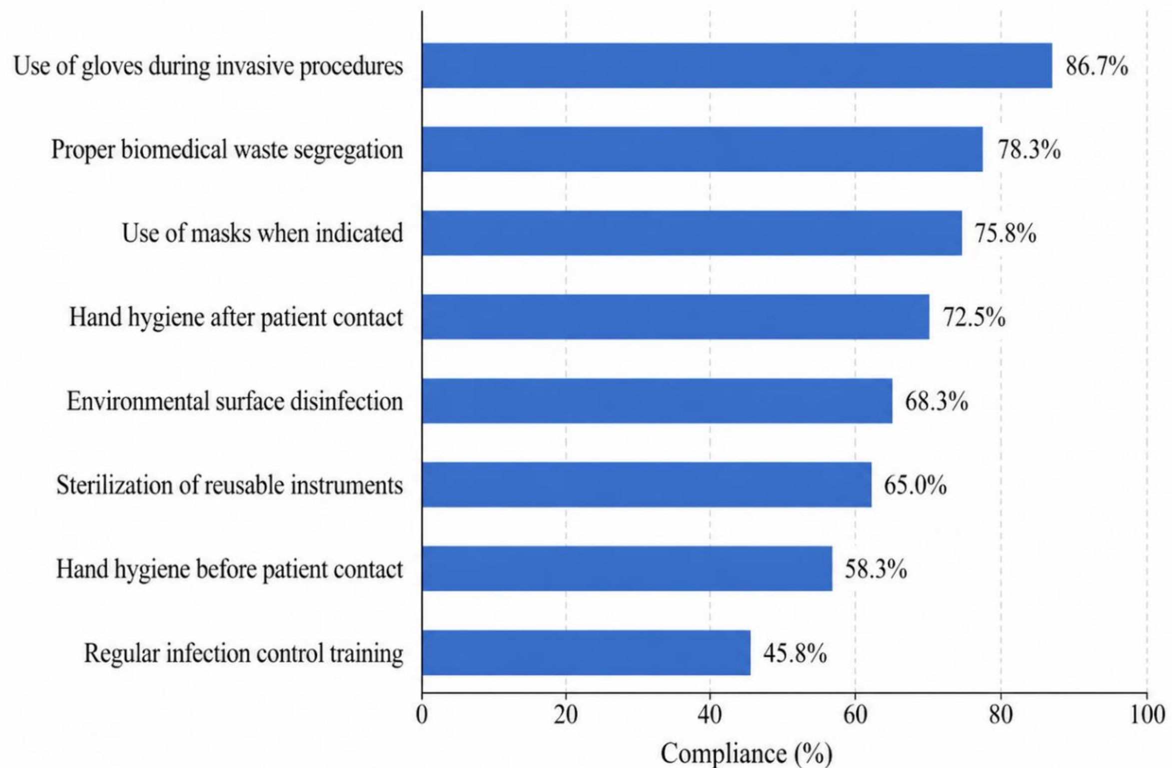

Figure 2. Compliance with Selected Infection Control Practices among Healthcare Workers

Figure 2 indicates that only 58.3% of healthcare workers had hand hygiene compliance before coming into contact with patients, whereas 45.8% of healthcare workers reported regular infection control training. These results indicate that despite the regularity of certain infection prevention procedures, there were still significant loopholes in hand hygiene, sterilization techniques, cleaning of environmental conditions, and ongoing professional education.

3.6 Association between Infection Control Practices and Antimicrobial Resistance

Multidrug-resistant isolates were analyzed in terms of their distribution across selected departments in hospitals. The highest percentage of MDR isolates was observed in intensive care units and surgical wards than in outpatient departments. The highest proportion of MDR was observed in intensive care units, possibly related to increased exposure to antibiotics, length of stay, high invasive treatments, and increased patient susceptibility.
The number of MDR isolates was also higher in departments that reported lower compliance to infection control practices. As an example, hand hygiene compliance and environmental disinfection in intensive care units and surgical wards were relatively lower than outpatient departments. This implies that there may be a correlation between poor infection prevention measures and the presence of resistant organisms.
Even though the current results indicate that there is a relationship between the lack of infection control and antimicrobial resistance, the causality cannot be proven due to the cross-sectional study. Nevertheless, the identified trend justifies the necessity of more intensive interventions aimed at preventing infection and antimicrobial stewardship in high-risk hospital units.

4. Discussion

The current research examined the antimicrobial resistance trends and infection control in hospital clinical settings. The results indicated that the culture positivity rate was high, with Gram-negative organisms making up most of the bacterial isolates. The most common pathogen identified was Escherichia coli, then Klebsiella pneumoniae, Staphylococcus aureus, Pseudomonas aeruginosa and Acinetobacter baumannii. This pattern suggests that Gram-negative bacteria, especially Enterobacterales and non-fermenting Gram-negative bacilli, are major causes of hospital-associated bacterial infections. The same trends have been observed in the past, with MDR organisms often being detected in urine, wound, blood, respiratory, and other clinical samples, proving that the type of specimen has a potent impact on the distribution of resistant pathogens (Li et al., 2022). Urine had the largest percentage of culture positive isolates in the current study and this could be due to the high rate of infection of the urinary tract and the frequent empirical use of antibiotics in suspected urinary infections.

The resistance map in this study is of clinical significance. It was found that there was a high resistance to widely used antibiotics such as ampicillin, ceftriaxone, ciprofloxacin and cotrimoxazole. The resistance to third-generation cephalosporins was also the most notable among K. pneumoniae and E. coli, raising the concern of the potential existence of extended-spectrum beta-lactamase-producing strains. These results align with the evidence of hospital level AMR that indicates that multidrug-resistant bacteria are not randomly distributed but tend to be concentrated by patient location, exposure to antibiotics, source of specimens, and institutional capacity to manage infections (Chen et al., 2022). Even though the rate of resistance to meropenem was lower than to cephalosporins and fluoroquinolones, the emergence of carbapenem-resistant isolates among K. pneumoniae, P. aeruginosa, and A. baumannii is a serious issue since carbapenems are usually used in severe cases of infections caused by resistant Gram-negative organisms.

The total incidence of multidrug resistance in the study was 50.0, which means that every two bacterial isolates was resistant to more than two classes of antimicrobials. The most prevalent MDR was found in A. baumannii, then K. pneumoniae and P. aeruginosa. The importance of such a pattern is that the organisms are often linked to healthcare-associated infections, invasive treatments, environmental preservation, and few treatment choices. It is especially worrying to note that the MDR rate of A. baumannii is very high and this pathogen has been known to thrive in hospital settings and succumb to spreading via contaminated surfaces, equipment and improper hand hygiene. The observed MDR burden justifies the importance of the routine surveillance at the level of the hospital and local antibiograms and predictive monitoring systems to detect high-risk wards and organisms before resistance becomes harder to manage (Chen et al., 2022).

Findings in infection control identified mixed adherence levels among health care providers. Invasive procedure gloves and biomedical waste segregation compliance was relatively high and hand hygiene compliance before contact with patients and routine infection control training was relatively low. The significance of this gap is that compliance selective to visible or procedure-based practices might be insufficient to break transmission of resistant organisms. Pre-contact hand hygiene is especially relevant as it helps avoid the transmission of the pathogens present in the healthcare setting to the vulnerable patients. The observed suboptimal compliance is indicative that the current infection prevention programs should transition beyond the written protocols and emphasize on ongoing staff education, direct observation, audit, feedback and accountability. The same suggestions have been highlighted in the literature that indicated that infection prevention and antibiotic stewardship measures should be functional, quantifiable, and embedded into the daily practice of clinical activities (Coffey et al., 2023).

The results also indicate the possibility of a connection between infection control gaps and MDR. MDR isolates were more prevalent in the intensive care units and surgical wards, and compliance with the chosen infection prevention practices was low there. This correlation is reasonable since these units imply long-term hospitalization and invasive equipment, the use of broad-spectrum antibiotics, and the contact with patients. Nevertheless, due to the cross-sectional nature of the study, it is not possible to draw any causal conclusions. MDR organism carrying screening at the time of admission can be especially advantageous in these high-risk locations since it is able to reveal colonized patients beforehand and inform isolation, cohorting, and special measures (Joubert et al., 2022). The screening is particularly applicable in the instances where prevalence of MDR is high and the cases involve transfers between wards, hospitals or long-term care centers.

The findings demonstrate the significance of antimicrobial stewardship programs in minimizing the unnecessary exposure to antibiotics and enhancing treatment decisions. The implementation of antimicrobial stewardship has been linked to enhanced prescribing, increased compliance with guidelines, and better management of inappropriate prescribing of antimicrobials in hospitals (Al-Omari et al., 2020). The fact that antibiotics that are currently used are highly resistant to the effects of treatment shows that empirical treatment ought to be directed by locally-based susceptibility data instead of habitual prescribing. Among the best

practices of stewardship, prospective audit and feedback, formulary restriction, clinical decision support, multidisciplinary review, and frequent use of hospital antibiograms are the top ones (Stenehjem et al., 2023). Such strategies can be used to minimize the selective pressure and maintain the potency of last-line agents.
The research also justifies the importance of merging antimicrobial stewardship with the use of infection prevention and control. Stewardship is insufficient to mitigate the use of the inappropriate antibiotics, yet it will not be able to reduce cross-transmission in case hand hygiene, environmental sanitation, isolation, and device care are also poor. On the other hand, infection control is not enough to tackle resistance, as the use of broad-spectrum antibiotics is still excessive. Carbapenem-resistant Enterobacterales Evidence indicates that coordinated infection control and stewardship interventions are more effective than uncoordinated interventions since they mitigate both the transmission and antimicrobial selection pressure (Cornistein et al., 2023). Thus, integrated approaches that interconnect the microbiology surveillance, antibiotic policy, staff training, and compliance monitoring should be implemented in hospitals.
Lastly, the antimicrobial stewardship programs in hospitals should be assessed periodically to be able to decide whether the interventions are yielding some results. Assessment is to encompass antibiotic usage, resistance patterns, clinical performance, adherence to practice, infection rate, and staff involvement in the stewardship practices. Recent findings also stress that stewardship initiatives need to be evaluated based on both implementation status and actual effects on the quality of prescribing and patient outcomes (Abdel Hadi et al., 2024). According to the current results, the main priority measures are to enhance compliance with hand hygiene, train to improve the level of infection control, create department-specific antibiograms, screen at-risk admissions, and implement an antimicrobial stewardship and infection prevention committee. These steps can contribute to decreasing the spread of MDR and enhance empirical treatment and patient safety in the clinical environment of hospitals.

5. Conclusion

This research showed that there was a significant load of antimicrobial resistance in hospital-based clinical practice with the Gram-negative bacteria taking up most of the bacterial isolates. The most common organism that was isolated was Escherichia coli, then Klebsiella pneumoniae, Staphylococcus aureus, Pseudomonas aeruginosa, and Acinetobacter baumannii. The high rate of the occurrence of isolates in the urine, wound swabs, and blood samples suggest that urinary tract infections, wound infections, and bloodstream infections continue to be significant sources of bacterial disease in hospital settings. The results of antimicrobial susceptibility were characterized by high resistance to most commonly used antibiotics mainly ampicillin, ceftriaxone, ciprofloxacin, and cotrimoxazole. General prevalence of multidrug resistance was 50.0% with the highest rate of MDR among Acinetobacter baumannii, and then Klebsiella pneumoniae and Pseudomonas aeruginosa. The results indicate that MDR Gram-negative organisms are a significant therapeutic and infection control issue in a hospital. The research also found gaps in infection prevention practices. Glove use and biomedical waste segregation were relatively well-compliant, but hand hygiene prior to contact with patients and frequent training in infection control were less than ideal. Such lapses can help perpetuate and spread resistant organisms, particularly in high risk units like intensive care units and surgical wards. On the whole, the results indicate that antimicrobial resistance monitoring, periodically preparing hospital-specific antibiograms, enhancing hand hygiene compliance, frequent infection control training, and reinforcing antimicrobial stewardship initiatives should be more closely linked with the evidence. The combination of infection control measures and reasonable use of antibiotics is necessary to minimize the transmission of MDRs, enhance clinical outcomes, and reinforce the safety of patients in healthcare facilities that use hospitals.

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