Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/asx3v039

ANTIMICROBIAL RESISTANCE PATTERNS IN PATHOGENS ISOLATED FROM PERITONEAL DRAIN FLUIDS IN ABDOMINAL SURGERIES

Dr Muhammad Kalim[1], Dr Zainab[2*], Dr Zubeda Irshad[3], Dr Naseer Ahmed[4], Dr Mohsina Haq[5]

[1]Assistant Professor, Department of General Surgery, MTI-Lady Reading Hospital, Peshawar, Pakistan
[2*]Lecturer, Department of Pathology, Bacha Khan Medical College, Mardan, Pakistan
[3]Assistant Professor (Microbiology), Department of Pathology, Burns and Plastic Surgery Center, MTI-Hayatabad Medical Complex, Peshawar, Pakistan
[4]Associate Professor, Department of Pharmacology, Rehman College of Dentistry, Peshawar, Pakistan
[5]Professor of Microbiology, Department of Pathology, Peshawar Medical College, Peshawar, Pakistan

***Corresponding author:** Dr Zainab
*Lecturer, Department of Pathology, Bacha Khan Medical College, Mardan, Pakistan
Email: xaynebzia111@gmail.com

ABSTRACT

Background: To determine the spectrum of pathogens and their antimicrobial resistance patterns in peritoneal drain fluid samples collected from patients undergoing abdominal surgeries at Lady Reading Hospital.

Methods: This' prospective observational study was conducted from January 2023 to January 2024' including 73 patients who underwent abdominal surgery with postoperative drain placement. Drain fluid samples were collected under aseptic conditions and subjected to standard culture and sensitivity testing according to Clinical and Laboratory Standards Institute (CLSI) guidelines. Demographic details, surgical characteristics, and resistance trends were analyzed using SPSS version 26, with a p-value <0.05 considered significant.

Results: Gram-negative organisms predominated, with *Escherichia coli* (30.1%) and *Klebsiella spp.* (20.5%) being the most frequent isolates. Among Gram-positive organisms, *Staphylococcus aureus* (12.3%) was common, while *Candida spp.* (8.2%) were the leading fungal isolates. Resistance to ceftriaxone (58.5%) and ciprofloxacin (66.0%) was widespread among Gram-negative bacteria, while carbapenem resistance was observed in nearly one-third of isolates. Vancomycin and linezolid remained highly effective against Gram-positive organisms. Multidrug resistance was most notable in *Klebsiella* (80%) and *Acinetobacter spp.* (83.3%).

Conclusion: 'The study highlights a high prevalence of antimicrobial resistance in pathogens isolated from peritoneal drain fluids following abdominal surgery'. The predominance of multidrug-resistant Gram-negative bacteria underscores the urgent need for culture-guided therapy, antimicrobial stewardship, and strict infection control policies in surgical practice.

Keywords: Antimicrobial resistance, Peritoneal drain, Abdominal surgery, Gram-negative bacteria, Multidrug resistance, Postoperative infection

INTRODUCTION

Intra-abdominal infections remain a leading cause of morbidity and mortality following abdominal surgery. Placement of peritoneal drains, though frequently practiced for monitoring and prevention of fluid collections, carries the risk of secondary bacterial colonization and infection. The organisms recovered from drain fluids often reflect the pathogens implicated in postoperative sepsis, making their study clinically relevant [1-3].

The global rise of antimicrobial resistance (AMR) has further complicated the management of these infections. In recent years, multidrug-resistant (MDR) organisms such as *Escherichia coli, Klebsiella spp., Pseudomonas spp.*, and *Acinetobacter spp.* have been increasingly reported from surgical sites and intra-abdominal collections. This trend is particularly alarming in low- and middle-income countries, where empirical antibiotic use is common and culture-guided therapy is often underutilized. Reports from South Asia highlight high resistance rates to cephalosporins and fluoroquinolones, with growing carbapenem resistance threatening last-line therapeutic options [4-6].

Gram-positive organisms, particularly *Staphylococcus aureus* and *Enterococcus spp.*, also play a significant role in postoperative infections. The emergence of methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant strains has further restricted treatment choices. Fungal pathogens such as *Candida spp.* are being increasingly recognized in critically ill surgical patients, adding another dimension to the problem[7-9].

Pakistan has reported some of the highest regional rates of MDR organisms, yet data specifically addressing peritoneal drain cultures remain limited. Most studies focus on bloodstream or urinary tract infections, leaving a gap in evidence for abdominal surgery patients. Given the rising ‘burden of resistance and its impact on postoperative outcomes, this study was conducted to assess the spectrum of pathogens and their antimicrobial resistance patterns in peritoneal drain fluids at Lady Reading Hospital, Peshawar’.

METHODOLOGY

This study was designed as a prospective observational study conducted in the Department of General Surgery at Lady Reading Hospital, Peshawar. The research was carried out ‘over a period of one year, from January 2023 to January 2024’. Ethical approval for the study was obtained from the Institutional Review Board of Lady Reading Hospital prior to data collection. Written informed consent was obtained from all participants or their attendants. Patient confidentiality was strictly maintained throughout the study, and no personal identifiers were disclosed in the analysis or reporting.

A total of 73 patients who underwent abdominal surgeries and had peritoneal drains placed postoperatively were included. The sample size was determined based on the average annual surgical volume of the hospital and the anticipated prevalence of culture-positive peritoneal drain fluid reported in earlier regional studies, ensuring adequate statistical power.

Inclusion Criteria

- Patients of all age groups undergoing abdominal surgery (emergency or elective).
- Presence of a peritoneal drain postoperatively.
- Patients who gave informed consent for participation.

Exclusion Criteria

- Patients already on prolonged (>72 hours) broad-spectrum antibiotic therapy before drain collection.
- Cases with inadequate or contaminated drain fluid samples.
- Patients with incomplete records or those lost to follow-up.

After obtaining approval from the Institutional Review Board of Lady Reading Hospital, patients fulfilling the inclusion criteria were enrolled. Demographic and clinical details such as age, gender, comorbidities, type of surgery, indication for surgery, and antibiotic prophylaxis were recorded on a structured proforma.

Peritoneal drain fluid samples were collected aseptically within 24–48 hours after surgery and transported immediately to the hospital's microbiology laboratory. Standard aseptic precautions were observed during sample collection to minimize contamination.

Samples were cultured on blood agar, MacConkey agar, and Sabouraud's dextrose agar for bacterial and fungal growth. Plates were incubated at 37°C for 24–48 hours. Organisms were identified by colony morphology, Gram staining, and standard biochemical tests.

Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method following Clinical and Laboratory Standards Institute (CLSI) guidelines. A range of antibiotics commonly used in surgical prophylaxis and treatment were tested, including third-generation cephalosporins, aminoglycosides, fluoroquinolones, carbapenems, glycopeptides, and antifungals where applicable.

- Multidrug resistance (MDR): Resistance to three or more different classes of antibiotics.
- Methicillin-resistant *Staphylococcus aureus* (MRSA): Defined by resistance to cefoxitin.
- Extended-spectrum beta-lactamase (ESBL): Confirmed by combined disk diffusion mthod.

'Data were entered and analyzed using SPSS version 26.0'. Continuous variables (such as age and hospital stay) were expressed as mean ± standard deviation, while categorical variables (such as gender, type of surgery, and isolated organisms) were presented as frequencies and percentages.

Comparisons of resistance patterns across demographic and clinical groups were performed using the Chi-square test or Fisher's exact test where appropriate. A p-value of <0.05 was considered statistically significant.

RESULTS

Out of the total 73 patients included in this study, the majority were above 40 years of age, followed by those between 20 and 40 years. Males slightly outnumbered females, though the gender difference was not statistically significant. Comorbidities were present in nearly half of the patients, with diabetes and hypertension being the most common. Interestingly, the presence of comorbidities showed a significant association with culture positivity (p=0.04). Emergency surgeries constituted a higher proportion compared to elective procedures, and this difference was statistically significant (p=0.02).

Table 1. Demographic Characteristics of Patients (n=73)

Variable	Frequency (n)	Percentage (%)	p-value
Age groups			
<20 years	10	13.7	
20–40 years	28	38.4	
>40 years	35	47.9	0.21
Gender			
Male	41	56.2	
Female	32	43.8	0.34
Comorbidities			
Diabetes	15	20.5	
Hypertension	12	16.4	
Malignancy	8	11.0	
None	38	52.1	0.04*
Type of surgery			
Emergency	45	61.6	
Elective	28	38.4	0.02*

Culture positivity revealed a predominance of Gram-negative organisms, particularly *Escherichia coli* and *Klebsiella spp.*, which together accounted for nearly half of all isolates. Among Gram-positive organisms, *Staphylococcus aureus* was the leading isolate, while *Candida spp.* were the most frequent fungal isolates. The distribution of isolates across the groups was statistically significant (p=0.001), suggesting a non-random pattern of pathogen recovery.

Table 2. Pathogens Isolated from Peritoneal Drain Fluid (n=73)

Pathogen Isolated	Frequency (n)	Percentage (%)	p-value
Gram-negative			
Escherichia coli	22	30.1	
Klebsiella spp.	15	20.5	
Pseudomonas spp.	10	13.7	
Acinetobacter spp.	6	8.2	
Gram-positive			
Staphylococcus aureus	9	12.3	
Enterococcus spp.	5	6.8	
Fungal			
Candida spp.	6	8.2	0.001*

Analysis of antimicrobial resistance among Gram-negative isolates revealed high resistance rates to third-generation cephalosporins, with more than half of the isolates resistant to ceftriaxone. Resistance to ciprofloxacin was also high (66%), while carbapenem resistance was comparatively lower, though still concerning. Aminoglycosides such as amikacin demonstrated better efficacy, while colistin remained the most effective antibiotic with a sensitivity rate exceeding 90%. The resistance differences across drug classes were statistically significant for most comparisons.

Table 3. Antimicrobial Resistance Patterns in Gram-negative Isolates

Antibiotic Tested	Sensitive (%)	Resistant (%)	p-value
Ceftriaxone	22 (41.5)	31 (58.5)	0.001*
Piperacillin–Tazobactam	30 (56.6)	23 (43.4)	0.02*
Imipenem	35 (66.0)	18 (34.0)	0.08
Amikacin	33 (62.3)	20 (37.7)	0.04*
Ciprofloxacin	18 (34.0)	35 (66.0)	0.001*
Colistin	50 (94.3)	3 (5.7)	0.56

Among Gram-positive organisms, resistance to penicillin was notably high, with nearly three-quarters of isolates resistant. On the other hand, vancomycin and linezolid retained excellent activity, with resistance rates below 15%. Clindamycin showed moderate activity with equal proportions of sensitive and resistant strains. Although vancomycin resistance was rare, the emergence of such strains remains a clinical concern.

Table 4. Antimicrobial Resistance Patterns in Gram-positive Isolates

Antibiotic Tested	Sensitive (%)	Resistant (%)	p-value
Penicillin	4 (28.6)	10 (71.4)	0.001*
Vancomycin	12 (85.7)	2 (14.3)	0.09
Linezolid	13 (92.9)	1 (7.1)	0.11
Clindamycin	7 (50.0)	7 (50.0)	0.42

The burden of multidrug resistance was substantial across both Gram-negative and Gram-positive organisms. The highest MDR rates were noted in *Klebsiella spp.* and *Acinetobacter spp.*, exceeding 80%. Nearly two-thirds of *E. coli* and *Pseudomonas* isolates were also multidrug resistant. Among Gram-positive organisms, two-thirds of *Staphylococcus aureus* isolates were MRSA. These findings

underscore the limited treatment options available and highlight the pressing need for strict antimicrobial stewardship.

Table 5. Multidrug Resistance (MDR) among Isolates

Pathogen	MDR Cases (n)	Percentage (%)	p-value
E. coli	15	68.2	0.001*
Klebsiella spp.	12	80.0	0.001*
Pseudomonas spp.	7	70.0	0.02*
Acinetobacter spp.	5	83.3	0.01*
Staph. aureus (MRSA)	6	66.7	0.03*

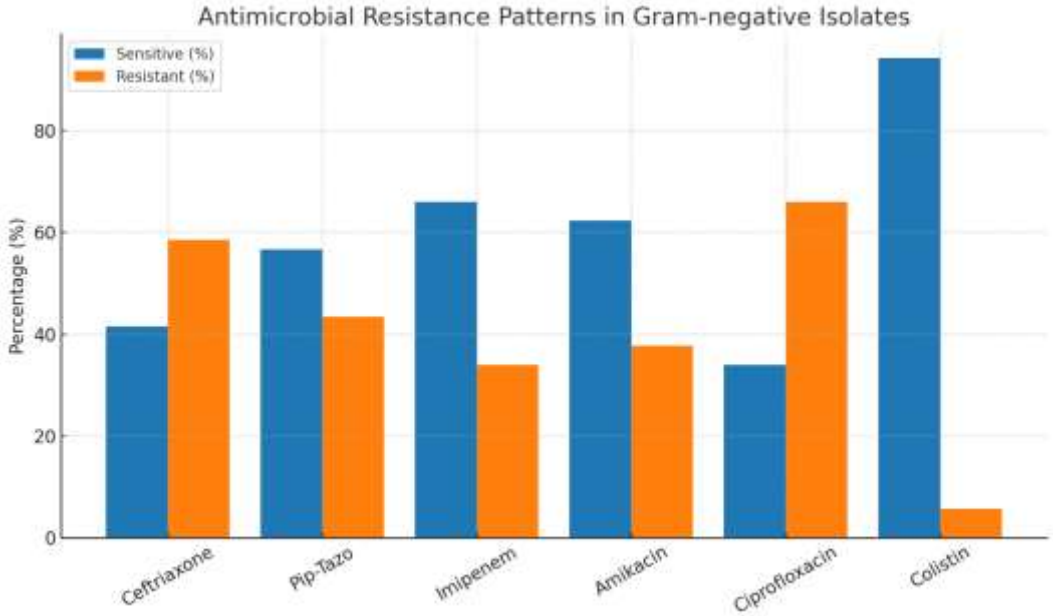

Figure 1: Bar graph showing sensitivity vs. resistance rates in Gram-negative isolates across key antibiotics.

DISCUSSION

The present study highlights the concerning burden of antimicrobial resistance (AMR) among pathogens isolated from peritoneal drain fluids of patients undergoing abdominal surgeries at Lady Reading Hospital. Our findings demonstrate that Gram-negative organisms predominated, with *Escherichia coli* and *Klebsiella spp.* being the most frequent isolates, followed by *Pseudomonas spp.* and *Acinetobacter spp.* This pattern was consistent with studies, where Enterobacteriaceae have been reported as the leading cause of postoperative intra-abdominal infections [10-12].

Resistance to third-generation cephalosporins was particularly high in our study, with more than half of Gram-negative isolates resistant to ceftriaxone. This aligns with the studies reported cephalosporin resistance exceeding 60% among *E. coli* and *Klebsiella* isolates from intra-abdominal infections. The widespread use and often inappropriate empirical reliance on cephalosporins may explain this alarming trend [13-15].

Carbapenems, often considered the last line of defense, showed better activity but resistance was still observed in approximately one-third of isolates. Similar rates have been described in South Asian surveillance reports of studies raising major concerns about the emergence of carbapenem-resistant Enterobacteriaceae (CRE). Although colistin retained excellent activity, its increasing use poses the threat of future resistance, which has already been reported sporadically in neighboring countries [16].

Among Gram-positive isolates, Staphylococcus aureus accounted for the majority, with nearly two-thirds being methicillin-resistant (MRSA). Our MRSA rate was higher compared to Western data (Laupland et al., 2021), but comparable to local hospital-based reports [17]. Vancomycin and linezolid remained highly effective, consistent with global findings [18].

The multidrug resistance (MDR) burden observed in our study was significant, particularly among *Klebsiella spp.* and *Acinetobacter spp.*, where MDR exceeded 80%. Such levels mirror those reported by World Health Organization regional AMR surveillance, which categorizes these pathogens as "critical priority" organisms requiring urgent development of new antibiotics [19].
Our results reinforce the importance of antimicrobial stewardship programs. Empirical therapy guided by local antibiograms, strict infection control practices, and judicious antibiotic use are essential to curb the rising resistance trend. Furthermore, early culture-guided therapy in abdominal surgeries can improve outcomes, reduce hospital stay, and minimize complications, as highlighted by studies[20].

CONCLUSION

'This study demonstrates a high prevalence of antimicrobial resistance among pathogens isolated from peritoneal drain fluids in abdominal surgeries, with Gram-negative bacteria being the most common isolates'. Resistance to commonly used cephalosporins and fluoroquinolones was widespread, while carbapenem resistance was also notable. The high rates of MDR, particularly in *Klebsiella* and *Acinetobacter spp.*, underscore the severity of the AMR crisis in surgical infections.
Effective control strategies, including routine surveillance, antimicrobial stewardship, and evidence-based antibiotic prescribing, are urgently needed. Strengthening infection control measures in surgical wards and limiting the inappropriate use of broad-spectrum antibiotics are critical steps. 'Future studies with larger multi-center cohorts are recommended to further validate these findings and guide national policy'.

REFERENCES

1. Alelign, D., et al., *Bacterial pathogens, drug-resistance profile and its associated factors from patients with suspected peritonitis in Southern Ethiopia.* 2021: p. 4107-4117.
2. De Waele, J.J., et al., *The role of abdominal drain cultures in managing abdominal infections.* 2022. **11**(5): p. 697.
3. Hu, A., et al., *Antibiotic resistance is common in the cultures of intraabdominal abscess drainage after appendectomy.* 2022. **57**(9): p. 102-106.
4. Chan, P.C., et al., *Patterns and infection outcomes of bacterial colonization in patients with indwelling abdominal drains for malignant ascites.* 2020. **9**(6): p. 4490501-4494501.
5. Bender, F., et al., *Drug resistant bacteria in perianal abscesses are frequent and relevant.* 2022. **12**(1): p. 14866.
6. Obst, W., et al., *The need of antimicrobial stewardship in post-operative infectious complications of abdominal surgery.* 2022. **38**(5): p. 345-353.
7. Esposito, A.C., et al., *Do Cultures From Percutaneously Drained Intra-abdominal Abscesses Change Treatment? A Retrospective Review.* 2023. **66**(3): p. 451-457.
8. Xiong, Y.-m. and X.J.C.M.S. Rao, *Clinical and microbiological characteristics of patients with complicated intra-abdominal infections in intensive care unit.* 2020. **40**(1): p. 104-109.
9. Garzon-González, L.N., et al., *Association between bacterial resistance profile and the development of intra-abdominal abscesses in pediatric patients with perforated appendicitis: cohort study.* 2023. **40**(1): p. 18.
10. Bassetti, M., et al., *Post-operative abdominal infections: epidemiology, operational definitions, and outcomes.* 2020. **46**(2): p. 163-172.
11. Bhaskar, K., et al., *Bacterial peritonitis in paediatric appendicitis; microbial epidemiology and antimicrobial management.* 2023. **22**(1): p. 45.
12. De Waele, J.J., et al., *Optimized Treatment of Nosocomial Peritonitis.* 2023. **12**(12): p. 1711.
13. Djebala, S., et al., *Antimicrobial susceptibility profile of several bacteria species identified in the peritoneal exudate of cows affected by parietal fibrinous peritonitis after caesarean section.* 2021. **8**(12): p. 295.
14. Yasin, N.A., et al., *Epidemiological characteristics, antimicrobial susceptibility profile, and surgical outcome of complicated intra-abdominal infection at a Tertiary Hospital in Somalia.* 2022. **15**: p. 7427.

15. Leon, L., et al., *Serum and peritoneal exudate concentrations after high doses of β-lactams in critically ill patients with severe intra-abdominal infections: an observational prospective study.* 2020. **75**(1): p. 156-161.
16. Solís-Sánchez, P., et al., *Chronic diarrhea Due to aeromonas hydrophila in an immunosuppressed patient with a pancreas–Kidney transplant.* 2023. **12**(9): p. 1151.
17. Dziubinski, N., et al., *Retrospective identification of bacterial isolates from emergency laparotomy surgical site infections in horses.* 2020. **87**: p. 102927.
18. Yang, S., et al., *Molecular epidemiology of Myroides odoratimimus in nosocomial catheter-related infection at a general hospital in China.* 2020: p. 1981-1993.
19. Puia, V.R., et al. *CT-based radiomic analysis may predict bacteriological features of infected intraperitoneal fluid collections after gastric cancer surgery*. in *Healthcare*. 2022. MDPI.
20. Halima, D.-Y., et al., *The intraperitoneal bacteriology and antimicrobial resistance in acute appendicitis among children: a retrospective cohort study between the years 2007–2017.* 2021. **180**(7): p. 2091-2098.