Al-Farouk journal of sciences
Volume (2), Issue (5) (Nov, 2026)
ISSN: 3135-2359

مجلة الفاروق للعلوم
المجلد (2) العدد 5 نوفمبر 2026
عدد خاص بالمؤتمر العلمي الرابع للعلوم والتقنية
28–29 نوفمبر 2026 مصراتة – ليبيا
إدارة المعاهد العليا – وزارة التعليم التقني

Bacterial Resistance Patterns at Suhar Hospital, Northern Oman: A Retrospective Study

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Received: 29/7/2026 Revised: 20/8/2026 Accepted: 28/8/2026 Publication: 28/11/2026

Abstract

Background: Antimicrobial resistance threatens treatment effectiveness and patient outcomes. Suhar Hospital launched its antimicrobial stewardship program (ASP) in 2019. This study describes bacterial resistance phenotypes among clinical isolates processed at the hospital during 2022.

Aim: To describe the distribution of major bacterial resistance phenotypes among clinical isolates processed at Suhar Hospital in 2022 and examine variation across three surveillance periods.

Methodology: This retrospective study included clinically significant bacterial isolates processed at Suhar Hospital from 1 January to 31 December 2022 and subjected to antimicrobial susceptibility testing. Duplicate isolates from the same admission episode, environmental samples, surveillance cultures, non-bacterial isolates, and records with incomplete microbiological data were excluded. Data were extracted from electronic medical records and the microbiology laboratory database. Descriptive analyses and comparisons across three surveillance periods were performed using SPSS.

Results: A total of 7,155 isolates from Suhar Hospital departments were processed during 2022. Among these, 2,376 (31%) exhibited resistance phenotypes, including carbapenem-resistant Enterobacterales (6.84%), extended-spectrum beta-lactamase-producing organisms (13.78%), multidrug-resistant Acinetobacter baumannii (4.66%), methicillin-resistant Staphylococcus aureus (4.97%), and vancomycin-resistant Enterococcus (0.17%). Resistance patterns were observed across pediatric and adult departments.

Conclusion: Among isolates processed in 2022, the overall distribution of major resistance phenotypes was relatively stable across the three surveillance periods. Because the study did not include a pre-ASP comparison period, longitudinal data across the full five years, or antimicrobial consumption data, these findings cannot establish the impact of the ASP. Continued surveillance and evaluation of stewardship processes are needed.

KEYWORDS: Antimicrobial resistance, Antimicrobial stewardship, Hospital surveillance, Multidrug-resistant organisms Oman.

1. Introduction

Antimicrobial resistance (AMR) has become a major threat to healthcare systems worldwide because it reduces the effectiveness of standard antimicrobial therapy, prolongs hospital stay, increases mortality, and raises treatment costs. Recent global surveillance data from the World Health Organization showed that one in six laboratory-confirmed bacterial infections in 2023 was resistant to commonly used antibiotics, with resistance increasing across more than 40% of monitored pathogen–antibiotic combinations [1]. This burden is particularly concerning in hospital settings where resistant gram-negative organisms such as Escherichia coli, Klebsiella pneumoniae, and Acinetobacter species continue to compromise empirical treatment choices and infection control efforts [1]. The World Health Organization Eastern Mediterranean Region also reports high antibiotic consumption and increasing resistance rates, making local surveillance essential for guiding clinical decisions [2].

Antimicrobial stewardship programs (ASPs) were developed to optimize antibiotic prescribing, improve treatment outcomes, and reduce the emergence of resistant organisms. Evidence from hospital-based studies has shown that structured stewardship interventions improve adherence to antimicrobial guidelines, reduce unnecessary broad-spectrum antibiotic exposure, and support earlier de-escalation of therapy. A recent hospital evaluation demonstrated that stewardship review achieved antibiotic cessation or step-down in 60% of reviewed cases, with adherence to stewardship recommendations exceeding 80% [3].

In Oman, antimicrobial resistance remains a growing clinical concern, especially in secondary and tertiary hospitals where broad-spectrum antibiotics are frequently prescribed for severe infections. To address this challenge, Suhar Hospital launched its antimicrobial stewardship program in 2019 as part of a broader strategy to strengthen rational antimicrobial use, improve microbiological surveillance, and support evidence-based prescribing. Continuous evaluation of bacterial resistance trends after stewardship implementation is necessary to determine whether local prescribing interventions are influencing resistance patterns and to identify emerging threats within the hospital environment.

This study aimed to describe bacterial resistance patterns among clinical isolates processed at Suhar Hospital during 2022 and compare the distribution of resistance phenotypes across three surveillance periods. As the available dataset covers 2022 only, it describes resistance patterns during one calendar year rather than evaluating changes over the full five years since ASP implementation.

2. Materials and Methods

Study design and setting

This retrospective observational study was conducted at the microbiology laboratory of Suhar Hospital, a secondary care referral hospital in Northern Oman. The study evaluated bacterial isolates recovered from clinical specimens processed between 1 January 2022 and 31 December 2022. Suhar Hospital provides medical, surgical, pediatric, obstetric, gynecological, emergency, and critical care services and receives specimens from both inpatient and outpatient settings.

Study population

The study population consisted of all bacterial isolates recovered from clinical specimens submitted to the microbiology laboratory during the study period. Isolates originated from patients admitted to various hospital departments, including medical wards, surgical wards, intensive care units, pediatric wards, emergency services, and outpatient clinics. Inclusion criteria included all clinically significant bacterial isolates obtained from patient specimens processed between January and December 2022 and subjected to antimicrobial susceptibility testing. Exclusion criteria comprised duplicate isolates from the same admission episode, environmental samples, surveillance cultures, non-bacterial isolates, and records with incomplete microbiological data.

Data collection procedures

Data were retrospectively extracted from the hospital electronic medical record system and microbiology laboratory database using a standardized data collection form. Variables collected included patient demographics, admission category, hospital department, specimen type, bacterial identification, and antimicrobial resistance phenotype. All data were anonymized before analysis and verified by cross-checking laboratory and medical record databases to ensure completeness and accuracy.

Microbiological analysis and statistics

Clinical specimens were processed using routine microbiological laboratory procedures. Bacterial identification and antimicrobial susceptibility testing were performed according to standard laboratory protocols, and organisms were classified under routine resistance reporting categories used in annual surveillance. Statistical analysis was performed using SPSS version 31. Descriptive statistics were used to summarize antimicrobial resistance patterns. Categorical variables were expressed as frequencies and percentages. Resistance trends were evaluated across three surveillance periods (January–April, May–August, and September–December). Differences between periods were assessed using the Chi-square test, with statistical significance defined as $p < 0.05$.

The study was approved by the Ministry of Health Research and Ethics Review Committee and authorized by Suhar Hospital before commencement of data collection.

3. RESULTS

Source of clinical isolates

Isolates were recovered from a broad range of hospital departments, including adult medical, surgical, critical care, emergency, obstetrics and gynecology, nephrology, and pediatric services, providing comprehensive representation of clinical specimens processed during the study period.

Overall isolate distribution

During 2022, 7,155 bacterial isolates were processed, including 5,844 (81.6%) from adult departments and 1,311 (18.4%) from pediatric departments. The proportion of multidrug-resistant organisms was similar across the three surveillance periods (27.7%, 27.9%, and 27.4%, respectively; $\chi^2 = 12.203$, $p = 0.069$). Although isolates came from both adult and pediatric services, the available aggregate results do not provide resistance phenotype rates stratified by age group. Therefore, differences in resistance patterns between adult and pediatric patients cannot be assessed from the reported data (Figure 1).

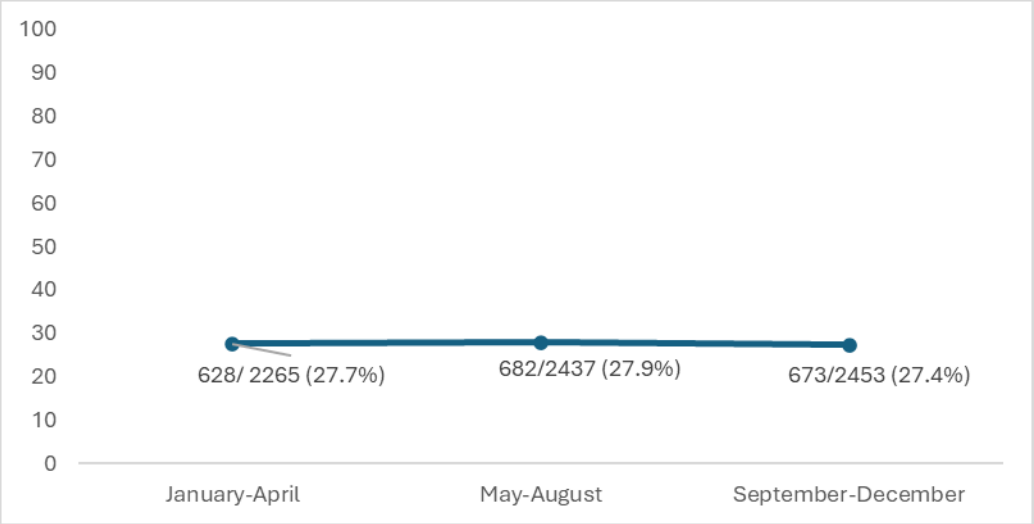


Figure 1: Distribution of bacterial isolates and MDROs across surveillance periods

Antimicrobial resistance phenotypes

Five major antimicrobial resistance phenotypes were identified among the bacterial isolates: extended-spectrum beta-lactamase (ESBL)-producing organisms, carbapenem-resistant Enterobacterales (CRE), methicillin-resistant Staphylococcus aureus (MRSA), multidrug-resistant Acinetobacter baumannii (MDR-A. baumannii), and vancomycin-resistant Enterococcus (VRE). Among the 7,155 processed isolates, 2,376 (31.0%) exhibited one of these resistance phenotypes. ESBL-producing organisms were the most prevalent (13.78%), followed by CRE (6.84%), MRSA (4.97%), MDR-A. baumannii (4.66%), and VRE (0.17%). These resistance phenotypes were detected across both adult and pediatric services, indicating widespread distribution within the hospital. The distribution of individual resistance phenotypes across the three surveillance periods is presented in Figure 2.

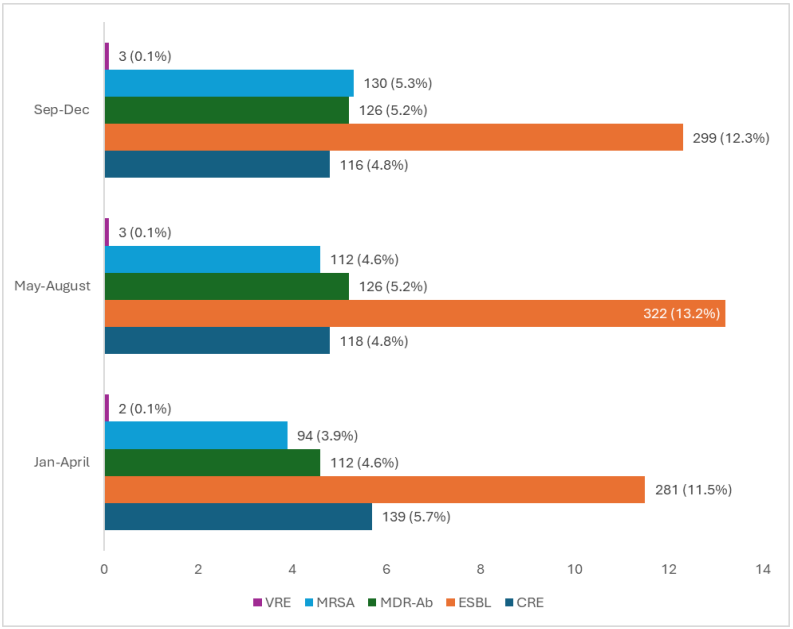


Figure 2: Temporal distribution of five major antimicrobial resistance phenotypes during the three surveillance periods

Distribution of resistant isolates across the three surveillance periods.

The distribution of individual antimicrobial resistance phenotypes across the three surveillance periods is presented in Figure 2. ESBL-producing organisms remained the predominant resistance phenotype throughout the study period, although their frequency increased during the second surveillance period before declining modestly during the final period. MDR-Acinetobacter baumannii increased after the first surveillance period and subsequently remained stable. MRSA demonstrated minor fluctuations, whereas CRE and VRE remained consistently uncommon throughout the study period.

Trends in antimicrobial resistance

ESBL-producing isolates increased during the second surveillance period and declined modestly during the final surveillance period, resulting in an overall stable resistance pattern. MDRO-AB increased after the first quarter and then stabilized. MRSA showed minor fluctuations but persisted throughout the study period. CRE and VRE remained infrequent, with no evidence of a rising trend during 2022.

4. DISCUSSION

This study evaluated antimicrobial resistance patterns following five years of antimicrobial stewardship program (ASP) implementation at Suhar Hospital. Overall, antimicrobial resistance remained relatively stable throughout 2022, with Gram-negative organisms accounting for the majority of resistant isolates. These findings are consistent with global and regional surveillance reports identifying Gram-negative pathogens as the principal contributors to antimicrobial resistance in healthcare settings [1,2].

Although ESBL-producing organisms remained the predominant resistance phenotype, their frequency fluctuated across the three surveillance periods. These changes should not be interpreted as evidence of an ASP effect. The manuscript dataset does not document which stewardship interventions were implemented during each year, their implementation dates, compliance, or antibiotic consumption. Common ASP approaches such as prospective audit and feedback, restriction or pre-authorization of selected antibiotics, review of microbiology results, de-escalation, and guideline-based prescribing may be relevant areas for local evaluation, but their implementation at Suhar Hospital during the study period must be confirmed from hospital records before being reported as study procedures. Previous studies have reported benefits from hospital stewardship interventions [3,4].

CRE and VRE remained infrequent throughout the study period, suggesting that antimicrobial restriction policies and stewardship interventions may have helped limit the emergence of these high-priority resistant pathogens. In contrast, MRSA and MDR-Acinetobacter baumannii persisted across all surveillance periods, indicating that antimicrobial stewardship should continue to be integrated with robust infection prevention and control measures. The persistence of MDR-Acinetobacter baumannii is clinically important because this pathogen is associated with prolonged hospitalization, intensive care admission, environmental persistence, and increased healthcare-associated infections [5].

Collectively, the findings show that the distribution of the selected resistance phenotypes did not differ substantially across the three surveillance periods in 2022. They do not demonstrate that the ASP maintained resistance rates, because the study did not assess a pre-ASP baseline, five-year longitudinal trends, antimicrobial use, or intervention fidelity. Future evaluations should link annual resistance data with antibiotic consumption and documented ASP activities to assess associations more directly [3,4,6].

5. Study limitations

This study has several limitations. The retrospective single-center design may limit generalizability. The available dataset covered 2022 only and did not include annual data for the full five years following

ASP initiation or a pre-implementation comparator. Antimicrobial consumption, patient-level clinical outcomes, molecular characterization, and a documented inventory of ASP interventions were unavailable. Resistance phenotype results were not stratified by adult and pediatric groups, preventing a direct comparison between these populations. In addition, the detailed patient–organism deduplication algorithm was not documented beyond exclusion of duplicates from the same admission episode. These limitations prevent causal conclusions about the ASP's impact.

6. Future recommendations

Future multicenter studies incorporating antimicrobial utilization data, molecular surveillance, patient clinical outcomes, and longer follow-up periods are recommended to provide a more comprehensive evaluation of the long-term impact of antimicrobial stewardship programs on antimicrobial resistance in Oman.

7. CONCLUSION

In this single-year analysis, the selected antimicrobial resistance phenotypes showed no statistically significant variation in the proportion of multidrug-resistant organisms across the three surveillance periods in 2022. The findings describe the hospital's 2022 resistance profile but do not establish the impact of the ASP launched in 2019. Continued surveillance should combine annual resistance data with antimicrobial consumption, documented stewardship interventions, and separate adult and pediatric analyses to support evaluation and guide practice in Northern Oman.

CONFLICT OF INTEREST STATEMENT: None to declare.

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