



Screening of Multidrug-Resistant Organisms and Risk Factor Analysis in the Intensive Care Units from a Tertiary Care Center

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Abstract Objectives: MDROs are defined as bacteria that are resistant to multiple classes of antibiotics, rendering standard treatment options ineffective. **Methods:** A prospective study was conducted at Panimalar Medical College Hospital and Research Institute in the Intensive Care Units (MICU, SICU, ICCU and Neuro ICU) during November 2023. Patients aged over 18 years admitted to the ICU were included, while inpatients below 18 years, those from wards and outpatients were excluded. **Results:** The results showed that, among 123 ICU patients, 34 (27.6%) were culture-positive for Multidrug-Resistant Organisms (MDROs), while 89 (72.4%) were culture-negative. *Klebsiella pneumoniae* and *Escherichia coli* were the predominant organisms, particularly among elderly females and patients with multiple risk factors, highlighting the importance of effective infection-control measures and appropriate antimicrobial management in the ICU. **Conclusion:** The study found that MDROs were common among ICU patients, especially in elderly females and those with multiple risk factors like prior antibiotic use, prolonged ICU stays and comorbidities. These findings highlight the need for better infection control, proper antibiotic use and focused care for high-risk patients to reduce MDROs in ICUs.

Key Words Multidrug Resistant Organisms, Risk Factors, Antibiotics

INTRODUCTION

Multidrug-Resistant Organisms (MDROs) are microorganisms that have developed resistance to multiple groups of antimicrobial drugs, which limits the available treatment options and makes infections more challenging to manage. The screening of Multidrug-Resistant Organisms (MDROs) and the analysis of risk factors in Intensive Care Units (ICUs) is a critical area of research, particularly in tertiary care centers where patients are often at heightened risk due to their underlying conditions and the invasive procedures they undergo. The prevalence of MDROs in ICUs is concerning, with various studies indicating that these pathogens are responsible for a significant proportion of Healthcare-Associated Infections (HAIs) [1,2]. Resistance of common pathogens has been associated with multiple factors including increased length of hospital stay, broad antibiotic use and invasive devices [3,4].

Empirical antibiotic therapy in ICUs should be guided by local resistance patterns to ensure effective treatment. Studies have shown that inappropriate

empirical therapy can lead to increased mortality rates, particularly in cases of infections caused by MDROs [5,6]. For instance, the inappropriate use of broad-spectrum antibiotics can not only fail to control the infection but also contribute to the further development of resistance [7]. Therefore, it is essential for healthcare providers to have access to updated data on local antimicrobial susceptibility trends to optimize treatment regimens [8,9].

Risk factors for acquiring MDRO infections in ICUs include prolonged mechanical ventilation, the presence of invasive devices and prior antibiotic exposure [10,11]. Specifically, patients who have undergone prolonged ICU stays are at a greater risk of colonization and subsequent infection by resistant organisms, such as carbapenem-resistant *Klebsiella pneumoniae* [12]. Furthermore, the interplay between colonization pressure and antibiotic exposure has been highlighted, indicating that the presence of colonized patients in the ICU can significantly increase the risk for non-colonized patients [13].

In addition to patient-specific factors, environmental factors within the ICU, such as infection control practices and antibiotic management programs, play a crucial role in the spread of MDROs [14-16]. The implementation of antibiotic management programs in ICUs has been shown to improve patient outcomes by reducing unnecessary antibiotic use and optimizing treatment protocols [17,18].

The screening of MDROs in ICUs is essential for identifying at-risk patients and implementing appropriate therapeutic strategies. Continuous surveillance of resistance patterns, combined with robust infection control measures and antibiotic management, is critical in combating the rising threat of multidrug-resistant infections in critically ill patients. So the study aimed to analyze the risk factors and antimicrobial susceptibility patterns associated with Multidrug-Resistant Organisms (MDROs).

METHODS

A prospective study was conducted at Panimalar Medical College Hospital and Research Institute in the Intensive Care Units during November to December 2023. Patients admitted to the ICU were informed about the study and consent was obtained. Participants were divided into two groups based on the presence of MDROs, determined through antibiotic susceptibility patterns. Risk factors examined included previous antibiotic use, prolonged ICU stay, invasive procedures, immunocompromised states, underlying chronic diseases, surgical history, previous hospitalizations, use of immunosuppressive therapy, inadequate infection control practices, presence of indwelling devices, age, nutritional status, co-infections, high patient-to-nurse ratios and environmental factors.

Patients aged over 18 years admitted to the ICU were included, while inpatients below 18 years, those from wards and outpatients were excluded. The study utilized continuous sampling with a target sample size of 123 and appropriate statistical analyses, including the Chi-square test, were employed to evaluate the data.

Results were expressed using medians and percentiles for quantitative non-parametric measures, as well as numbers and percentages for categorical variables, to identify key factors contributing to the development of MDROs and inform improved infection control practices.

Sample Processing and Identification

Clinical specimens collected from the ICU patients were processed using standard microbiological techniques. Following Gram staining, primary culture and isolation, the bacterial isolates were identified using the VITEK® 2 automated microbial identification system. Antimicrobial Susceptibility Testing (AST) was also performed using the VITEK® 2 system to determine the susceptibility patterns of the isolated organisms. The results were interpreted according to the applicable Clinical and Laboratory Standards Institute (CLSI) guidelines. Multidrug-Resistant Organisms (MDROs) were identified based on the antimicrobial susceptibility profiles of the isolates.

RESULTS

Culture Results, MDRO Cases and Demographic Variables

The study analyzed MDRO prevalence among 123 ICU patients, with 34 culture-positive cases (14 males, 20 females) and 89 culture-negative cases. Culture-positive samples were predominantly from urine (17 cases), followed by blood (12), exudates (11) and respiratory samples (6). MDROs were identified in 16 cases, primarily from urine (11 cases) and were more common in females (11 cases) than males (5 cases). Age distribution showed higher MDRO prevalence in elderly females (71-80 years, 6 cases) and younger to middle-aged males (20-30 and 61-70 years, 2 cases each). These findings highlight gender and age-related trends, with urine being the most frequent source of MDROs, underscoring the need for targeted infection control and antimicrobial management (Table 1).

Patient Characteristics, Microbial Profile and Risk Factor Analysis

The Figure 1 summarizes ICU patient data, highlighting microbial profiles, demographics and associated risk factors for infections. It lists patient ID, organism type, sample source, Gram classification, age, sex and key risk factors, including prior antibiotic use, prolonged ICU stay, comorbidities (e.g., diabetes, hypertension, COPD), invasive procedures and immunosuppressive therapy. Risk factors are tallied as "Multiple Risk Factors Total." MDROs, notably *Klebsiella pneumoniae* and *Escherichia coli*, were prevalent among elderly females and those with multiple risk factors, underscoring the importance of robust infection control and antimicrobial management in ICU management.

Table 1: Distribution of Culture Results, MDRO Cases and Demographic Variables of ICU Patients (n = 123)

Gender	Culture positive	Culture Negative
Male	14	41
Female	20	48
Total	34	89
Multiple Sample distribution	Culture positive	Culture Negative
Blood	12	-
Urine	17	-
Exudate	11	-
Respiratory	6	-
Sample distribution	MDR	Non MDR
Blood	5	7
Urine	11	6
Exudate	4	7
Respiratory	1	5
Total	21	25
Total Number of cases	MDR	NON MDR
Culture Positive Patients	16	18
Gender	MDRO - Male	MDRO - Female
Count = 16	5	11
Age	MDRO - Male	MDRO - Female
20-30	2	2
31-40	0	0
41-50	0	0
51-60	1	1
61- 70	2	1
71- 80	0	6
81-90	0	1
Total	5	11

PATIENT ID	ORGANISM	SPECIES	SUSCEPTIBILITY	RISK FACTORS	MICROBIAL PROFILE	PATIENT CHARACTERISTICS	RISK FACTOR ANALYSIS
P001	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P001	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P001	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P002	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P002	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P003	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P004	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P004	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P005	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P006	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P007	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P007	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P008	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P009	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P010	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P011	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P012	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P013	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P014	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P015	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P016	MDR	MDR	MDR	MDR	MDR	MDR	MDR
P016	MDR	MDR	MDR	MDR	MDR	MDR	MDR

Figure 1: Patient Characteristics, Microbial Profile and Risk Factor Analysis

Table 2: MDRO Patients Associated with Multiple Risk Factors

Patient ID	MDRO patients associated With multiple risk factors total
P001	8
P001	
P001	
P002	2
P002	
P003	6
P004	1
P005	3
P006	1
P007	3
P007	
P008	7
P009	7
P010	4
P011	7
P012	1
P013	3
P014	4
P015	3
P016	5
P016	

MDRO Patients Associated with Multiple Risk Factors

The Table 2 highlights the number of risk factors associated with MDRO patients, with totals ranging from 1 to 8. Patient P001 had the highest risk factor count (8), while others, such as P008, P009 and P011, had 7 risk factors each, indicating significant vulnerabilities. Moderate-risk patients (4-5 risk factors) included P010, P014 and P016, while minimal-risk patients (1-3 risk factors) included P002, P005, P007, P012, P013 and P015. Patients with higher risk factor counts were strongly associated with MDRO infections, emphasizing the need for focused infection control and preventive measures in vulnerable populations.

DISCUSSION

The study analyzed MDRO prevalence among 123 ICU patients, with 34 culture-positive and 89 culture-negative cases. The analysis revealed a culture-positive rate of 27.6% (34 cases), underscoring the significant prevalence of these pathogens in critical care settings. The predominance of urinary tract infections, with 17 cases identified, aligns with existing literature that highlights urinary tract infections as a common source of MDROs in ICU patients [19,20]. Notably, the demographic data indicating a higher incidence among elderly females, particularly those aged 71-80 years, suggests that age and gender are critical risk factors for MDRO infections in this population [21,22].

The identification of *Klebsiella pneumoniae* and *Escherichia coli* as the most common MDROs is consistent with findings from various studies that report these organisms as prevalent in ICU settings, often linked to prior antibiotic use and prolonged hospital stays [23,24]. The correlation between the number of risk factors and the likelihood of MDRO infection is particularly concerning; patients exhibiting multiple risk factors, such as prolonged ICU stays and invasive procedures, are at a significantly increased risk for acquiring these infections [25]. This is further supported by evidence that prolonged mechanical ventilation and the presence of comorbidities exacerbate the risk of colonization and infection by resistant organisms [26,27].

The data from this study highlight the critical need for targeted infection control measures and antimicrobial management strategies in ICUs. The association of multiple risk factors with MDRO infections emphasizes the necessity for vigilant monitoring and tailored interventions, especially for vulnerable populations such as elderly females [28,29]. Implementing robust infection control practices, including regular surveillance of microbial profiles and adherence to antibiotic stewardship programs, can mitigate the risk of MDRO transmission and improve patient outcomes [30,31].

CONCLUSION

The study found that MDROs were common among ICU patients, especially in elderly females and those with multiple risk factors like prior antibiotic use, prolonged ICU stays and comorbidities. The most frequent pathogens were *Klebsiella pneumoniae* and *Escherichia coli*, with urine being the primary source. These findings highlight the need for better infection control, proper antibiotic use and focused care for high-risk patients to reduce MDROs in ICUs.

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