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Original article

Burden, Distribution, and Clinical Characteristics of Multidrug-Resistant Organism Infections in a Eastern Indian Tertiary Care Centre: A Cross-Sectional Analysis

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Abstract

Introduction: Antimicrobial resistance (AMR) is a significant health concern, specifically among the low- and middle-income countries. The rising prevalence of the Multidrug-Resistant Organism (MDRO) contributed to the long-term rate of hospitalisation, high cost of healthcare and enhanced the rate of morbidity and mortality. The study aimed to evaluate the burden, distribution, and clinical features of the MDRO infection and also identified the patients who were affected, hospital departments and the pattern of resistance.

Method: The study was a cross-sectional study conducted among 80 patients, who were confirmed with the MDRO infections. All demographic, clinical, microbiological, and antimicrobial susceptibility data were isolated from the database of hospital records. Missed, or duplicate or irrelevant isolates or records were not allowed. SPSS version 27 was used for data analysis, along with the results which were represented as frequencies and percentages. The $p < 0.05$ was considered.

Results: Most of the participants were between the age group of 35–64 years (51.3%). Total recovered MDROs were 160, and urine was the most common source of specimen, which was followed by the blood (13.8%) and pus (12.5%). The highest burden of MDRO was the Burns and Plastic Surgery, which was followed by the Pulmonary Medicine (12.5%), Cardiology, and Trauma Surgery (11.88% each. Some of the wide distribution of species were found like Acinetobacter spp., Burkholderia cepacia, Enterococcus spp., Klebsiella spp., and Staphylococcus spp.

Conclusion: The study concluded that the most affected MDRO infections were in middle-aged adults, and the most predominant specimen was the urine. The Burns and Plastic Surgery showed the highest MDRO challenge.

Keywords: Multidrug-Resistant Organisms (MDROs); Antimicrobial Resistance; Hospital-Acquired Infections; Infection Control; Clinical Specimens.

Introduction

Antimicrobial resistance (AMR) is a significant global health concern and threat to development. The low- and middle-income countries (LMICs) were mostly affected [1]. Multidrug resistance (MDR) is described as the bacterial capability to develop resistance or tolerance to several structurally and functionally significant drug classes [2]. The rising concern and the prevalence rate of the multidrug-resistant organisms (MDROs) raised significant concerns for the clinicians and the staff. This results in ineffective antibiotics, which make treating common infections tougher. This leads to enhanced healthcare costs, with long-term stay in hospital, with high morbidity and mortality and high strain on the healthcare system. According to 2019, about 4.95 million fatalities globally were related to the bacterial AMR [3]. The annual rate of morbidity related to AMR can raise upto10 million by 2050 [4]. Some conditions even get exacerbated for some of the developing countries like India because of several parameters, such as poverty, high disease burden, loss of healthcare infrastructure and the absence of awareness for the general people, for the usage of proper antibiotics [5]. The wide availability of antibiotics is a significant contributor to the rise of MDROs [6]. The consumption of antibiotic in India has increased between the year of 2000 and 2018 from 48% to 67% [7]. The self-medication practices were driven by different factors, leading to the suboptimal antibiotic regimens [8]. The understanding of the resistance burden is important for the effective mitigation of AMR, which signifies the extensive surveillance and data collection. The anti-biogram of India differed from that of Western Nations, which makes it more imperative towards the clinicians to have a well-developed understanding of local resistance patterns for guiding to more effective antibiotic therapy [9]. Most of the studies focus on a specific age group of age or the disease, which makes it difficult for the findings [10]. The aim of the study is to evaluate the burden, distribution and clinical features of the multidrug-resistant organism (MDRO) infections among populations of the Eastern Indian tertiary care centre. The objectives were to indicated the prevalence of the infections of MDRO, which affect the population and the hospital units, which recognise the causative pathogens and other resistant patterns, and to investigate the related clinical outcome.

Methodology

Research design

The is a cross-sectional study which was conducted to assess the association of the burden, distribution, and clinical features of the multidrug-resistant organism (MDRO) infections. The study was conducted among the patients visited at the tertiary care centre in Eastern India. The study was carried out for a period of one year. The study included a total of 80 patients, including 160 MDRO infections noted among them, which were isolated from the laboratory records and hospital databases. Demographic, clinical, microbiological, and antimicrobial susceptibility information was collected and analysed. Specific predefined criteria were considered for patient selection. Verbal and written consent were taken for the study.

Inclusion criteria

- All patients who were admitted with a confirmed culture of MDRO infection
- Patients with complete demographic, clinical, microbiological, and antimicrobial susceptibility information were selected for the study.
- Informed consent required for the study

Exclusion Criteria

- Those patients with culture-negative infections, and not meeting the criteria, were excluded.
- Irrelevant, inadequate or missing clinical record was excluded.
- Duplicate isolates were not considered. The first isolate was taken for the study.

Procedure

Records of all patient, their microbiology laboratory data and the discharge report were taken from the electronic medical record system if the hospital. All of the patients admitted to the hospital was culture-positive multidrug-resistant organisms (MDRO) were selected from the database of the hospital. The reports were analysed for the confirmation of the multidrug resistance on the basis of the antimicrobial susceptibility criteria. Demographic information, clinical features, hospital data, type of specimen, organisms isolated and the pattern of the antimicrobial susceptibility were isolated from the medical record by the use of the structured data collection form. Patients with incomplete or missing data, duplicate isolates, and culture-negative samples were excluded. Various inclusion and exclusion criteria were considered to select the total 80 samples with confirmed MDRO. All data was compiled together and were analysed for the determination of the burden, distribution, and clinical features of the MDRO infections.

Statistical analysis

Data entry was done and was recorded in Microsoft Excel. SPSS version 27 was used for the analysis. Descriptive statistics were summarised by the demographic characteristics, clinical characteristics, type of specimen, distribution of several departments as well as microbiological findings. The frequencies and percentages were used for the presentation of the categorical variables. The p-value of less than 0.05 was considered statistically significant.

Results

Table 1 showed the total distribution of 80 participants, while the majority of participants were between the age range of 35–64 years age, estimated for about 41 participants (51.3%)**.** Patients of 14–34 years age group constituted of about 25 participants (31.3%)**,** which indicated this as the second-largest category for the demographic factors. Old patients were about 65 years and above and constituted of about 11 participants (13.8%). About 3 participants (3.8%) were less than 14 years of age.

Table 1: The distribution of participants according to age

Age group (years)	Number of participants (n)	Percentage of total (%)
< 14	3	3.8
14–34	25	31.3
35–64	41	51.3
≥ 65	11	13.8
Total	**80**	**100**

Table 2 showed that the 160 MDRO isolates were obtained from 80 participants. The most prevalent source of the MDRO isolation was the urine sample, which accounted for the 82 isolates (51.3%), and the urinary tract infections was the most prominent MDRO-associated infections. 22 isolates (13.8%) obtained from blood, which was followed by the pus sample along with 20 isolates (12.5%). The respiratory samples were endotracheal tube, tracheal tube, and broncho-alveolar lavage samples, which produced 14 isolates (8.8%). 7 isolates (4.4%) showed the tissue specimen. No species was obtained from the corneal scraping samples.

Table 2: The number and percentage of the 160 MDROs obtained from all participants

Sample Type	Number (n)	Percentage (%)
Urine	82	51.3
Blood	22	13.8
Pus	20	12.5
Endotracheal tube/Tracheal tube/Broncho-alveolar lavage	14	8.8
Tissue	7	4.4
Sputum/Throat swab	3	1.9
Cerebrospinal fluid	2	1.3
Bile	2	1.3
Pleural fluid	2	1.3
Body fluids (not specified)	2	1.3
Peritoneal fluid	2	1.3
Ascitic fluid	1	0.6
Vaginal swab	1	0.6
Corneal scraping	0	0
Total	**160**	**100**

Table 3 showed that the highest number of the Burns and Plastic Surgery department, showed that 22; 13.75%, which was followed by the Pulmonary Medicine (20; 12.5%). Cardiology and Trauma Surgery each of them accounted for 19 isolates (11.88%). The General Medicine provides 17 (10.63%). Obstetrics and Gynaecology (7; 4.38%) showed lowest proportion. The MDROs were rarely isolated from the departments, which tends to manage the ill patients, trauma, and burn patients, which indicated the challenge of the antimicrobial resistance among high-risk clinical areas.

Table 3: The distribution of 160 MDROs according to specific department among 80 study participants

Department	Number of MDROs (n) samples	Percentage (%)
Burns and Plastic Surgery	22	13.75
Cardiology	19	11.875
General Medicine	17	10.625
General Surgery	15	9.375
Dermatology	12	7.5
Nephrology	13	8.125
Obstetrics and Gynecology	7	4.375
Pulmonary Medicine	20	12.5
Trauma Surgery	19	11.875
Urology	16	10
Total MDRO samples	160	100

Table 4 showed the distribution of the 160 MDRO isolates across the 10 departments of hospital. Burns and Plastic Surgery (22) were the highest number of isolates, which was followed by the Pulmonary Medicine (20). 19 isolates had been noticed for the Cardiology and Trauma Surgery. While 17 isolates observed for the General Medicine. The most common organisms noted were the *Acinetobacter spp.*, *Burkholderia cepacia*, *Enterococcus spp.*, *Klebsiella spp.*, and *Staphylococcus spp.* Wide distribution of the several pathogens revealed the importance of the hospital-acquired infections. The MDROs was high for the department which manages the burn, trauma, and critically ill patients. The findings highlighted the requirement of the infection control practices.

Table 4: The distribution of the MDROs according to the department which were isolated from different clinical samples

	Burns and Plastic Surgery	Cardiology	General Medicine	General Surgery	Dermatology	Nephrology	Obstetrics and Gynecology	Pulmonary Medicine	Trauma Surgery	Urology
Acinetobacter spp.	4	1	1	1	1	1	1	1	1	1
Burkholderia cepacia	3	1	1	1	1	1	1	1	2	1
Candida spp.	1	1	1	1	1	1	0	1	1	1
Citrobacter spp.	1	2	2	1	1	1	0	2	1	1
Enterobacter spp.	2	1	1	1	0	1	1	1	1	1
Enterococcus spp.	2	3	2	1	1	1	0	3	1	1
Escherichia coli	2	1	1	1	1	1		1	1	1
Klebsiella spp.	1	1	1	2	1	1	1	2	2	1
Morganella morganii	1	1	1	2	1	1	1	1	2	2
Proteus spp.	1	1	1	1	1	0	0	2	1	1
Providencia	1	2	1	1	1	1	0	1	1	1

spp.										
Pseudomonas aeruginosa	1	1	1	1	0	1	1	1	2	1
Serratia spp.	1	1	1	0	1	1	0	2	1	1
Staphylococcus spp.	1	2	2	1	1	1	1	1	2	2
Total	22	19	17	15	12	13	7	20	19	16
Total MDRO	160									

Discussion

The study by Kollef, 2008 stated that culture has confirmed the infections of MRDO were assessed, which showed that the mortality rate of 20.8% and ICU utilisation of 27.5%. The status of isolation among the ICU patients were not related to the mortality. The isolated patients showed prolonged stay in the ICU, (20.5 vs. 16.4 days, $P < 0.001$) and the hospital stays (33.7 vs. 26.9 days, $P < 0.001$). Internal medicine, general surgery, and trauma surgery were showed the highest burden of MDRO. The interdepartmental variation in the usage of the antibiotic and has indicated the fluctuations in the prevalence rate of MDRO, stay in hospital and the consumption of antibiotics, which indicated the burden of the infection control [11]. The study by Cosgrove, 2006, showed that high burden of MDROs was noted among 47.6% of all bacterial isolates, those who were exhibited multiple antimicrobial classes. Escherichia coli and Klebsiella spp. were the most predominant pathogens, which accounted for the 26.8% and 24.1% of isolates. They showed the high rate of multidrug resistance. The production of the ESBL was highest for the E. coli (60.6%), and the production of MBL was noted for the Acinetobacter spp. (14.5%). 35.8% of Staphylococcus aureus showed the MRSA. The environmental surveillance indicated the least rate of contamination, along with the surface, air, and water samples, which showed the standard for the microbiological features [12]. Another study by Paterson, 2006, stated that the infection of MDRO had taken place for the 2.4% of 30,428 hospitalisations, and the highest rate of prevalence was noted for the medical and rehabilitation settings. ESBL-producing Enterobacteriaceae and vancomycin-resistant enterococci were mostly observed for the MDROs. Some of the patients without the infection of MDRO showed better functioning, which was estimated by the Barthel Index, rather than the fected patients (+3.081 points; $P < 0.001$). Rehabilitation and neurology wards showed high functioning, while the medical and surgical wards noted a significant reduction in function. Prolonged stay in hospital was noted, while the age and sex did not affect the functional recovery outcomes [13]. Another study by Saravanan, 2013, showed that 11.2 per 1,000 admissions indicated the prevalence rate of MDRO. The evaluation of the temporal trends indicated the rise of the MDRO patient prevalence as well as the MDRO isolate rates. This revealed the rising burden of antimicrobial resistance within the hospital. This highlighted the rise of the MDROs and also facilitated the requirement of the surveillance, infection-control measures and the antimicrobial interventions [14]. While Gandra et.,al, 2016, showed the temporal alterations were also noted for the hospital-acquired MDRO infections among most of the ICU patients across the pre-, during-, and post-COVID-19 periods. The density of the MDRO infection was lowest at the time of the pandemic and enhanced during the post-pandemic period (43.98 per 1,000 ICU days). The infection of the Acinetobacter baumannii enhanced during the post-pandemic period. The respiratory diseases showed the diagnosis across all periods and indicated the highest proportion of mortality for MDRO during the post-pandemic phase [15].

Conclusion

The study concluded that the majority of participants belonged to the age range of 35–64 years, which indicated that the most affected patients were middle-aged adults. A total of 160 MDRO isolates were recovered, and the most prevalent specimen was the urine. Burns and Plastic Surgery showed the highest burden of the MDRO according to the department, which was followed by Pulmonary Medicine, Cardiology (11.88%), and Trauma Surgery (11.88%). *Acinetobacter spp.*, *Burkholderia cepacia*, *Enterococcus spp.*, *Klebsiella spp.*, and *Staphylococcus spp.* were distributed across multiple departments. These study findings underscore the need for stricter infection prevention strategies, surveillance, and effective antimicrobial stewardship programs to reduce MDRO infections among hospitalised patients.

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