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Microbiological and Antibiotic Susceptibility Patterns in Cardiothoracic and Vascular Intensive Care Unit of a Tertiary Level Hospital in Nepal

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Abstract

Background: Sepsis has been one of the most important conditions for morbidity and mortality of Intensive care unit (ICU) patients. Antibiotics remain one of the major combating factors for it. Indiscriminate antimicrobial usage and poor prescription practices have contributed to the development of multidrug resistant (MDR) organisms. Therefore, the current study was designed to evaluate the spectrum, and susceptibility patterns of pathogens isolated from patients admitted to our Cardiothoracic and Vascular Intensive care unit. **Materials and Methods:** The study was conducted in Cardiothoracic and Vascular ICU of a tertiary care teaching hospital from February 2019 to March 2021. Samples (blood, urine, wound swab, tracheal aspirate, and central venous catheter tip) for culture were taken from all the patients in Sepsis admitted in Cardiothoracic and Vascular ICU above 18 years of age during the study period. The culture reports (microbiological profile and their susceptibility pattern) were collected and data collection of all enrolled patients was done. **Results:** Out of the total 128 samples studied 75 (58.5%) were culture positive. The predominant organisms isolated were Gram negative organisms (*Klebsiella*, *Pseudomonas*, *Acinetobacter*, followed by *E. coli*). The highest prevalence of microbial growth was found in tracheal aspirate (46.8%), followed by blood (21.8%). Antibiotic susceptibility results showed the highest sensitivity of those common pathogens towards higher antibiotics only (especially Polymyxin B and Colistin). **Conclusion:** The emergence of

multidrug resistant organisms and lesser availability of a higher group of antibiotics is a major concern. So there is a need for regular hospital based antibiograms, strict infection control programs, and implementation of antimicrobial stewardship programmes for guiding clinicians in choosing appropriate therapy and preventing the surge of multidrug resistant organisms.

Keywords

Sepsis, Antibiotics, Intensive Care Unit

1. Introduction

The Intensive care unit (ICU) is often the core site of infections due to its extremely vulnerable population and increased risk of becoming infected through multiple procedures and the use of invasive devices [1]. The worldwide incidence rate is 23.7 infections per 1000 patient days and rates of nosocomial infections range from 5% - 30% among ICU patients [2]. The ongoing example of resistance in the community and hospital is considered as a major threat for public health, and especially the ICU has been described as a factory for creating, disseminating and amplifying antimicrobial resistance [1].

There is a wide variation in current practices practically due to the lack of evidence on the best strategies to treat critically ill patients. Inappropriate antimicrobial use and poor prescription practices have contributed to the development of multi-drug resistant organisms [3]. Antibiotic resistance is on the rise throughout the world adding to the number of DALY's (Disability-adjusted life years) lost but also to the financial burden [4] [5].

Empirical antibiotic therapy has been a traditional practice, especially in developing countries, to reduce morbidity and mortality associated with sepsis because of the routine delays in receiving culture reports and antibiotic susceptibility analysis. Also, the current international guidelines may not be the ideal treatment strategies for all regions because of the variation in the context of the microbial patterns.

In Nepal, very few studies regarding antibiotic susceptibility patterns, especially in Cardiothoracic and vascular set up, have been done. So, the present study is designed to find out the microbiological profile and the antibiotic susceptibility pattern in cultures (blood, urine, tracheal aspirate, and sputum) in Cardiothoracic and Vascular ICU during the study period.

2. Material and Methods

A cross sectional study was carried out based on culture reports of bacterial isolates from the Cardiothoracic and Vascular ICU of Manmohan Cardiothoracic Vascular and Transplant Centre, Institute of Medicine from February 2019 to March 2021. Ethical clearance for the study was taken from Institutional Review Committee, Institute of Medicine.

Our ICU enrolls postoperative cardiac, thoracic and vascular cases as well as those admitted from emergency department and wards requiring ICU. The demographic data on patient's age and gender were collected. Patients in sepsis (defined on the basis of "The Third International Consensus definitions for Sepsis and Septic Shock") were enrolled in the study.

The clinical specimens were received in the microbiology laboratory for culture and sensitivity. The specimens included were blood, urine, tracheal aspirate, central venous catheter tip and body fluids (pleural fluid).

The tracheal aspirate was inoculated onto blood agar and MacConkey agar and aerobically incubated at 37 degree Celsius for 24 hours. Chocolate and blood plates were inoculated in carbon dioxide at 35 - 37 degree Celsius and MacConkey in ambient air for 24 hours. Positive cultures that had isolates were identified and sensitivity cultures done.

Blood specimen was inoculated in brain heart infusion broth and incubated aerobically for 24 hours before subculturing onto blood agar, MacConkey agar and Chocolate agar.

Urine specimen was cultured in blood agar and MacConkey agar which was then incubated at 35 - 37 degree Celsius for (18 - 24) hours. Positive cultures were Gram stained and subcultured and tested for sensitivities.

Growth obtained on solid media after 24 hours of aerobic incubation was processed for identification and antimicrobial susceptibility. Antimicrobial susceptibility of bacterial isolates was determined by Kirby-Bauer disk diffusion method as recommended by CLSI (Clinical and Laboratory Standards Institute).Using sterile loop of four to five in number, the processing was done and the suspended solution made was then plated using a swab on Muller Hinton agar. Zone of inhibition was measured and interpreted as susceptible, intermediate or resistant. Antibiotic discs were obtained from HiMedia, Mumbai, India.

Organisms were identified using the colony characteristics, morphology of growth, Grams stain and different biochemical tests as per standard guidelines.

Data collection was done in a preformed sheet. Values were calculated as frequency, percentage and are presented in charts and tables. The graphical outline of the study design is shown in Figure 1.

Data Management and Analysis

Statistical analysis was done after the completion of the study. All the data analysis was performed using SPSS (Statistical Package for the Social Sciences) version 25. Demographics, frequency of the organisms, their sensitivity were evaluated using descriptive studies.

3. Results

Demographic Characteristics

In our study, majority of the patients belonged to (61 - 80) year age group (Table 1). Among them, 84 (65.6%) patients were males while 44 (34.3%) were

females belonging to different age groups (Table 2).

Total samples sent for microbiological analysis during the study period was 128. There was no growth in 53 (41.4%) cases. Among the growths, majority of them were gram negative organisms. The isolated organism with highest incidence was *Klebsiella* (18.8%), *Pseudomonas* (9.4%), *Acinetobacter* (9.4%) followed by *E. coli* (7.8%). The only Gram positive isolate in our study was Coagulase Negative Staphylococcus aureus (3.1%) and there were no growths of Methicillin Resistant Staphylococcus aureus (Table 3).

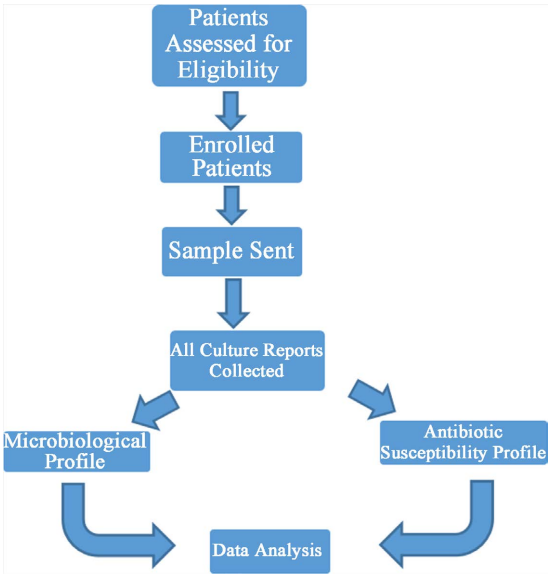


Figure 1. Graphic outline of the study design.

Table 1. Age distribution of patients.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	under 20	4	3.1	3.1	3.1
	21 - 40	29	22.7	22.7	25.8
	41 - 60	32	25.0	25.0	50.8
	61 - 80	52	40.6	40.6	91.4
	above 80	11	8.6	8.6	100.0
	Total	128	100.0	100.0	

Table 2. Sex distribution of patients.

		M Count	F Count	Total Count
Age groups	under 20	1	3	4
	21 - 40	16	13	29
	41 - 60	13	19	42
	61 - 80	36	16	52
	above 80	8	3	11

Table 3. Types of organisms isolated.

	Frequency	Percent	Valid Percent	Cumulative Percent
Pseudomonas Aeruginosa	12	9.4	9.4	9.4
Coagulase negative *Staphylococcus aureus*	4	3.1	3.1	12.5
Klebsiella Pneumoniae	24	18.8	18.8	31.3
no growth	53	41.4	41.4	72.7
E. coli	10	7.8	7.8	80.5
Burkhderia cepacia	5	3.9	3.9	84.4
Citrobacter Species	5	3.9	3.9	88.3
Proteous vulgaris	2	1.6	1.6	89.8
Acinetobacter CB complex	10	7.8	7.8	97.7
Acinetobacter baumanii complex	2	1.6	1.6	99.2
Yeast	1	0.8	0.8	100.0
Total	128	100.0	100.0	

The distribution of clinical isolates in different specimens is shown in (Table 4). Majority of growth of the commonest organisms were seen in tracheal aspirate (46.8%) and blood (21.8%).

Antimicrobial sensitivity pattern of the different major bacterial isolates to different antimicrobials is shown in (Table 5). Klebsiella species showed less than 40 percent sensitivity to most of the antibiotics including amikacin, meropenem,imipenem, tazobactum piperacillin except Polymyxin and Colistin (Graph 1) whereas for Pseudomonas aeruginosa it was found to be less than 70 percent to these antibiotics (Graph 2).

The sensitivity pattern of acinetobacter species shows the following pattern—amikacin (21%), imipenem (14%), tazobactum piperacillin (7%) wheras *E. coli* showed 54 percent sensitivity to meropenem and imipenem (Graph 3).

The last resort antibiotics Polymyxin B and Colistin were the only antibiotics showing highest sensitivity. Polymyxin B was the most effective antibiotic against Klebsiella (91%) and Pseudomonas (88%) respectively whereas Polymyxin B and Colistin showed equal efficacy against acetinobacter (85%).

The most commonly used antibiotics in our set up are Ceftriaxone, Flucloxacillin, Gentamycin, Meropenem, Amoxicillin/Clavulanic acid. From our study, the commonest antimicrobials have shown less than 60 percent sensitivity toward one of the higher group of antibiotics (Carbapenems) whereas the only antibiotics showing highest sensitivity were the last resort ones(Polymyxin B and Colistin) and this is alarming.

De-escalation of antibiotic was done on the basis of culture directed results and procalcitionin levels. Hence, these findings definitely point towards the

Table 4. Isolates from various specimens.

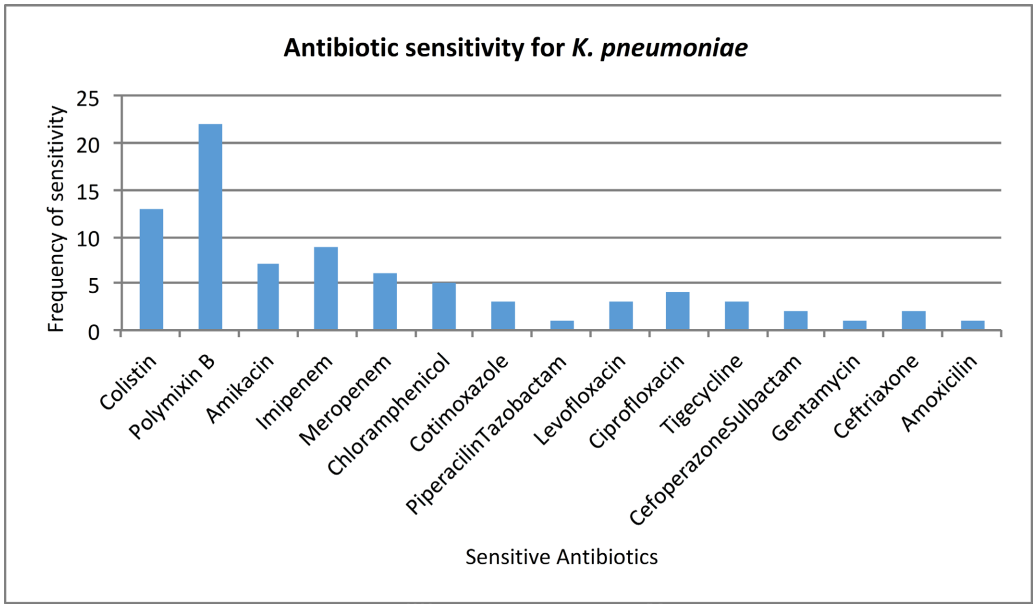
		Blood	Tracheal Aspirate	Urine	Central Venous Catheter Tip	Body Fluids
Types of organism	*Pseudomonas aeruginosa*	3	7	1	0	1
	Coagulase Negative *Staphylococcus aureus*	1	1	0	0	2
	Methicilin Resistant *Staphylococcus aureus*	0	0	0	0	0
	Klebsiella pneumoniae	5	13	0	0	6
	Citrobacter freundi	0	0	0	0	0
	no growth	13	18	15	2	5
	E. coli	0	8	0	0	2
	Burkhderia cepacia	3	2	0	0	0
	Citrobacter species	1	1	1	0	2
	Proteus vulgaris	0	2	0	0	0
	Acinetobacter CB complex	2	5	0	0	3
	Acinetonobacter baumanii complex	0	2	0	0	0
	Staphylococcus aureus	0	0	0	0	0
	Yeast	0	1	0	0	0

Table 5. Antimicrobial sensitivity pattern of different major bacterial isolates sensitive to different antibiotics.

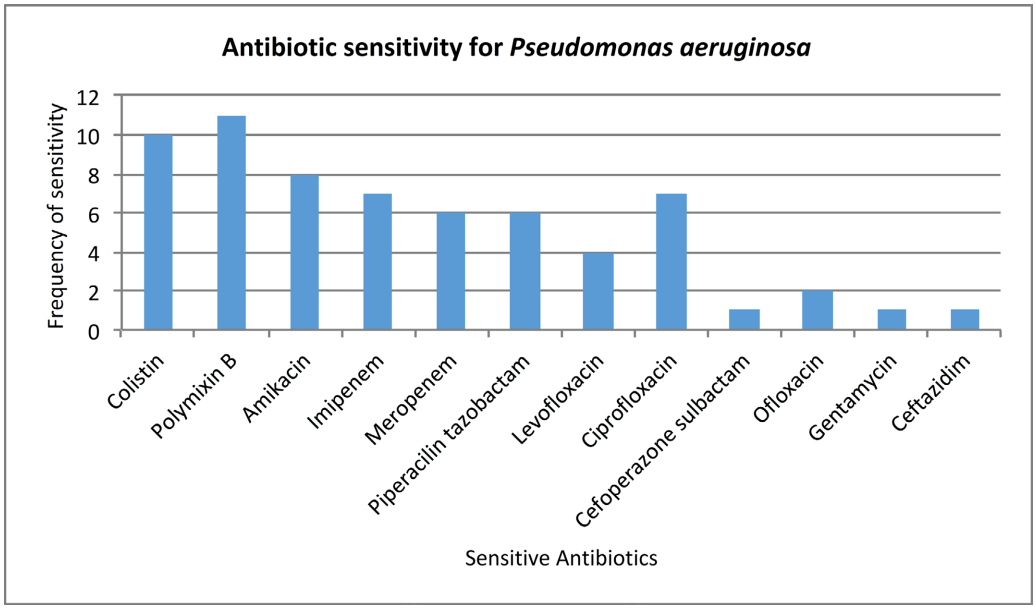
Antibiotic	*Klebsiella*	*Pseudomonas aeruginosa*	*Acetinobacter* Species	*E. coli*
Colistin	13(52%)	10 (83%)	12 (85%)	7 (63%)
Polymyxin B	22 (88%)	11 (91%)	12 (85%)	11 (100%)
Amikacin	7 (28%)	8(66%)	3 (21%)	3 (27%)
Imipenem	9 (36%)	7 (58%)	2 (14%)	6 (54%)
Meropenem	6 (24%)	6 (50%)	0	6 (54%)
Chloramphenicol	5 (20%)	0	0	0
Cotimoxazole	3 (12%)	0	2 (14%)	2 (18%)
Piperacilin/Tazobactam	1 (4%)	6 (50%)	1 (7%)	1 (9%)
Levofloxacin	3 (12%)	4 (33%)	2 (14%)	2 (18%)
Ciprofloxacin	4 (16%)	7 (58%)	0	1 (9%)
Tigecycline	3 (12%)	0	4 (28%)	3 (27%)
Cefoperazone/Sulbactam	2 (8%)	1 (8%)	0	1 (9%)
Doxycycline	0	0	0	0
Ofloxacin	0	2 (16%)	0	0
Vancomycin	0	0	0	0

Continued

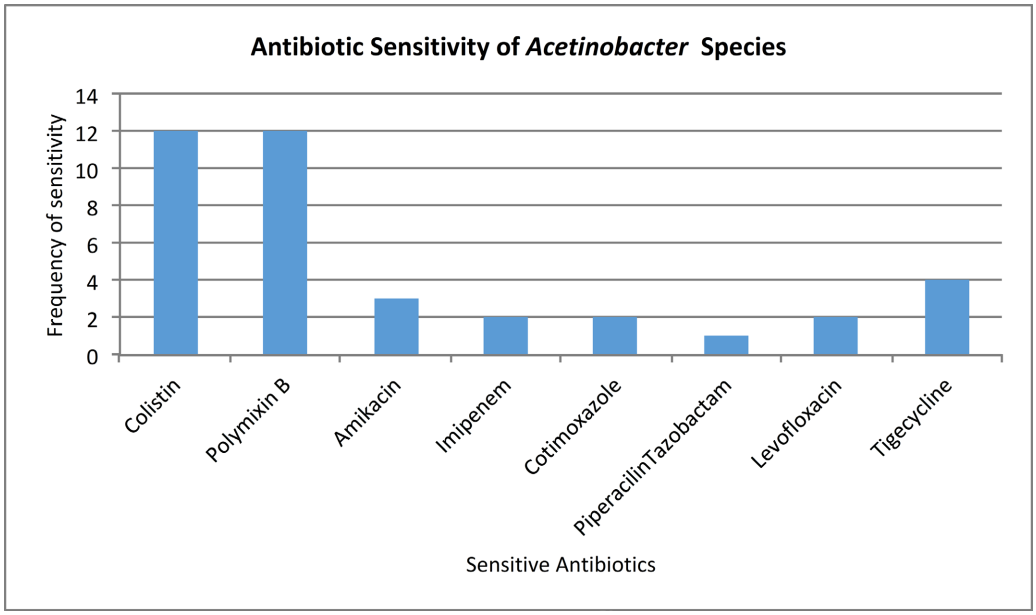
Clindamycin	0	0	0	0
Gentamycin	1 (4%)	1 (8%)	0	0
Linezolid	0	0	0	0
Teicoplanin	0	0	0	0
Ceftriaxone	2 (8%)	0	0	0
Amoxicilin	1 (4%)	0	0	0
Ceftazidime	0	1 (8%)	0	0



Graph 1. Antibiotic Sensitivity for *K. pneumonia.*



Graph 2. Antibiotic Sensitivity for *Pseudomonas aeruginosa.*



Graph 3. Antibiotic Sensitivity for *Acetinobacter Species.*

extensive surge of sensitivity of major bacterial growths towards higher antibiotics (especially Carbapenems, Polymyxin B and Colistin).

4. Discussion

Antimicrobial resistance is an emerging clinical problem in all the ICUs throughout the world. Both Gram positive and Gram-negative bacteria are reported as important causes of hospital acquired infections [6]. ICUs are facing increasingly rapid emergence and spread of antimicrobial resistant bacteria. Moreover, antimicrobials are prescribed prophylactically and empirically without carrying out sensitivity studies particularly in developing countries.

Presently in most the institutes, antibiotic therapy is either based on the studies conducted in western countries or is according to the treating physicians' clinical experience, which might not adequately reflect the sensitivity and resistance pattern. Therefore, the present study is undertaken to observe the microorganism profile and antibiotic susceptibility pattern of various microbes in Cardiothoracic and Vascular ICU.

Microbial growth was seen in 75 out of 128 samples (58.5%) which may be due to nature of admission criteria in our set up (includes post operative, emergency and ward cases requiring ICU).

The majority growth from the isolates were Gram negative organisms (*Klebsiella*, *Pseudomanas*, *Acetinobacter*, *E. coli*) which was also seen in the study done by Sheth k *et al.*, and also in similar studies done in USA, Serbia, Egypt, Indonesia and India [2] [5] [6] [7] [8] [9].

Our results show negligible sensitivity of Cephalosporins (<10%) towards the commonest organisms indicating towards their overuse which was similar to the findings of the study done by Sheth *et al.* [6].

None of the commonest isolates showed 100 percent sensitivity towards any antibiotics except *E. coli* to Polymyxin B. The highest sensitivity by the commonest isolates is towards Polymyxin B and Colistin only, which is alarming.

Radji *et al.* evaluated the sensitivity pattern of bacterial pathogen in the intensive care unit (ICU) of a tertiary level hospital. Cross sectional retrospective study of bacterial pathogens was carried out on a total of 722 patients that were admitted to ICU. They found most bacteria were resistant to third generation Cephalosporins and Quinolone antibiotics [4]. Fluoroquinolones and Aminoglycosides have also shown less than 50 percent sensitivity towards *Klebsiella*, *Acetinobacter* and *E. coli* except *Pseudomonas* in our study.

Syal *et al.* conducted similar study in Indira Gandhi Medical College. They collected endotracheal tube culture samples and of the total samples 56.3% showed growth of microorganisms. The culture isolates demonstrated high degree of resistance to most of the antibiotics tested. [4]

Dessie *et al.* did a similar study to determine bacterial pathogens and drug susceptibility from surgical site-infected wound specimens. From a total of 107 swabs collected, 90 (84.1%) were culture positive and 104 organisms were isolated. *E. coli* (23.1%) was the most common organism isolated, followed by multidrug resistant *Acetinobacter* species (22.1%). More than 58 (75%) of gram negative isolates showed multiple drug resistance. [10]

Irrational use of antibiotics leads to the emergence and dissemination of resistant organisms and upsurges its treatment costs. So development of antibiogram strategies is imperative in all ICUs for effective treatment strategies and reducing the spread of resistance patterns.

5. Limitations

1) Retrospective design.

2) Laboratory error is one of the major concerns.

3) Sampling techniques (bronchoalveolar lavage might have been more informative than tracheal aspirate) can have influencing reports.

4) Less sample size is due to the influence of COVID 19 pandemic era.

5) Due to limited laboratory facilities, we were unable to investigate anaerobic organisms.

6. Conclusion

Different bacteriological profiles with multidrug resistant patterns have been found in different setups because of geographical region, population, lack of antibiogram, inefficient Institutional and government policies. Hence measures like regular surveillance of antibiotic susceptibility patterns of individual setups, strict infection control measures, antibiotic policy formulation, and its implementation will have a major impact on reducing the surge of multidrug resistant organisms.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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