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Original Article

Detection of Uropathogens and their Antimicrobial Susceptibility Pattern by VITEK2 Automated System in the Intensive Care Unit

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Abstract

Background: Indwelling urinary catheters are frequently used in critically ill patients. Approximately 66% of patients in intensive care have a urinary catheter in place. Catheter-associated urinary tract infection (CAUTI) is a significant cause of morbidity and mortality, affecting all ages. Antibiotic resistance is one of the biggest public health challenges of our time. Infection with antibiotic-resistant bacteria has become an increasingly complex problem in ICU.

Objective: To identify catheter-associated uropathogens and their antimicrobial susceptibility pattern by VITEK2 automated system in intensive care unit patients in Rajshahi Medical College Hospital.

Material and Method: A cross-sectional descriptive study was conducted in the Microbiology department of Rajshahi Medical College, the Intensive Care Unit of Rajshahi Medical College Hospital, and a commercial laboratory in Rajshahi during the period of January 2021 to December 2021. The specimen (urine) was inoculated in blood agar, nutrient agar, and MacConkey's agar media and incubated aerobically at 37˚C for 24 hours. Bacterial isolations and susceptibility tests were done by VITEK2 automated system.

Result: Out of the total 96 samples, culture yielded growth was 36 (37.50%), and culture-negative cases were 60(62.50%). In all age groups, males were predominant, totaling 63 (66.20%). A maximum of 33 cases were found in the age group of 18-30 years where males 23(69.70%) and females 10(30.30%). Among the culture-positive isolates, gram-negative organisms were higher (87.17%) than gram-positive (12.82%). Among 39 isolates, *Escherichia coli* was the predominant organism of 12(30.76%). Other isolates were *Klebsiella spp.* 10(25.64%), *Pseudomonas spp.* 5(12.82%), *Acinetobacter spp.* 4(10.25%), *Enterobacter spp.* 2(05.12%), CoNS 3(07.69%) respectively. Regarding the antimicrobial susceptibility test, gram-negative organisms were highly susceptible to Colistin, followed by Ertapenem, Imipenem, Meropenem, and Amikacin. The most effective drugs for Gram-positive were Linezolid. Other susceptible drugs against Gram-positive bacteria were Vancomycin and Tigecycline.

Conclusion: Most of the isolated bacteria are multidrug resistant. Determining antimicrobial susceptibility by VITEK2 will aid the physician in choosing appropriate antibiotics and treating multidrug-resistant cases.

Keywords: Cathetar-associated UTI; Multidrug resistant bacteria; VITEK 2 automated system.

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Introduction

Urinary tract infections (UTIs) is one of the leading cause of hospital visits worldwide. It also accounts for about 30%-40% of all hospital-associated infections leading to increased morbidity, hospital stay, and even death in immunocompromised patients.[1] The most critical risk factor for developing UTI in a hospital is urinary catheterization which is around 15-25% of all hospitalized patients. Approximately 150 million people develop catheter-associated UTIs

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worldwide, resulting in a significant financial burden.[2]

Patients with a urinary catheter for more than 48 hours who develop at least two of the signs or symptoms of fever (>38), urgency, frequency, dysuria, or suprapubic tenderness with no other recognized cause are clinically defined as a case of CA-UTI.[3] Patients admitted to intensive care units (ICUs) are the most susceptible host for developing UTI due to their more frequent necessity of urinary catheterization and longer duration of catheter use. Other risk factors are Female gender, antibiotic use, diabetes mellitus, renal failure, malnutrition, omissions in urinary catheter care, contamination of drainage bags, and periurethral colonization.[4]

Etiological characteristics of CAUTI vary among countries and even hospitals in the same country. Most infections are caused by *Escherichia coli*, followed by *Pseudomonas spp*, *Proteus species, Staphylococcus aureus, Klebsiella spp.,* and *Acinetobacter spp*. Most of the infections are antibiotic-resistant, which is due to the widespread misuse of antibiotics.[5] Rapid and reliable identification and antimicrobial susceptibility of microorganisms are essential for effectively managing infectious diseases. VITEK 2 plays a significant role in fulfilling the demand as it gives identification results within 4-6 hours, and AST is usually available within 16- 18 hours.[6]

Now a day, antibiotic-resistant bacteria are a significant threat among critically ill patients in ICU. Antimicrobial-resistant patterns are constantly changing with time. So it is necessary to conduct surveillance studies to obtain data about the regional microorganisms and their susceptibility to antibiotics. This study is aimed to provide such information for our clinicians.[7]

Materials and Methods

A cross-sectional type of descriptive study was conducted in the Microbiology department of Rajshahi Medical College, the Intensive Care Unit department of Rajshahi Medical College Hospital, and a commercial laboratory in Rajshahi from January 2021 to December 2021. The samples from the patients were collected in aseptic precautions. The specimen (urine) was inoculated in blood agar, nutrient agar and MacConkey's agar media and incubated aerobically at 37˚C for 24 hours. If culture plates showed the growth of bacteria, then subculture was done on blood agar and MacConkey agar for a pure colony. Then bacterial isolations and susceptibility tests were done by the VITEK2 automated system.

Results

Table 1: Age and sex distribution of samples (N= 96).

Age (Years)	Sex		Total
	Male	Female	N (%)
18-30	23 (23.95%)	10 (10.42%)	33 (34.37%)
31-40	12 (12.50%)	08 (08.33%)	20 (20.83%)
41-50	15 (15.62%)	09 (09.38%)	24 (25.00%)
51-60	07 (07.29%)	04(04.16%)	11 (11.45%)
>60	06 (06.25%)	02 (2.08%)	08 (08.33%)
Total	63(65.62%)	33(34.37%)	96 (100%)

Table I shows five age groups. Males were predominant, with a total number of 63 (65.62%). A maximum of 33(34.37%) cases were found in the age group of 18-30 years where males 23(23.95%) and females 10(10.42%).

Table 2: Duration of catheterization and occurrence of UTI (N=96).

Considering the duration of catheterization, the majority of the culture-positive cases (57.14%) were found where catheterization remained prolonged (>8 days)

Days of catheterization	Number of suspected cases	Number of culture-positive cases	Percentage
2-3	44	13	29.54%
4-7	31	11	35.48%
>8	21	12	57.14%

Table 3: Analysis of culture results of collected samples (N=96).

Result of the culture	Number	Percentage
Culture positive	36	37.50%
Culture negative	60	62.50%

Out of 96 samples, 36(37.50%) were culture positive, and 60 (62.50%) were culture-negative.

Table 4: Distribution of bacteria in clinical samples of ICU (N=39).

Bacteria	Number (Percentages)
Escherichia coli	12(30.76%)
Klebsiella spp.	10(25.64%)
Pseudomonas spp.	5(12.82%)
Acinetobacter spp.	4(10.25%)
Enterobacter spp.	2(05.12%)
Stenotrophomonas spp.	1(02.56%)
Enterococci spp.	1(02.56%)
Staphylococcus spp.	1(02.56%)
CONs	3(07.69%)
Total	39(100.00%)

Among 39 isolates, *Escherichia coli* was the predominant organism of 12(30.76%).

Table 5: Antimicrobial sensitivity patterns of commonly isolated bacteria.

Antimicrobial agents	*Escherichia coli* (12)	*Klebsiella spp.* (10)	*Pseudomonas spp.* (10)	*Acinetobacter spp.* (04)
Ampicillin	8.33%	0	-	-
Amoxicillin/ Clavulanic Acid	58.33%	10%	-	-
Piperacillin/ Tazobactum	66.66%	10%	-	0
Cefuroxime	33.33%	0	-	-
Cefuroxime Axetil	33.33%	0	-	-
Ceftriaxone	25%	0	-	0
Cefoperazone/ Sulbactam	66.66%	30%	40%	0
Cefepime	66.66%	10%	40%	0
Ertapepem	83.33%	100%	-	-
Imipenem	75%	40%	60%	0
Meropenem	83.33%	40%	60%	0
Amikacin	83.33%	30%	60%	-
Gentamicin	83.33%	30%	40%	0
Nalidixic acid	83.33%	10%	-	-
Ciprofloxacin	16.66%	10%	40%	0
Tigecycline	100%	-	0	75%
Nitrofurantoin	75%	20%	-	-
Colistin	83.33%	100%	20%	75%
Trimethoprim/ Sulfamethoxazole	33.33%	20%	-	25%

Table V shows the antimicrobial sensitivity pattern of commonly isolated bacteria. *Escherichia coli* shows the highest sensitivity (100%) against Tigecycline, followed by Colistin, Amikacin, Gentamicin, Meropenem, and Ertapenem (83.33%, respectively). *Klebsiella spp.* showed the highest sensitivity (100%) against Colistin and Ertapenem. The highest sensitivity (60%) against *Pseudomonas spp* shows against Amikacin, Imipenem, and Meropenem. Tigecycline and Colistin show 75% sensitivity against *Acinetobacter spp.*

Discussion

A total of 96 specimens (urine) were collected from clinically suspected infected patients from the intensive care unit of RMCH for isolation, identification, and antimicrobial susceptibility pattern.

Table I shows the age and sex distribution of various clinical samples. Among them, 63 (65.62%) were male, and 33 (34.37%) were female. This study is nearly similar to Ahmed *et al.* in Bangladesh and Paary *et al.* in India, who also found male: female ratio of 60%: 40% and 64.2%: 34.8%, respectively.[8,9] Female has less

excess to hospital care due to financial and social factors, so the number of female patients may be less (Akter *et al.*).[10] Our study is nearly dissimilar to the study of De *et al.* in India; Shaikh in Pakistan, where the male and female isolation rates were 45.8%: 54.2% and 52.6%: 47.4%, respectively.[11,12] This may be due to geographical, and racial differences.

Table I also shows the age distribution of various infection cases. A maximum of 33 (34.37%) cases were found within the age group of 18- 30 years. Our study is nearly similar with the study of Afroz *et al.* in Bangladesh and Dutta *et al.* in India found isolates rates were 35.7% and 36%, respectively.[13,14] However, Ahmed *et al.* in Bangladesh found the major age group was 61-70; De *et al.* in India found the major age group was 45-59.[8,11] This may be due to the variation in the study population, geography, living condition, and racial factor.

Table II shows that considering the duration of catheterization, in the present study, most cases (57.14%) were found where catheterization remains more than eight days. Similar findings were observed by Majumder *et al.* in Bangladesh and Sangamithra *et al.* in India were 71% and 57%, respectively.[15,16]

Out of 96 samples, 36(37.50%) were culture positive, and 60 (62.50%) were culture-negative (Table III), according to the study of Fatema *et al.* in Bangladesh and Deptula *et al.* in Poland who found culture-positive cases, 42.40% and 39.8% respectively.[17,18] This finding differed from other studies like Amin *et al.* in Bangladesh and De *et al.* in India, which found around 22.7% and 19%, respectively.[19,11] The relatively high incidence of infections in this study may be due to poor nutritional status, poor adherence to aseptic measures, and high proportion of mechanical ventilation (Akter *et al.*). [10]

According to Gram Staining characteristics, 34(87.17%) isolated organisms were Gram-negative, and 5 (12.82%) were Gram-positive. Our study is nearly similar to the study of Alam in Bangladesh (Gram-negative (90.18%) and Gram-positive (9.82%); Khan *et al*. in India (Gram-negative (82.5) and Gram-positive (17.5%).[20,21] Our study is nearly dissimilar to the study of De *et al*. in India (Gram-negative (66.3%) and Gram-positive (33.6%); Kanj *et al*. in Argentina (Gram-negative (81.8) and Gram-positive (18.2%).[11,22]

This study observed mixed bacterial infection in 03 (07.69%) cases. It was similar to Alam in Bangladesh (10.20%). Dissimilarity showed with Subramanya in India (21.15%).[20,23]

Among 39 isolates, *Escherichia coli* was the predominant organism of 12(30.76%). Many studies have found *Escherichia coli* as the most prevalent organism, but their percentage greatly varied. Alam in Bangladesh and Dutta *et al*. in India found 33.13% and 26%, respectively.[20,14] These findings were nearly similar to the present study. Lower isolation was observed by Khan *et al*. in India.[21]

Other gram-negative isolates were Klebsiella spp. 10(25.64%), Pseudomonas spp. 5(12.82%), Acinetobacter spp. 4(10.25%), Enterobacter spp. 2(05.12%), Stenotrophomonas spp. 1(02.56%). This study was in agreement with other studies by Khan et al. in India (Klebsiella spp.24.6%, Pseudomonas spp. 20.2%, Acinetobacter spp. 15.8%); Qadder et al. in Pakistan (Klebsiella spp. 12.2%, Pseudomonas spp. 13%, Acinetobacter spp. 15.3%).[21,24] Dissimilarity was observed with Fatema et al. in Bangladesh (Klebsiella spp.9.9%, Pseudomonas spp. 21.5%, Acinetobacter spp. 46.5%, Enterobacter spp. .1%) and Rosenthal et al.in USA (Pseudomonas spp. 9%), Acinetobacter spp. 22%), Enterobacter spp. 22%).[17,25]

In the present study, among the isolated gram-positive bacteria, 1(02.56%) was Enterococci spp., and 1(02.56%) was Staphylococcus spp. Furthermore, 3(07.69%) were coagulase-negative Staphylococcus. This was in accordance with the findings of Fatema et al. in Bangladesh (Enterococci spp. 0.2%, Staphylococcus spp. 02.9%); Kanj et al. in Argentina (Enterococci spp. 01.80%, coagulase-negative Staphylococcus.7.3%).[17,22] Dissimilarity was observed with Dutta et al. in India (Enterococci spp. 15 %, Staphylococcus spp. 12%) and Safdar et al. in the USA (Enterococci spp. 12 %,

Staphylococcus spp. 6.5, coagulase-negative Staphylococcus 20.5%).[14,26] The difference may be attributed to the difference in geographical location, nutritional status, health care settings, and immune status of patient (Bhandari et al.).[27]

The pattern of antimicrobial resistance is essential for epidemiological and clinical purposes. The present study shows the antimicrobial susceptibility pattern of E. coli (Table VI) that was the predominant organism, showing the highest sensitive to Tigecycline (100%), followed by Colistin, Amikacin, Gentamycin, Meropenem, and Ertapenem (83.33% respectively). This study conformed with the reports of Afroz et al. in Bangladesh, who found Colistin 89% sensitive, followed by Amikacin and Imipenem 67%, and Behra A et al. in India found Colistin 94.5%, Meropenem 94.5% sensitive.[13,28] Our study is slightly dissimilar with the finding of Jesmin et al. in Bangladesh (Amikacin 28.57%, Gentamicin 14.29%, Meropenem 50%); Khan et al. India Amikacin 40%, Meropenem 48%) respectively.[29,21]

The second prevalent organism, Klebsiella pneumoniae, shows the highest sensitivity towards Colistin and Ertapenem (100%, respectively), followed by Imipenem and Meropenem (40%, respectively). These findings were nearly comparable with other studies by Fatema et al. in Bangladesh (Colistin 100%, Imipenem 45.2%); Khan et al. in India (Colistin 100%).[17,21] The highest sensitivity of Pseudomonas aeruginosa is shown by Amikacin, Meropenem, and Imipenem (60%, respectively). Similar reports were found in the study conducted by Majumder et al. in Bangladesh (Amikacin 57.14%, Imipenem 85.71%). Ahmed et al. in Bangladesh (Amikacin 50%, Meopenem 66.1%).[15,8] Dissimilarity found by Fatema et al. in Bangladesh (Amikacin 28.6%, Imipenem 14.97%), Rosenthal et al. in Argentina (Amikacin 90%, Imipenem 73.9%).[17,25]

The antimicrobial susceptibility pattern of Acinetobacter baumannii complex shows Tigecycline and Colistin 75% sensitive, followed by Trimethoprim/ Sulfamethoxazole 25% respectively). Nearly similar results were also observed by Afroz et al. in Bangladesh (Colistin 78%) and Khan et al. in India (Tigecycline and Colistin 100%).[13,21] A bit different results were observed by Fatema et al. in Bangladesh (Trimethoprim/ Sulfamethoxazole 3.85%); Jesmin et al. in Bangladesh (Colistin 58.33%, Trimethoprim/ Sulfamethoxazole 66.67%).[17,29]

The most effective drugs for Gram-positive were Linezolid. Other susceptible drugs against Gram-positive bacteria were Vancomycin and Tigecycline. These findings were similar to Afroz et al. in Bangladesh.[13]

This present situation in the ICU is alarming because most isolated bacteria were multidrug resistant. So rapid, reliable diagnosis of bacteria with appropriate AST is crucial for reducing mortality and morbidity.

Conclusion

Most of the isolated bacteria are multidrug resistant. Therefore, determining antimicrobial susceptibility by VITEK2 will aid the physician in choosing appropriate antibiotics and treating multidrug-resistant cases.

Conflict of interest: None declared

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