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Original Research Article

Bacteriological Profile and Drug Susceptibility Pattern of Uropathogens among the Patients Admitted in Intensive Care Units of a Tertiary Care Hospital in South Bihar

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Abstract:

Introduction: Antimicrobial resistance is a major emerging world-wide problem in the intensive care unit (ICUs). Different types of uropathogenic organism causes infection and these organisms are developing resistance due to unnecessary usage of common antimicrobial agents which indicates strong necessity of detailed study on this public health problem for designing the appropriate Antimicrobial Policy as a global Antimicrobial Stewardship Programme.

Material and Methods: This prospective laboratory based study was carried out in Department of Microbiology, NMCH, and Sasaram from Dec'2022 to Nov'2023. Total 273 urine samples from patients admitted in ICUs were tested following the CLSI guidelines (2023). Antimicrobial Susceptibility pattern of isolates were determined employing Kirby-Bauer Disk-diffusion method.

Results: This study revealed 59(21.6%) culture positive bacterial isolates in 273 samples comprising of 18(30.5%) Gram-positive cocci and 41(69.4%) Gram-negative bacilli. Gram-negative bacteria were Escherichia coli 15(25.4%), Pseudomonas aeruginosa 11(18.6%), Citrobacter species 08(13.5%), Klebsiella pneumoniae 05(8.4%) and 2(3.3%) Acinetobacter baumannii. Gram-positive isolates were Enterococci species 11(18.6%) and Staphylococcus aureus 07(11.8%). Gram-positive isolates were sensitive to Nitrofurantoin (83.3%), Piperacillin-tazobactam (85.7%) with 88.8% sensitivity to Vancomycin and 100% to Linezolid. Gram-negative isolates were sensitive to Meropenem (58.5%), Nitrofurantoin (68.2%), and Fosfomycin (82.9%) with 100% sensitivity to Polymyxin B. This study showed resistance to Ampicillin (72.7%) and Ciprofloxacin (83.4%) for Gram-positive isolates and resistant to Ampicillin (93.3%), Ofloxacin (86.6%), Ceftriaxone (83.3%), Cefotaxime (83.3%) and Ciprofloxacin (82.9%) among Gram-negative isolates.

Conclusion: This study showed prevalence of 21.6% uropathogens among ICU patients with Gram-negative bacteria 41(69.4%) and Gram-positive bacteria 18(30.5%) infection respectively with maximum sensitivity to Vancomycin, Linezolid and Polymyxin B. Study demonstrated multidrug resistance to Ampicillin, Ciprofloxacin, Ceftriaxone and Cefotaxime which is considered as a great concern of emergence of antibiotic resistance in this rural health setup.

Keywords: Intensive Care Units, Antimicrobial Resistance, Uropathogens.

Introduction

Antibiotic resistance is a major emerging world-wide problem in the intensive care unit (ICU) including India. The patient in the ICU has a 5 to 7 fold higher risk of nosocomial infection compared with the other patients. This is a consequence of impaired defense mechanism, applying invasive methods and monitoring devices, exposure to broad-spectrum antibiotics and the colonization of

resistant microorganisms. [1] Urinary tract infection (UTI) is one of the most commonly encountered bacterial infection found by the clinicians in developing countries for both community and hospital (nosocomial) settings. It is one of the challenging problem to the clinicians because of multidrug resistant pathogens which increases the morbidity and mortality rates. [2]

UTI is one of the most common infection for which antibiotics are prescribed. With an estimate of 150 million cases per year globally UTI is the 2nd most common infection among hospitalized patients globally with a cumulative healthcare cost expenditure of about $6 billion annually. [3]

Although UTIs occur in both men and women, clinical studies suggest that the overall prevalence of UTI is higher in women. An estimated 50% of women experience at least one episode of UTI at some point in their lifetime and between 20% and 40% of women have recurrent episodes. [4] Infection in the male population remains uncommon however after the fifth decade of life, it increases due to enlargement of the prostate which begins to interfere with emptying of the bladder. [5]

The major symptoms noticed in the UTI are burning sensation during micturition and sensation to urinate frequently, an urgency to urinate all the time in the absence of vaginal or urethral discharge and significant abdominal pain. Symptoms of an upper urinary tract infection or pyelonephritis, such as flank pain, rise in temperature, or nausea and vomiting along with the classic symptoms of a lower urinary tract infection, bloody urine or visible pus in the urine are also seen. [6]

Hospital acquired infections (HAIs) are an important public health problem in developing as well as in developed countries. [7]CAUTI are the most frequent nosocomial infections and are responsible for 20-30% of HAIs in medical or surgical ICUs. Risk factors associated with CAUTI includes: duration of ICU stay, length of catheterization, female patients, age over 50 years and immunocompromised. [8]

Various micro-organisms are responsible for UTI like bacteria, viruses, fungus, and parasite. Most common infection is caused by bacteria. The causative micro-organisms like Escherichiacoli, Klebsiella pneumoniae, Proteus species, Pseudomonas aeruginosa, Citrobacter species, Acinetobacter species, Enterococcus species and Staphylococcus aureusare responsible for UTI. [9] The predisposing factors responsible for UTI should be identified early and treated in time. Delayed treatment can lead to recurrence and if persist for long time can cause renal complications like hydronephrosis, acute pyelonephritis, acute renal failure, and irreversible kidney damage. This study helps to know the prevalence of urinary tract infection in intensive care units, their causative uropathogenic microorganisms and antimicrobial susceptibility pattern in this rural tertiary care hospital setup. [10]

Materials and Methods:

This prospective laboratory based study was carried out in the Department of Microbiology, Narayan Medical College Hospital, and Sasaram from Dec'2022 to Nov'2023.Total 273 urine samples from patients admitted in different ICUs were tested following the CLSI guidelines (2023).

After taking all precautions, a freshly voided clean catch midstream urine sample was collected in a commercially available sterile and wide-mouthed plastic container meant for urinalysis and urine culture. Catheterized patients in critically ill patients with symptoms of UTI whose sample came for culture and sensitivity were also included in this study. Urine was cultured on cytokine lactose electrolyte deficient agar using a 0.001 ml calibrated wire loop and incubated at 37°C for 24 h. Urine wet mount examination and Gram-stain of an uncentrifuged sample were also done and examined for the presence of pus cells and organisms. [11]

Next morning, the isolates were identified by colony morphology, Gram-stain, motility test, and routine biochemical reactions using standard laboratory procedures. In cases, where Gram-negative bacilli or Gram-positive cocci were isolated, colony count of more than 105/ml of a single organism was considered diagnostic of UTI. [12] Samples which grew more than one type of organism (multiple growths) were considered as contaminated and were not taken as positive for infection. [13] Culture which showed the growth of fungal infection were excluded.

Antimicrobial susceptibility testing was done by Kirby-Bauer Disk diffusion method using Mueller Hinton Agar plates. Commercially available HiMedia discs were used. The bacterial suspension was made by inoculating tip of 2-3 well isolated identical colonies in peptone water. After 2 hours of incubation the turbidity was standardized by using 0.5 McFarland standards. By using a sterile swab stick a lawn culture was made on the Mueller-Hinton agar plates. The antibiotic discs (as per CLSI guidelines 2023) were placed and inoculated plates were incubated at 37 ℃. The results were read after overnight incubation and compared with standard chart. [14]

Results:

Study revealed 59(21.6%) culture positive bacterial isolates in 273 samples comprising of 41(69.4%) Gram-negative bacilli and 18(30.5%) Gram-positive cocci. Among them males were 148(54.2%) and females were 125(45.7%) in which

33(55.9%) males and 26(44.05%) females were culture positive respectively as shown in Table 1.

Table 1: Gender wise distribution of Total Sample (N = 273) and Culture Positive (N = 59)

Gender	Total Sample (N=273)	Culture Positive (N=59)
Male	148(54.2%)	33(55.9%)
Female	125(45.7%)	26(44.06%)

In this study, maximum number of patients were >60years. Among culture positive patients most of the patients in males were in age >60years while in percentage it is in between age-group 21years-40years. In females maximum number and percentage of culture positive patients were in between age-group 41years-60years as shown in Table 2.

Table 2: Age and Sex wise distribution of Total Sample (N=273) and Culture Positive (N=59)

Age-Group (in years)	Total Number of samples		Total Culture Positive samples	
	Male	Female	Male	Female
0day-1year	18	06	00	00
1year-20years	07	11	02(28.5%)	02(18.18%)
21years-40years	22	21	07(31.8%)	02(9.5%)
41years-60years	37	43	6(16.2%)	14(32.5%)
>60years	64	44	18(28.1%)	08(18.1%)
	148	125	33	26
Total	273		59(21.61%)	

In this study, UTI patients were from different ICUs in which most of the samples were from Medical ICU 171(62.6%) followed by CCU 52(19.04%), NICU 20(7.3%), PICU 14(5.1%), SICU 13(4.7%), CTVS ICU 03(1.09%) as shown in Table 3.

Table 3: Intensive Care Units wise distribution of Total Sample (N=273) and Culture Positive (N=59)

ICUs	Total Sample (N=273)	Culture Positive (N=59)
MICU	171(62.6%)	41(23.9%)
CCU	52(19.04%)	10(19.2%)
NICU	20(7.3%)	00
PICU	14(5.1%)	02(14.2%)
SICU	13(4.7%)	06(46.1%)
CTVS ICU	03(1.09%)	00

In this study, Escherichia coli (25.4%) were the most common isolate among urinary pathogens followed by Pseudomonas aeruginosa (18.6%), Enterococci species (18.6%), Citrobacter species (13.5%), Staphylococcus aureus (11.8%), Klebsiella pneumoniae (8.4%) and Acinetobacter baumannii (3.3%) as shown in Fig 1.

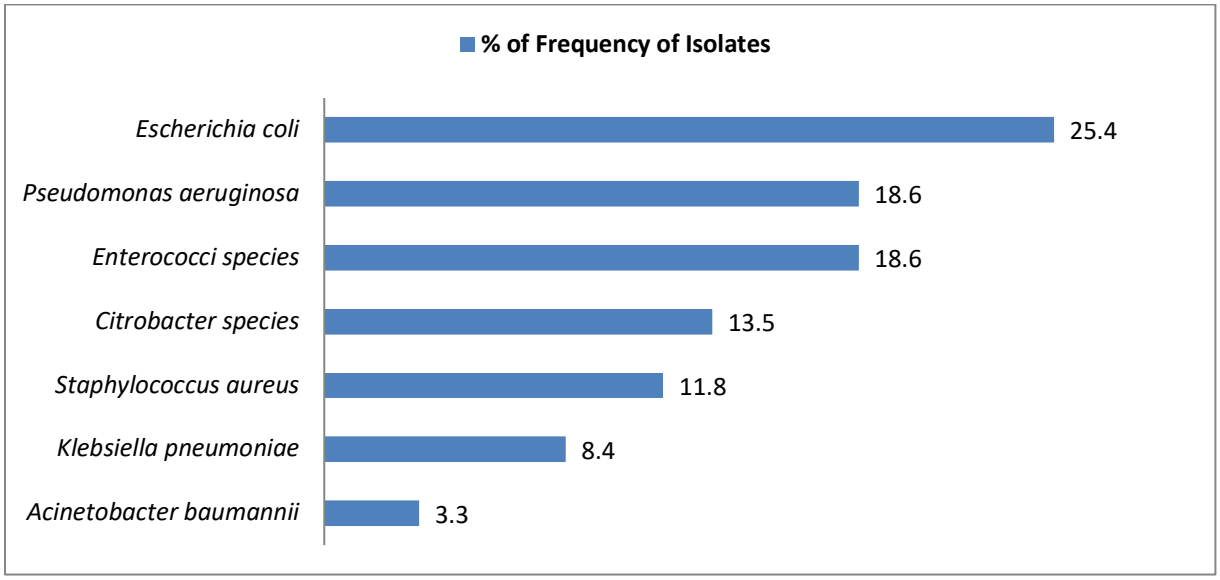

Figure 1: Frequency and Distribution of Isolated Organisms:

In this study, Escherichia coli 15(36.5%) were the most commonly isolated urinary pathogens among Gram-negative bacteria followed by Pseudomonas aeruginosa 11(26.8%), Citrobacter species 08(19.5%), Klebsiella

pneumoniae 05(12.1%) and 2(4.8%) Acinetobacter baumannii. Among Gram-positive bacteria Enterococci species 11(61.1%) were the most common isolate followed by Methicillin resistant Staphylococcus aureus 05(27.7%) and Staphylococcus aureus 02(11.1%) as shown in Table 4 and Table 5.

Table 4: Distribution of Organisms among Gram-negative Isolates:-

Organisms Isolated	No. of Organisms Isolated	% of Organisms Isolated
Escherichia coli	15	36.5%
Pseudomonas aeruginosa	11	26.8%
Citrobacter species	08	19.5%
Klebsiella pneumoniae	05	12.1%
Acinetobacter baumannii	02	4.8%

Table 5: Distribution of Organisms among Gram-positive Isolates

Organisms Isolated	No. of Organisms Isolated	% of Organisms Isolated
Enterococci species	11	61.1%
MRSA	05	27.7%
Staphylococcus aureus	02	11.1%

Antibiotic sensitivity was put up by the Kirby-Bauer disk diffusion method on Mueller-Hinton Agar using commercially available antibiotic discs (HiMedia) following the Clinical Laboratory Standard Institute (CLSI) guidelines (2023) as shown in Table 6, Table 7 and Fig 2, Fig 3.

Table 6 showed the sensitive and resistant pattern of Gram-positive cocci in which Antimicrobial agent like Vancomycin and Linezolid were 100% sensitive for Staphylococcus aureus and Methicillin resistant Staphylococcus aureus. Enterococci species were 81.81% sensitive for Vancomycin and 100% for Linezolid. Table 7 showed the sensitive and resistance pattern of Gram-negative bacilli in which Polymyxin B were found to be 100% sensitive.

Fig 2 showed the bar diagram for Sensitive and Resistance pattern of Gram-positive cocci in which Ciprofloxacin, Ampicillin and Gentamicin were found to have sensitivity less than 50% and in Fig 3 which showed the bar diagram for Sensitive and Resistance pattern of Gram-negative bacilli in which Ampicillin, Ofloxacin, Ceftriaxone, Cefotaxime, Ciprofloxacin, Ceftriaxone-sulbactam, Cotrimoxazole, Gentamicin and Amikacin were found to have less than 50% sensitivity.

Table 6: Antibiotic Sensitive and Resistant pattern of Gram-positive Cocci

Antimicrobial agents	Staphylococcus aureus (N=2)		Methicillin resistant Staphylococcus aureus (MRSA) (N=5)		Enterococci species (N=11)	
	S(%)	R(%)	S(%)	R(%)	S(%)	R(%)
Ampicillin	-	-	-	-	3(27.7)	8(72.7)
Amoxicillin	2(100)	0(0)	3(60)	2(40)	-	-
Piperacillin	2(100)	0(0)	2(40)	3(60)	-	-
Cotrimoxazole	0(0)	2(100)	4(80)	1(20)	-	-
Ciprofloxacin	1(50)	1(50)	1(20)	4(80)	1(9.09)	10(90.9)
Nitrofurantoin	2(100)	0(0)	4(80)	1(20)	9(81.81)	2(18.18)
Cefoxitin	2(100)	0(0)	0(0)	5(100)	-	-
Piperacillin-tazobactam	2(100)	0(0)	4(80)	1(20)	-	-
Gentamicin	2(100)	0(0)	3(60)	2(40)	2(18.18)	9(81.81)
Fosfomycin	2(100)	0(0)	3(60)	2(40)	-	-
Vancomycin	2(100)	0(0)	5(100)	0(0)	9(81.81)	2(18.18)
Linezolid	2(100)	0(0)	5(100)	0(0)	11(100)	0(0)

Table 7:Antibiotic Sensitive and Resistant pattern of Gram-negative bacilli:-

Antimicrobial agent	Escherichia coli (N=15)		Klebsiella pneumoniae (N=5)		Citrobacter species (N=8)		Pseudomonas aeruginosa (N=11)		Acinetobacter baumannii (N=2)	
	S(%)	R(%)	S(%)	R(%)	S(%)	R(%)	S(%)	R(%)	S(%)	R(%)
Ampicillin	1(6.6)	14(93.3)	0(0)	5(100)	0(0)	8(100)	-	-	1(50)	1(50)
Cotrimoxazole	6(40)	9(60)	2(40)	3(60)	3(37.5)	5(62.5)	-	-	2(100)	0(0)

Ciprofloxacin	2(13.3)	13(86.6)	1(20)	4(80)	0(0)	8(100)	3(27.2)	8(72.7)	1(50)	1(50)
Nitrofurantoin	14(93.3)	1(6.6)	4(80)	1(20)	5(62.5)	3(37.5)	4(36.3)	7(63.6)	1(50)	1(50)
Gentamicin	8(53.3)	7(46.6)	2(40)	3(60)	4(50)	4(50)	3(27.2)	8(72.7)	2(100)	0(0)
Amikacin	9(60%)	6(40)	1(20)	4(80)	5(62.5)	3(37.5)	2(18.1)	9(81.8)	2(100)	0(0)
Ofloxacin	1(6.6)	14(93.3)	1(20)	4(80)	1(12.5)	7(87.5)	-	-	0(0)	2(100)
Ceftriaxone	1(6.6)	14(93.3)	1(20)	4(80)	1(12.5)	7(87.5)	-	-	2(100)	0(0)
Cefotaxime	1(6.6)	14(93.3)	1(20)	4(80)	1(12.5)	7(87.5)	-	-	2(100)	0(0)
Ceftriaxone-sulbactam	5(33.3)	10(66.6)	1(20)	4(80)	3(37.5)	5(62.5)	-	-	2(100)	0(0)
Piperacillin-tazobactam	6(40)	9(60)	2(40)	3(60)	4(50)	4(50)	9(81.8)	2(18.1)	2(100)	0(0)
Meropenem	12(80)	3(20)	2(40)	3(60)	5(62.5)	3(37.5)	3(27.2)	8(72.7)	2(100)	0(0)
Imipenem	9(60)	6(40)	2(40)	3(60)	5(62.5)	3(37.5)	3(27.2)	8(72.7)	2(100)	0(0)
Fosfomycin	14(93.3)	1(6.6)	4(80)	1(20)	8(100)	0(0)	6(54.5)	5(45.4)	2(100)	0(0)
Polymyxin B	15(100)	0(0)	5(100)	0(0)	8(100)	0(0)	11(100)	0(0)	2(100)	0(0)

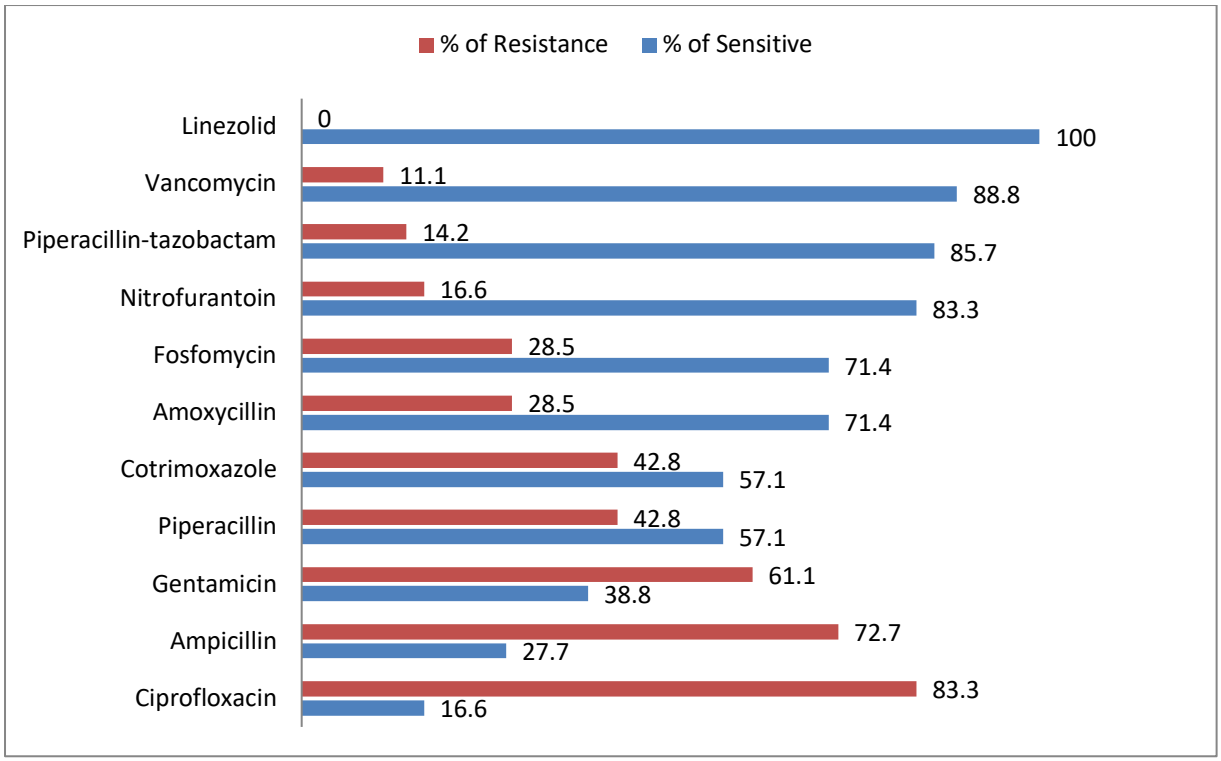

Figure 2: Antibiotic Sensitive and Resistance pattern of Gram-positive Cocci.

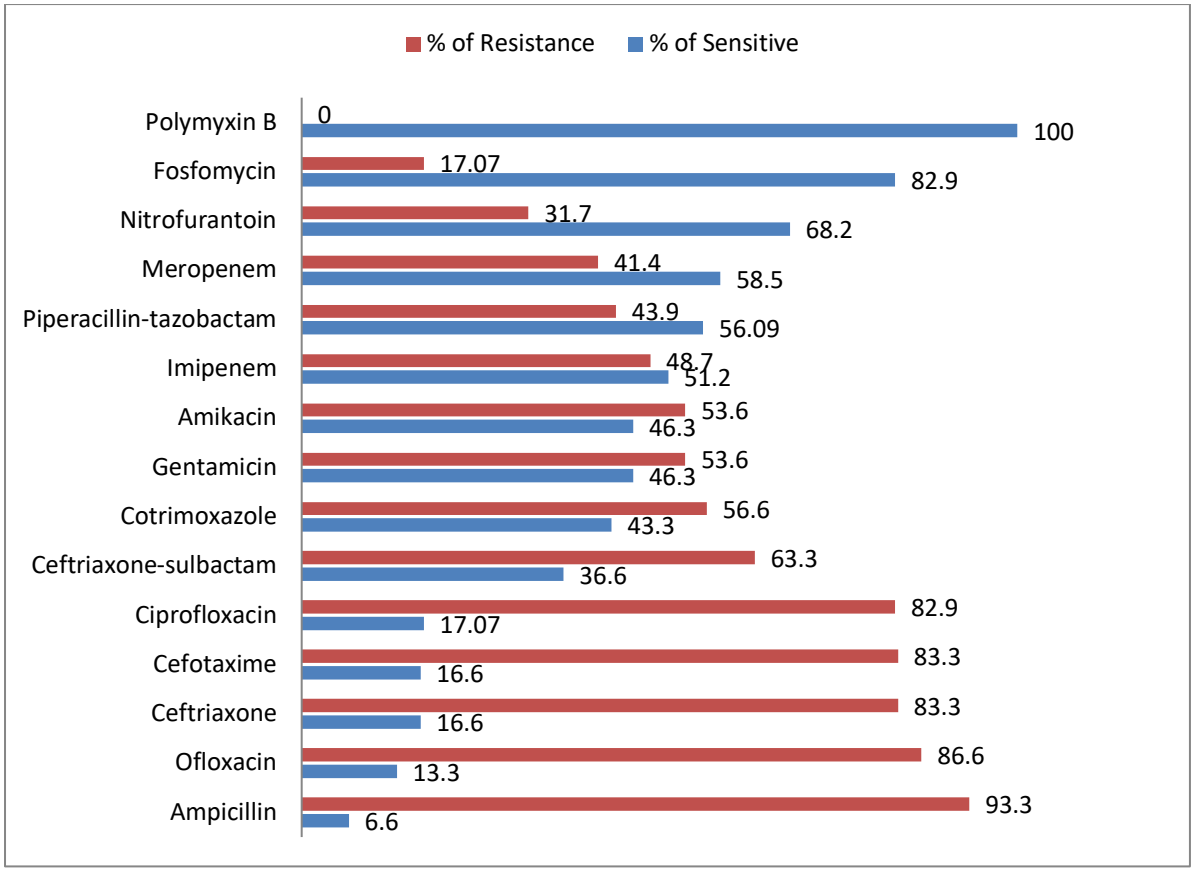

Figure 3: Antibiotic Sensitive and Resistance pattern of Gram –negative bacilli

Discussion

Reduction in antimicrobial resistance in the ICUs has been a goal for all intensive care units as it improves outcome and cost to the patients in terms of the expenses for costly antibiotics as well as duration of ICU stay.

Mortality associated with multi-drug resistant organisms is also a concern. [15]UTI has been reported to be one of the most common intensive care acquired infections in the world, accounting for 40% of nosocomial infections in ICU, and 80% of these infections are related to urinary instrumentation. [16]

In this study, a total of 273 urine samples suspected with urinary tract infections from different ICUs were received in Microbiology Laboratory for culture and sensitivity testing where 59(21.6%) showed positive bacterial growth. This rate of isolation is consistent with many studies done from India and abroad like Murugesan S et al. 2020 (22%) [17], Berhanu Adugna et al. 2021 (23.7%) [18], Dalal P et al. 2016 (24.26%) [19], Kumar Rakesh et al. 2014 (24.30%) [20].

However in this study, culture positivity rate is found to be lesser than most of the study done in India and abroad as in most study inclusion of fungal growth in positive culture were taken but we have not included them. Some of the study which shows higher culture positivity than this study were AdaneBitew et al. 2017 (36%) [21], T.S. Shailaja et al. 2017 (33.5%) [22]. Disparity in the rates of UTI in different studies could result from difference in the definition of bacteriuria, methodology, the length of the study period, size and type of study population.

In this study, 148(54.2%) were male and 125(45.7%) were female. Overall men 33(55.9%) had high culture positivity as compared with women 26(44.06%). However this is inconsistent with the studies done by others where women had high culture positivity with others as women were more prone to UTI because of anatomic reasons; short and straight urethra and short distance between the ostium of the urethra and the anus contribute to easy colonization of the peri-urethral region with enteric bacteria. [23,24]

This inconsistency of the result could be due to the reason because the most patients were from ICUs where specific age-group does not matter as most patients were catheterized as found in the study of M. Mojtahedzadeh et al. (2007) [25] where gender was not a risk factor for catheter-associated bacteriuria in their septic patients, and the male to female ratio showed no significant difference between the bacteriuric and non-bacteriuric patients. Gender as a risk factor was also not shown in some of the studies which is done specific for the

ICU patients like Rosser CJ et al. 1999 [26] where 65% were males and 35% were females.In this study, in the age-group of 21years-40years bacteriuria was found in 31.8% males and 9.5% females while in the age-group of 41years-60years bacteriuria were found in 16.2% males and 32.5% females could be because of post-menopausal case.

In >60years, 26.5% males were found to be have bacteriuria in this study and 20.4% females. This could be because of urine retention due to increasing frequency of prostate disease and diabetes mellitus in this age group as stated by Sonali waske et al. (2017) [27]. Bhargava et al. (2022) [28]also revealed that elderly males (51–80 y) had a higher incidence of UTI (35.9%) than elderly females (25.7%).

However catheter-associated urinary tract infection has become a major problem leading to increased morbidity and mortality in healthcare settings especially in ICUs as multiple factors like aseptic technique, hand hygiene, catheter care, and duration of catheterization can affect the incidence of CAUTI. Since the proportion of catheterized patients will always be comparatively higher in ICUs than wards. [29]The bacteriuria was identified in 69.4% due to Gram-negative bacteria and 30.5% due to Gram-positive bacteria. UTI originated from colonic bacteria which comprise mainly of Gram-negative bacteria. This finding was similar to study done by HP Kattel et al. (2012) [30] where 71.8%(191/266) were Gram negative bacterial isolates.

In this study, Escherichia coli (25.4%) were the most common isolate among urinary pathogens followed by Pseudomonas aeruginosa (18.6%), Enterococci species (18.6%), Citrobacter species (13.5%), Staphylococcus aureus (11.8%), Klebsiella pneumoniae (8.4%) and Acinetobacter baumannii (3.3%). This is consistent with the study done by others where most commonly isolated organisms were Escherichia coli like Tuli L et al. (2016) [31], Pattanayak C et al. (2013) [32]. In this study Pseudomonas aeruginosa was second most common while in the study done by Srideeprath et al. (2018) [33], Pseudomonas aeruginosa was the most common and Escherichia coli was the second most common. In this study, Enterococci species were also found to be high which is similar to study done by Shailaja T. S. et al. 2018. [34]

In this study, Enterococci species were 81.81% found to be sensitive and rest of the Gram-positive organisms were 100% sensitive for Vancomycin. Linezolid is 100% sensitive for Gram-positive bacteria. This is similar to the study done by N. Premanatham et al. (2015) [35] where Enterococci species were 80% sensitive for Vancomycin. In this study Ampicillin with 72.7% and Ciprofloxacin with 83.3% resistance for Gram-positive bacteria. In case of Gram-negative bacteria, Ampicillin 93.3%, Ofloxacin 86.6%, Ceftriaxone 83.3%, Cefotaxime 83.3% and Ciprofloxacin 82.9% were found to be resistant. The sensitivity of these Antimicrobial agents were low which is similar to study done by others like Kumar A et al. (2017) [36]. In this study sensitivity pattern of Fosfomycin (71.4%), Nitrofurantoin (83.3%), Piperacillin-tazobactam (85.7%), Vancomycin (88.8%) and Linezolid (100%) were good for Gram-positive organisms in this area. Sensitivity pattern of Gram-negative bacteria were high for Antimicrobial agents like Imipenem (51.2%), Piperacillin-tazobactam (56.09%), Meropenem (58.5%), Nitrofurantoin (68.2%), Fosfomycin (82.9%) and Polymyxin B (100%). Sensitivity pattern for Fosfomycin, Nitrofurantoin, Piperacillin-tazobactam were good for both Gram-positive and Gram-negative bacteria in this rural set up for uropathogens. Similar finding were found in other studies like Moktaet al.(2015) [37], Vicky P. Gandhi et al. (2017) [38].

In this present study overall sensitivity pattern for uropathogens were observed to be low. This could be because of overuse of antibiotics, random use of antibiotics as hit and trial method by clinicians without proper sensitivity test, unawareness of people about emergence of antibiotics resistance, random use of antibiotics without advice of physicians, prolonged intensive care unit stay, severe illness, use of instrumentation or catheterization etc. are the major cause of drug resistance in our country. [39] Thus periodic assessment of in vitro susceptibility pattern of urinary pathogens is necessary which serves as a guide for antibiotic therapy, as these organisms exhibit resistance to many first-line drugs used for UTI infection and also needed for empirical treatment for such infections. [40]

Conclusion

The treatment of UTI in general population is often done empirically by the general practitioners. Antibiotic susceptibility tests are ordered by the doctors only when the patient has failed to recover from initial treatment. The study of antimicrobial susceptibility pattern of UTI in ICUs patients can guide the clinicians in the rational choice of antibiotic treatment so that misuse of antibiotics may be prevented. [41]

This study showed that Gram-negative organisms were the leading cause of UTIs among adult population and they developed resistance against the routinely prescribed drugs. Periodic monitoring and surveillance need to be done to keep the emerging resistance among uropathogens in check so that the more effective treatment can be given to the patient. [42]

References

1. Chakraverti TK, Tripathi PC. Pattern of antibiotic susceptibility of common isolates in ICU of a tertiary care hospital: 2 years study.Int J Clin and Biomed Res. 2015; 1(2): 80-87.
2. Thangavel S, Maniyan G, Vijaya S, Venkateswaran C. Bacteriological Profile of Uropathogens and their Antimicrobial Susceptibility Pattern in Isolates from a Tertiary Care Hospital. Int J. Curr. Microbiol. App. Sci. 2017; 6(5):2279-86.
3. Karuna T, Kumar S, Garg R, Saigal S, Prasad L, Pandita KK. Changing Patterns of Antimicrobial Susceptibility of Uro-pathogens in Community-acquired Urinary Tract Infections in Central India: Two Year Prospective Surveillance Report. Infect Dis Diag Treat. 2023; 7(3):2577-1515.
4. Sood S, Gupta R. Antibiotic resistance pattern of community acquired uropathogens at a tertiary care hospital in Jaipur, Rajasthan. Indian J Community Med. 2012 Jan 1; 37(1):39-44.
5. Shah LJ, Vaghela GM, Mahida H. Urinary tract infection: Bacteriological profile and its antibiotic susceptibility in Western India. Nat J Med Res. 2015 Mar 31; 5(01):71-4.
6. Agarwal K, Harathi M, Payal Vijayalakshmi PH, Gandhi K, Rao SP. Bacteriological Profile and Antibiotic Susceptibility Profile of Emerging Gram-positive Uropathogens in Tertiary Care Centre, Visakhapatnam, India. J Critical Revs. 2020; 7(15):90-7.
7. Çelik İ, İnci N, Denk A, Sevim E, Yasar D, Yasar M. Prevalence of hospital acquired infections in anesthesiology intensive care unit. Fırat Tıp Dergisi. 2005; 10(3):132-5.
8. Neha Garg NG, Indu Shukla IS, Meher Rizvi MR, Ahmed SM, AbidaKhatoon AK, Fatima Khan FK. Microbiological profile and antibiotic sensitivity pattern of bacterial isolates causing urinary tract infection in intensive care unit patients in a tertiary care hospital in Aligarh region, India.Int J Curr Microbiol App Sci. 2015;1:163-172
9. Singh VP, Mehta A. Bacteriological profile of urinary tract infections at a tertiary care hospital in Western Uttar Pradesh, India. Int J Res Med Sci. 2017 May; 5(5):2126-9.
10. Agarwal A, Srivastava J, Bose S, Maheswari U. Uropathogens and their antibiotic susceptibility profile in a tertiary care hospital. Indian J Microbiol Res. 2021; 8:112-8.
11. Winn WC, Allen S, Janda W, Koneman E, Procop G, Schreckenberger P, et al., editors. Introduction to microbiology - Urinary tract infections. In: Koneman's Color Atlas and Textbook of Diagnostic Microbiology. 6th ed. Philadelphia: Lippincott Williams & Wilkins; 2006. p. 82-7.
12. Forbes BA, Sahm DF, Weissfeld AS, editors. Infections of the urinary tract. In: Bailey & Scott's Diagnostic Microbiology. 12th ed. St. Louis, USA: Mosby Elsevier; 2007. p. 842-54.
13. Shettigar S, Chandrashekar GS, Roche R, Nayak N, Anitha KB, Soans S. Bacteriological profile, antibiotic sensitivity pattern, and detection of extended spectrum β-lactamase in the isolates of urinary tract infection from children. Indian J Child Health. 2016 Mar 26; 3(1):27-31.
14. Clinical and Laboratory Standards Institute, Performance Standards for Antimicrobial Disk Susceptibility Tests: approved standard, 33rd ed., CLSI standard M100-S33. Wayne, PA: Clinical and Laboratory Standards Institute, 2023 Feb; 42(2).
15. Kaul S, Brahmadathan KN, Jagannati M, Sudarsanam TD, Pitchamuthu K, Abraham OC, John G. One-year trends in the gram-negative bacterial antibiotic susceptibility patterns in a medical intensive care unit in South India. Indian J Med Microbiol. 2007 Jul 1; 25(3):230-5.
16. Demir C, Metin S. Microorganisms grown in urine cultures and antimicrobial resistance patterns: A randomised retrospective analysis from a tertiary hospital. J Inf Developing Countries. 2023 Mar 31; 17(03):337-44.
17. Murugesan S, Samuel S, Rudrapathy P. Microbiological profile and antibiotic susceptibility pattern of uropathogens isolated among cancer patients at a tertiary care cancer centre, South India. Int J Pharm Sci. 2020; 11:56-63.
18. Adugna B, Sharew B, Jemal M. Bacterial Profile, Antimicrobial Susceptibility Pattern, and Associated Factors of Community-and Hospital-Acquired Urinary Tract Infection at Dessie Referral Hospital, Dessie, Northeast Ethiopia. Int J Microbiol. 2021;2021(1):1-14.
19. Dalal P, Pethani J, Sida H, Shah H. Microbiological profile of urinary tract infection in a tertiary care hospital. J Res Med Dental Science. 2016 Jul 1;4(3):204-9.
20. Rakesh K, Dahiya SS, Kirti H, Preeti S. Isolation of human pathogenic bacteria causing urinary tract infection and their antimicrobial susceptibility pattern in a tertiary care hospital, Jaipur, India. Int Res J Med Sci. 2014; 2:6-10.
21. Bitew A, Molalign T, Chanie M. Species distribution and antibiotic susceptibility profile of bacterial uropathogens among patients complaining urinary tract infections. BMC infectious dis. 2017 Dec; 17:1-8.
22. Shailaja TS, Mohankumar A. Bacteriological profile of urinary tract infection in a tertiary care centre. Indian J Microbiol Res. 2017;4(3):328-32.
23. Ruchi Mishra RM, Jayesh J, Singh AK, KusumJasuja KJ. Bacteriological profile and sensitivity pattern of microorganisms causing

urinary tract infection at a tertiary care center in eastern Uttar Pradesh. Int J Biomed Advn Res. 2016; 7(6): 292-297.
24. Sarasu VP, Rani SR. Bacteriological profile and antibiogram of urinary tract infections at a tertiary care hospital. Int J Med Microbiol Trop Dis. 2017;3(3):106-2.
25. Mojtahedzadeh M, Panahi Y, Fazeli MR, Najafi A, Pazouki M, Navehsi BM, Bazzaz A, Naghizadeh MM, Beiraghdar F. Intensive care unit-acquired urinary tract infections in patients admitted with sepsis: etiology, risk factors, and patterns of antimicrobial resistance. Int J Infs dis. 2008 May 1;12(3):312-8.
26. Rosser CJ, Bare RL, Meredith JW. Urinary tract infections in the critically ill patient with a urinary catheter. Am J Surg. 1999 Apr; 177:287-90.
27. Waske S, Marothi Y, Shah H, Pradhan R. Antibiotic resistance pattern of Uropathogens in a tertiary care hospital of Central India. Int J Med Microbiol Trop Dis. 2017 Apr-Jun;3(2):61-4.
28. Bhargava K, Nath G, Bhargava A, Kumari R, Aseri GK, Jain N. Bacterial profile and antibiotic susceptibility pattern of uropathogens causing urinary tract infection in the eastern part of Northern India. Frontiers in Microbiol. 2022 Aug 9; 13:1-9.
29. Soundaram GVG, Sundaramurthy R, Jeyashree K, Ganesan V, Arunagiri R, Charles J. Impact of Care Bundle Implementation on Incidence of Catheter-associated Urinary Tract Infection: A Comparative Study in the Intensive Care Units of a Tertiary Care Teaching Hospital in South India. Indian J Crit Care Med 2020;24(7):544–550.
30. Kattel HP, Mishra SK, Acharya J, Sigdel MR, Prasad N, Shah AS, Rijal BP, Sherchand JB, Pokhrel BM. Antibiotic sensitivity profile of different uropathogens in a tertiary care center in Nepal. J Nepal association Med lab sci. 2012;11(1):19-33.
31. Tuli L, Rai S, Arif D, Singh DK. Bacteriological profile and antimicrobial susceptibility pattern of isolates from Urinary tract infections in eastern Uttar Pradesh, India. Int J. Curr. Microbiol. App. Sci. 2016;5(3):428-35.
32. Pattanayak C, Patanaik SK, Datta PP, Panda P. A study on antibiotic sensitivity pattern of bacterial isolates in the intensive care unit of a tertiary care hospital in Eastern India. Int J Basic Clin Pharmacol. 2013 Mar;2(2):153-9.
33. Rath S, Sahoo S, Behera IC, Dhar SK, Sahu MC. Surveillance of Bacteria Associated with UTI and Drug Sensitivity Patterns at a Tertiary Care Teaching Hospital. Indian J Public Health Res Develop. 2018 Nov 1;9(11):2199-2204.
34. Shailaja TS, Kumar AM, Payyappilly RJ. Emerging trends in the antimicrobial resistance among uropathogens. Indian J Microbiol Res. 2018 Jan 24;5(1):47-51.
35. Premanatham N, John M, Lakshmi P, Reddy PS. Prevalence and antibiotic susceptibility pattern of bacterial pathogens causing urinary tract infections in humans at a tertiary care hospital in AP, India. J Biosci Technol. 2015;6(1):620-626.
36. Kumar A, Kumar R, Gari M, Keshri US, Mahato SK, Ranjeeta K. Antimicrobial susceptibility pattern of urine culture isolates in a tertiary care hospital of Jharkhand, India. Int J Basic Clin Pharmacol. 2017 Jul;6(7):1733-9.
37. Mokta K, Mokta J, Verma S, Singh D, Kanga A. Bacterial etiology and antibiotic susceptibility pattern of urinary tract infection in Sub-Himalayan Region of India-a retrospective study of clinical isolates. Nat J Med Allied Sci. 2015;4(1):38-45.
38. Gandhi VP, Patel M, Nerurkar A. Bacteriological profile and its antibiotic susceptibility in patients with Urinary Tract Infection at Tertiary Care Hospital, Valsad, Gujarat. Int J Med Microbiol Trop Dis. 2017 Apr;3(2):57-60.
39. Pardeshi P. Prevalence of urinary tract infections and current scenario of antibiotic susceptibility pattern of bacteria causing UTI. Indian J Microbiol Res. 2018 Jul;5(3):334-8.
40. Chaturvedi P, Lamba M, Sharma D, Mamoria VP. Bloodstream infections and antibiotic sensitivity pattern in intensive care unit. Tropical Doctor. 2021 Jan;51(1):44-8.
41. Singh VP, Mehta A. Bacteriological profile of urinary tract infections at a tertiary care hospital in Western Uttar Pradesh, India. Int J Res Med Sci. 2017 May;5(5):2126-9.
42. Thass N, Kumar M, Kaur R. Prevalence and antibiogram of bacterial pathogens causing urinary tract infection in a tertiary care hospital. Int J Med Sci Public Health. 2019 Jan 1;8(1):53-8.