



A STUDY OF UROPATHOGENS, DRUG RESISTANCE PROFILES, AND RISK FACTORS CONTRIBUTING TO URINARY TRACT INFECTIONS AMONG DIABETIC PATIENTS IN A TERTIARY CARE CENTRE, KANPUR

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Abstract

Background: Urinary tract infections (UTIs) are common among diabetic patients due to impaired immunity, poor glycemic control, and associated complications. These infections often lead to serious outcomes if not diagnosed and treated early.

Aim: To study the bacteriological spectrum, antimicrobial resistance patterns, and associated risk factors of UTIs in diabetic patients attending a tertiary care hospital in Kanpur.

Materials and Methods: This prospective observational study was conducted from January to December 2020. A total of 50 urine samples from diabetic patients were collected and processed using standard microbiological techniques. Identification of isolates and antibiotic susceptibility testing were performed according to CLSI guidelines.

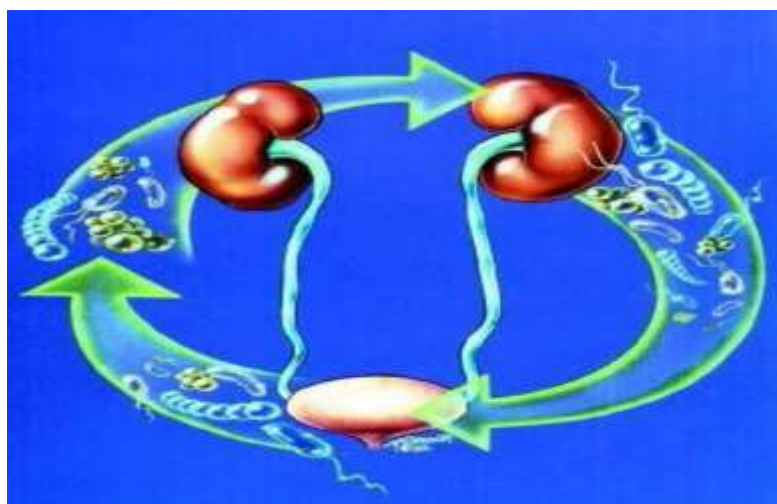
Results: Out of 50 samples, 8 (16%) were culture-positive for UTI. The majority of patients were in the 46–60 years age group (56%). Gram-negative bacilli were predominant (75%), with *Escherichia coli* (50%) as the most common isolate, followed by *Klebsiella* species. Gram-positive cocci accounted for 25% of isolates, including *Staphylococcus aureus* and *Staphylococcus lugdunensis*. Most Gram-negative isolates showed high sensitivity to Amikacin, Gentamycin, Carbapenems, and Tigecycline, while Gram-positive isolates were highly sensitive to Linezolid, Vancomycin, and Teicoplanin.

Conclusion: UTIs are fairly prevalent among diabetic patients, with *E. coli* being the predominant pathogen. The presence of antimicrobial resistance highlights the need for regular surveillance and appropriate antibiotic therapy. Early diagnosis and proper management are essential to reduce complications in diabetic individuals.

Introduction:

Urinary tract infection (UTI) is a major problem in diabetics. The risk of developing infection in diabetic patients is higher and urinary tract is the most common site for infection ^[1]. Changes in host defense mechanisms, the presence of diabetic cystopathy and micro-vascular disease in the kidneys may play a role in the higher incidence of UTI in diabetic patients ^[2]. Serious complications of urinary tract infection, such as emphysematous cystitis, pyelonephritis, renal or perinephric abscess, bacteremia and renal papillary necrosis occur more commonly in diabetic patients ^[3]. Acute renal failure is twice as likely to develop in bacteraemic patients ^[4].

Worldwide, diabetes mellitus (DM) is considered as one of the most challenging health problems of 21st century. It affects every aspect of patients' life, including quality of life (QoL), employment and even causing premature death ^[5]. All these changes make diabetic patients prone to have more infections such as UTI, RTI, skin and soft tissue infections (SSTIs). The prevalence of UTI is high among DM patients ^[6]. The prevalence of UTI was 38% among diabetic patients. UTI seen more common in females i.e. 63.16% while male's contribution was 36.84% among studied subjects. High sugar level is the main cause of prevalence of UTI among the DM patients. ^[7]



Upward arrow: ascending infection (bladder to kidney).

Downward arrow: descending (hematogenous) infection (kidney to bladder). ^[8]

Signs and Symptoms of UTI

Common symptoms of urinary tract infection include burning sensation during urination (dysuria), increased frequency and urgency of urination, cloudy or foul-smelling urine, and lower abdominal discomfort. In upper UTI, symptoms may also include fever, chills, nausea, and flank pain. Some patients, especially older adults, may have atypical or minimal symptoms. ^[9]

Morphology

E. coli is a gram negative facultative anaerobic and non-sporulating bacterium. ^[10] Cells are typically rod shaped, and are about 2.0µm long and 0.25µm in diameter, with a cell volume of 0.6-0.7µm. ^[11] *E. coli* is gram negative because its cell wall is composed of a thin peptidoglycan layer and outer membrane. Strains that possess flagella are motile. The flagella have a peritrichous arrangement. It also attaches and effaces to the microvilli of the intestine via an adhesion molecule known as intimin ^[12]

Cultural Characteristics:

Escherichia coli is a facultative anaerobe that grows aerobically between 10–40°C. It forms large, grayish-white, moist, smooth colonies on ordinary media. On blood agar, many strains—especially pathogenic ones—are hemolytic. On MacConkey agar, colonies appear bright pink due to lactose

fermentation. In broth, growth shows uniform turbidity with a heavy deposit that disperses upon shaking.

Biochemical Reactions:

- Catalase: positive
- Ferments glucose, lactose, mannitol, maltose (acid and gas produced)
- Does not ferment sucrose (typical strains)
- Indole: positive
- Methyl red: positive
- Voges-Proskauer: negative
- Citrate: negative

Role in Disease: E. coli is the leading cause of urinary tract infections (UTIs). Infection depends on host anatomy, defense mechanisms, and bacterial virulence. Pathogenic E. coli usually originates from the host's own bowel flora and enter the urinary tract via the urethra. Adherence to uroepithelial cells is essential for infection establishment.

Material and Methods:

This study was conducted in the Department of Microbiology and Department of Orthopedics Rama medical college Hospital and Research Centre Kanpur, Samples from outpatients and inpatients admitted to the orthopedic ward suspected to have osteomyelitis was collected from Rama Medical college Hospital and research center as the source of the sample for the study.

Study design: prospective study.

Type of study: observational study.

Study period: This study was conducted from January 2020 to December 2020.

Size of sample: 50 samples from patients with diabetic from medicine department was collected.

Inclusion criteria:

UTI and whose urine culture shows single pathogen with colony counts higher than or equal to 10⁵ colony forming units (CFU)/ml was included for the study.

Exclusion criteria:

Patient who has already taken antibiotic treatment for minimum of two weeks, and non-diabetic patients with UTI

Ethical clearance:

Ethical clearance was obtained from the Institutional Ethical Committee of RMCH & RC.

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Sample Collection & Processing:

Clean-catch midstream urine samples were collected in sterile wide-mouthed bottles. Pregnant women were instructed to wash hands and cleanse the periurethral area with sterile saline swabs to reduce contamination. Samples were processed within 2 hours or refrigerated at 4°C until processing.

A calibrated 0.01 ml sterile platinum loop was used to inoculate CLED agar. Plates were incubated aerobically at 37°C for 24 hours. Colonies were counted, and bacterial load was estimated by multiplying the count by 100. A significant bacteriuria was defined as $\geq 10,000$ CFU/ml.

Macroscopic Examination:

Turbid urine suggests pyuria, while red-colored urine indicates hematuria.

Microscopic Examination:

Microscopy detects pus cells, red blood cells, casts, bacteria, and yeast. ≥ 7 pus cells per high-power field in uncentrifuged urine indicates pyuria. Microorganisms were identified using standard biochemical tests, classified as pathogens, and antimicrobial susceptibility testing (AST) was performed according to CLSI guidelines

Oxidase Test: Detects cytochrome oxidase; dark purple within 5–10 sec=positive.

Catalase Test: Detects catalase enzyme; effervescence with H_2O_2 = positive.

Hanging Drop: Observes motility using peptone water and cover slip method.

Indole Test: Detects tryptophanase; red ring after Kovac's reagent = positive.

Urease Test: Detects urease; pink color = positive.

Citrate Test: Utilization of citrate as sole carbon source; blue=positive.

Mannitol Motility Test: Yellow = positive fermentation.

Triple Sugar Iron (TSI) Test: Determines fermentation of glucose, lactose, sucrose, H_2S production.

Methyl Red Test: Detects stable acid production from glucose; red=positive.

Voges-Proskauer Test: Detects acetoin production; pink/red=positive.

Hugh-Leifson Oxidation-Fermentation: Differentiates oxidative vs fermentative metabolism.

Decarboxylation (Lysine, Arginine, Ornithine): Blue/purple=positive.

Nitrate Reduction Test: Red color indicates nitrate reduced to nitrite.

Sugar Fermentation Test: Acid production (pink/red) indicates positive fermentation; gas may be produced in Durham tube.

Result:

A total of 50 urine samples from Diabetic patient were sent for microscopic examination and culture.

In 50 cases the urine culture was positive in 13 sample, giving an incidence of 26% in this study.

Table no-1 Showing prevalence of UTI

Total number of urinary Samples from diabetic patient	Patients with UTI in diabetic	Percentage
50	8	16%

Out of 50 urinary samples from diabetic patients, 8 cases (16%) were found to have UTI. This indicates that a relatively small proportion of diabetic patients in the sample were affected by urinary tract infections.

Graph no-1 Showing prevalence of UTI

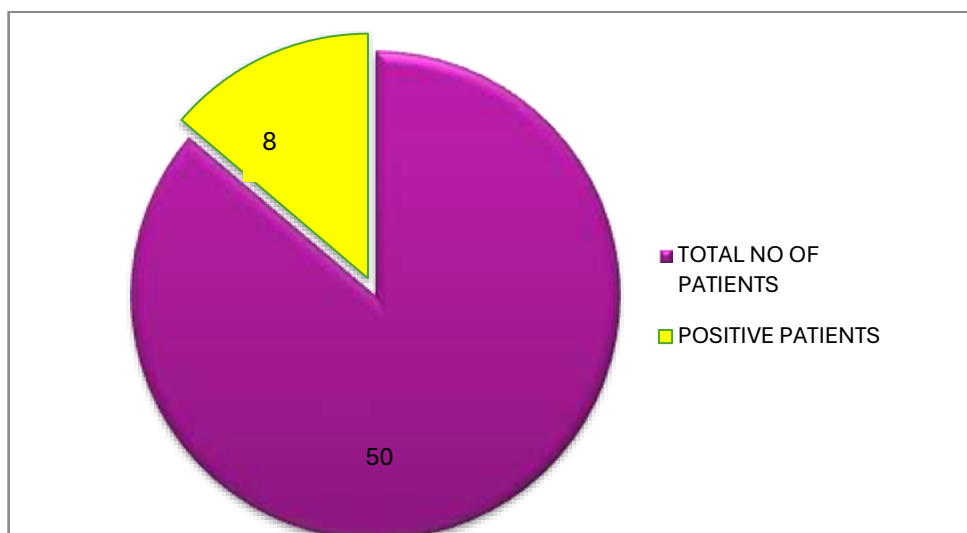


Table No 2- Distribution of 50 patients according to age groups

AGE groups	No.of cases	Percentage
30-45	11	22%
46-60	28	56%
61-75	11	22%

Graph No-2 Distribution of 50 patients according to age groups

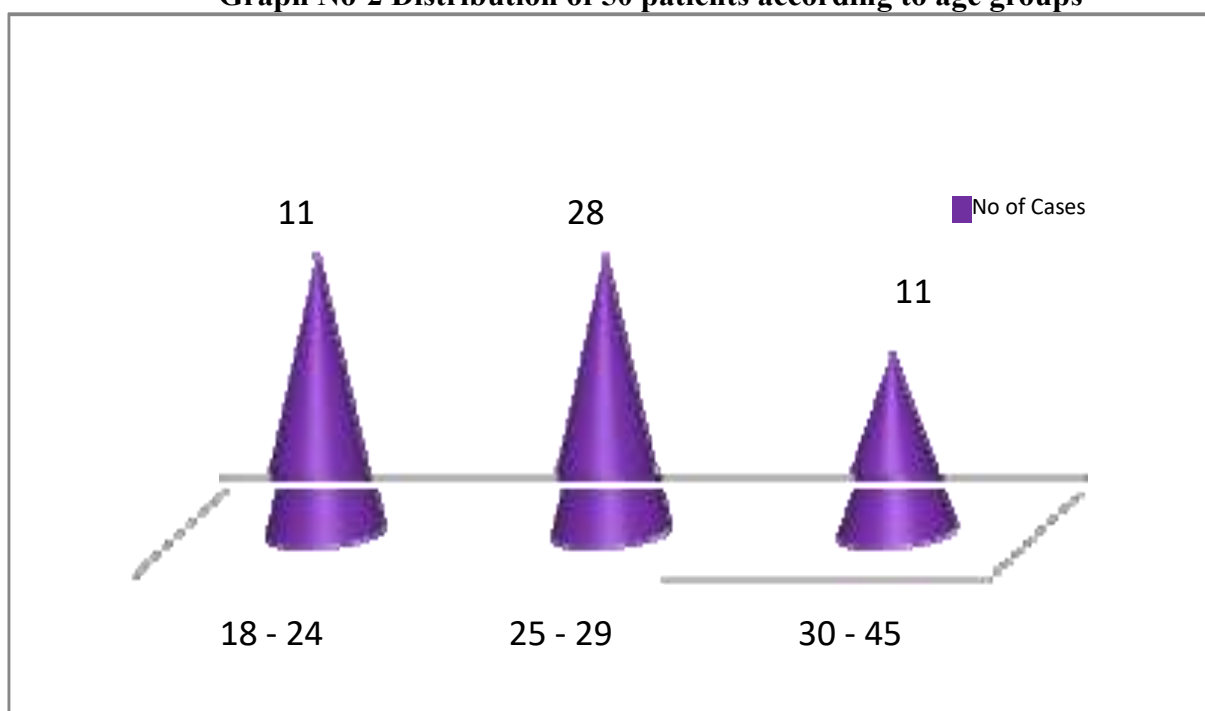


Table No-3 Showing distribution of 50 patients according to type of urine

Type of urine	No.of cases	Percentage

Clear	3	6%
Slight Turbid	12	24%
Turbid	35	70%

Graph No-3 Distribution of 50 patients according to type of urine

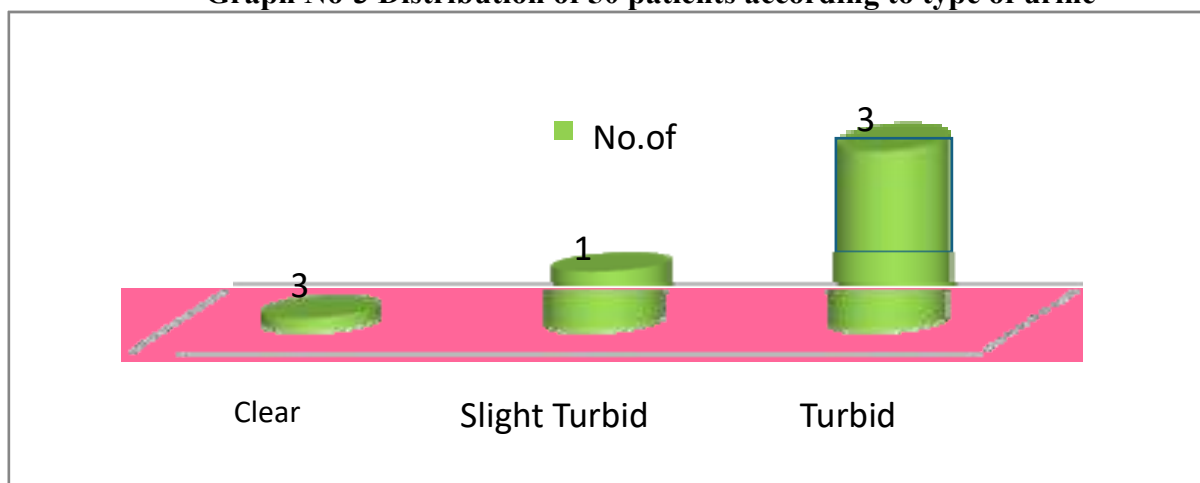


Table no4-Prevalance of UTI among diabetic patient

Investigated population	Symptomatic UTI		Asymptomatic UTI		Total	
	n	%	n	%	n	%
Diabetic patients (50)	5	10	3	6	8	16

Table no.5 Demographic Profile of diabetic patients

S.no	No.of cases	Place
1	12	Kalyanpur
2	11	Rawatpur
3	9	Bithoor
4	18	Mandhana

Age groups	No.of isolated organism	Percentage
30-45	3	38%
46-60	3	38%
61-75	2	25%

Mandhana has the highest number of cases (18), indicating it is the most affected area. Kalyanpur (12) and Rawatpur (11) show moderate numbers, while Bithoor has the lowest number of cases (9), suggesting comparatively lesser impact.

Table no -6 Age wise distribution of positive cases with UTI in pregnancy

Table No.7 Distribution Of gram positive and gram-negative Organism Isolated

Organism	No.	Percentage (%)
Gram Negative Bacilli (GNB)	6	12%
Gram Positive cocci(GPC)	2	4%

Out of the 8 isolates obtained, gram negative bacteria had a higher frequency of occurrence than gram positive bacteria

Table no-8 Distribution of percentage of isolated gram positive and gram negative organisms in 50 patients

Organism	No.of organism isolated	Total No.of sample	Percentage
E.coli	4	50	8%
KlebsiellaPneumonia	1	50	2%
Klebsiellaoxytoca	1	50	2%
Staphylococcus aureus	1	50	2%
Staphylococcus lugdinensis	1	50	2%

Graph no-8 Distribution of percentage of isolated gram-positive organisms in 50 patients.

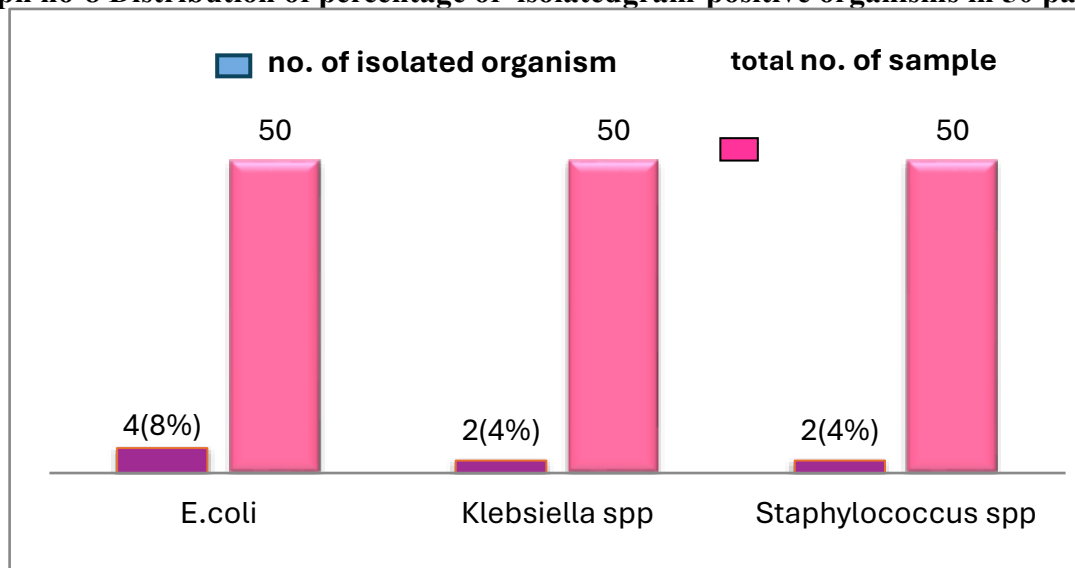


Table No.9 Profile Of Isolated Culture Positive Uropathogen

Organism	Number	Percentage(%)
Gram Negative Bacilli	6	12%
Escherichia coli	4	8%
Klebsiellaoxytoca	01	2%
Klebsiella pneumoniae	01	2%
Gram Positive Cocci	02	4%
Staphylococcus aureus	01	2%
Staphylococcus lugdinensis	01	2%

Out of 8 positive samples 6 showed gram-negative bacilli Among them the most common isolate was *Escherichia coli* (8%), followed by *Klebsiella oxytoca* (2%), *Klebsiella pneumoniae* (2%). 2 samples showed growth of Gram-positive cocci out of which 1(2%) were *Staphylococcus aureus* followed by 1(2%) isolates of *Staphylococcus lugdinensis*.

Graph no-9 Profile of isolated culture positive uropathogen

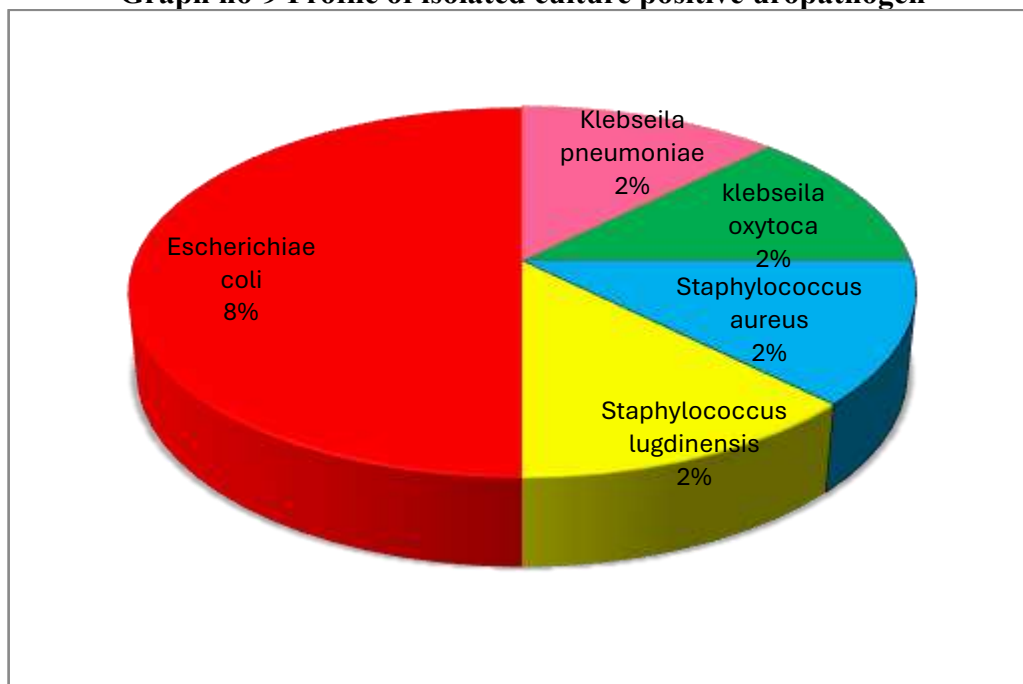


Table No.10 Antibiotic Susceptibility Pattern of Gram-Negative Isolates

Antimicrobial drug	<i>Escherichia coli</i>	<i>Klebsiella oxytoca</i>	<i>Klebsiella Pneumonia</i>
Amikacin	3(75%)	1(100%)	1(100%)
Ceftriaxone	4(100%)	0	0
Colistin	0	0	0
Gentamycin	4(100%)	1(100%)	1(100%)
Imepenem	4(100%)	0	0
Levofloxacin	0	1(100%)	1(00%)
Meropenem	4(100%)	1(2%)	1(00%)
Nitrofurantoin	3(75%)	0	0
Norfloxacin	0	1(100%)	1(100%)
Ofloxacin	0	1(100%)	1(100%)
Tigecycline	4(100%)	1(100%)	1(100%)

In case of *E.Coli*, Amikacin, Gentamycin, Nitrofurantoin, Tigecycline, Imepenem, Meropenem, Ceftriaxone showed maximum sensitivity, 100% followed by Norfloxacin, Ofloxacin, Colistin & Levofloxacin.

Klebsiella oxytoca, Amikacin, Gentamycin, Tigecycline, Meropenem, Norfloxacin, Ofloxacin, Levofloxacin. showed maximum sensitivity, 100% followed by Nitrofurantoin, Imepenem, Ceftriaxone & Colistin.

In case of Klebsiella pneumonia again (100%) sensitivity was seen to Amikacin, Gentamycin, Tigecycline, Meropenem, Norfloxacin, Ofloxacin, Levofloxacin, followed by Nitrofurantoin, Imepenem, Ceftriaxone & Colistin.

Graph No.10 Antibiotic Susceptibility Pattern for Gram Negative Bacteria

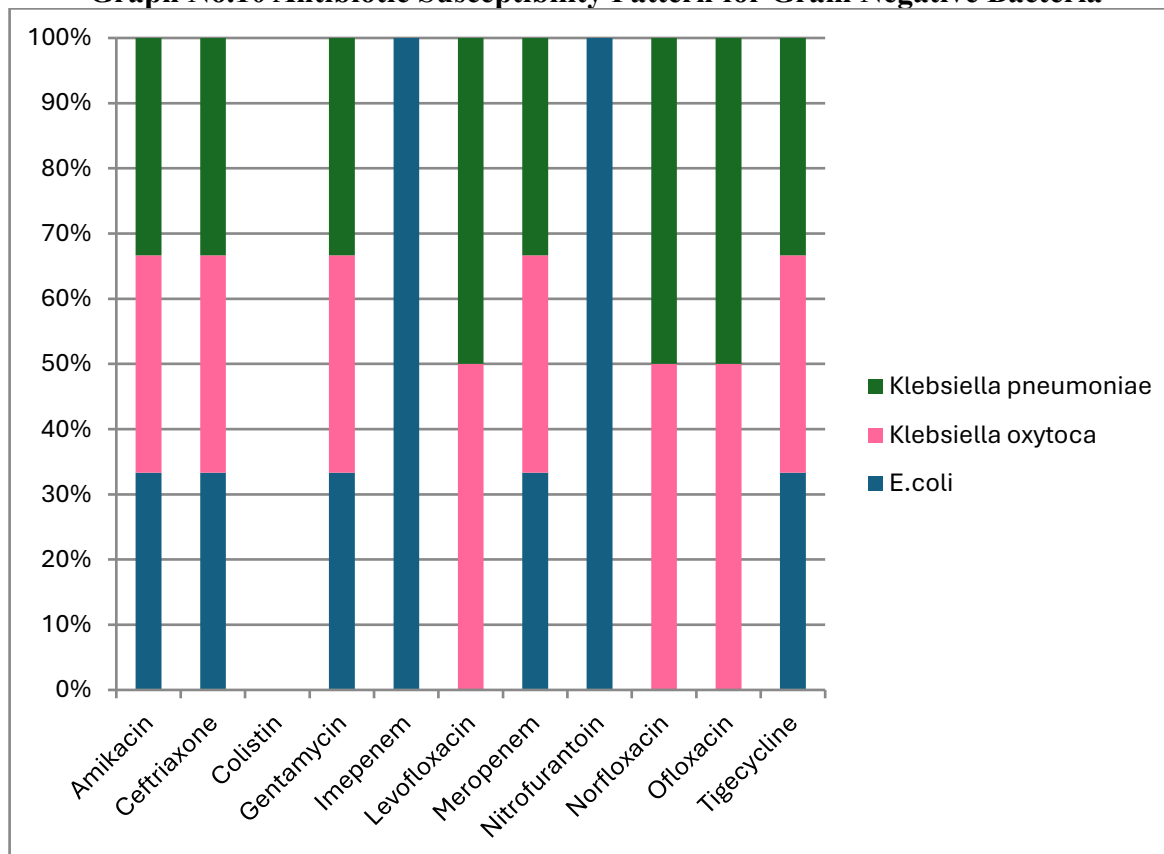


Table No.11 Antibiotic Susceptibility Pattern Of Gram Positive Isolates.

Antimicrobial drug	Staphylococcus aureus	Staphylococcus lugdunensis
Amikacin	1(100%)	1(100%)
Cefotaxime	1(100%)	1(100%)
Erythromycin	0(0%)	0(0%)
Gentamycin	1(100%)	1(100%)
Linezolid	1(100%)	1(100%)
Oxacillin	1(100%)	1(100%)
Penicillin	0(0%)	0(0%)
Tetracycline	1(100%)	1(100%)
Teicoplanin	1(100%)	1(100%)
Vancomycin	1(100%)	1(100%)
Azithromycin	1(100%)	1(100%)

In case of Staphylococcus aureus, Amikacin, Gentamycin, Nitrofurantoin, Tetracycline, Teicoplanin, Linezolid, oxacillin, Azithromycin and Vancomycin, showed 100% sensitivity followed by Penicillin, Erythromycin and Norfloxacin.

In case of *Staphylococcus lugdinensis*, Amikacin, Gentamycin, Nitrofurantoin, Tetracycline, Teicoplanin, Linezolid, oxacilin, Azithromycin and Vancomycin, showed 100% sensitivity followed by Penicillin, Erythromycin and Norfloxacin

Graph No.11 Antibiotic Susceptibility Pattern of Gram-Positive Isolates

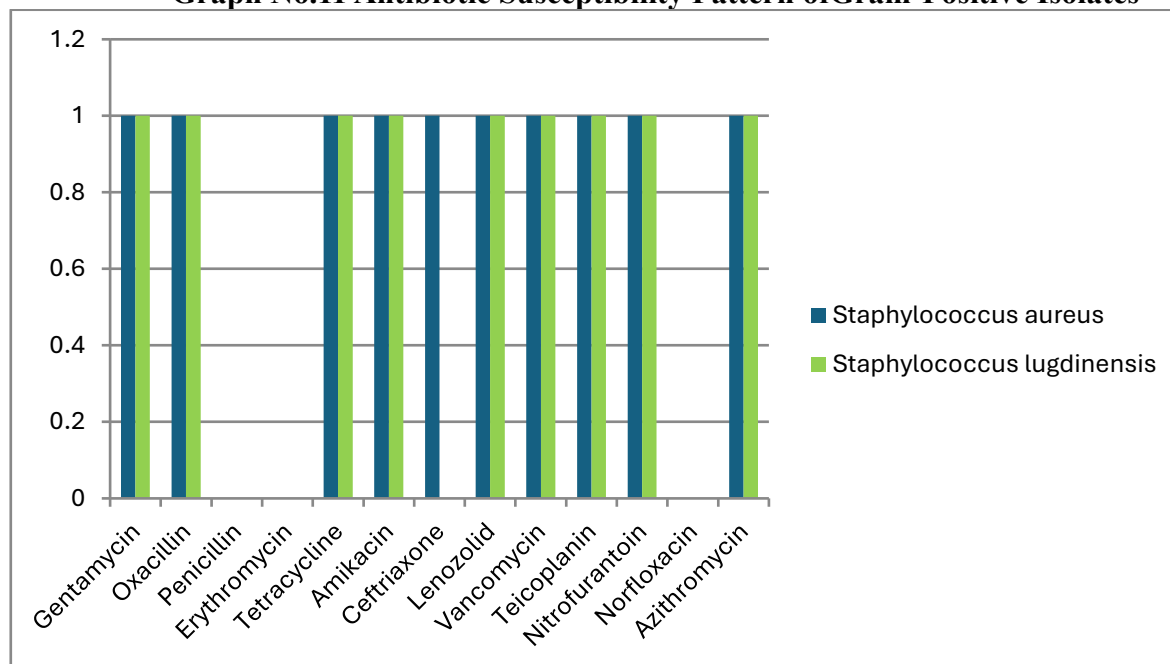


Table no.12 Relation of duration of pregnancy and bacteriuria

Trimester	Total no. of screened	Cases with bacteriuria	Percentage
		Number	%
First	12	1	8.3
Second	15	2	13.3
Third	23	5	21.7
Total	50	8	16

Graph no.12 Relation of duration trimester of pregnancy and bacteriuria

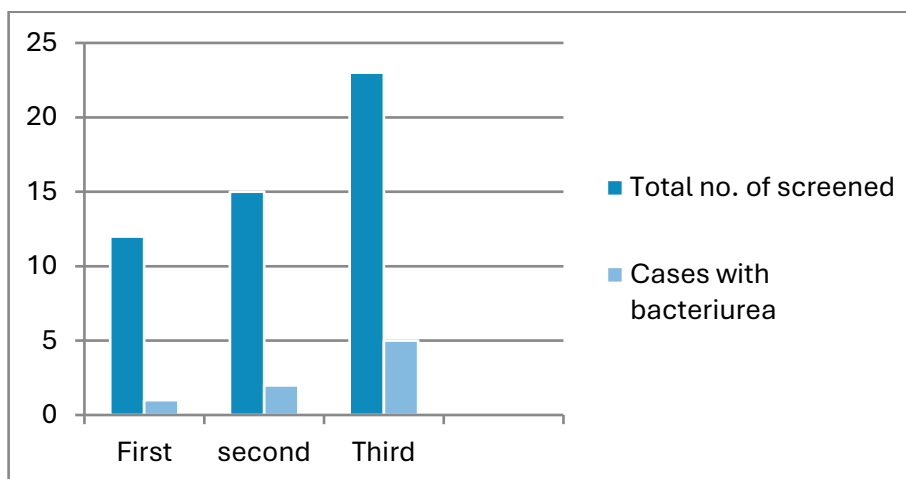
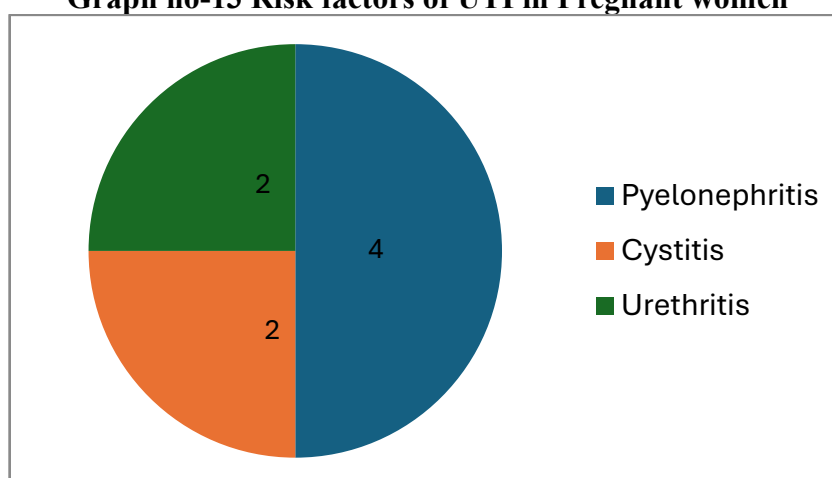


Table no-13 Risk factors of UTI in Pregnant women

S.no	Disease	No.of cases
1	Pyelonephritis	4
2	Cystitis	2
3	Urethritis	2

Graph no-13 Risk factors of UTI in Pregnant women



Discussion:

The present study shows that UTIs are relatively common among diabetic patients, with a prevalence of 16%. The highest incidence was observed in the 46–60 years age group. Gram-negative organisms were predominant, with *Escherichia coli* as the leading pathogen, which is consistent with other studies. The presence of *Klebsiella* species and Gram-positive cocci like *Staphylococcus aureus* further indicates a diverse microbial profile. Most isolates showed good sensitivity to aminoglycosides and carbapenems, while some resistance to commonly used antibiotics was noted. Factors such as poor glycemic control and urinary stasis may contribute to increased susceptibility.

Conclusion:

UTIs in diabetic patients are mainly caused by Gram-negative bacteria, particularly *Escherichia coli*.

Regular screening, early diagnosis, and appropriate antibiotic selection based on sensitivity patterns are crucial. Proper management of diabetes and awareness of risk factors can help reduce the incidence and complications of UTIs.

Conflict of Interest:

The authors declare that there is no conflict of interest regarding the publication of this study.

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