



Prevalence of UTI among Reproductive age of females in Gurugram, Haryana

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Abstract: Urinary tract infections are common now days and seen in both community and healthcare people. Uropathogens develop specific characteristics in order to colonize and persists in urinary tract. As a result many microorganisms seen in positive urine culture who have UTI like *E.coli*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Enterococcus faecium* etc. Antibiotic Resistance plays an important role in treating infections like UTI because due to AMR millions of deaths occur per year. If antibiotics lose their effectiveness, then it is unable to treat infections and control these public health threats.

Key Words: Urinary tract infection, MALDI TOF, *Escherichia coli* (*E. coli*), Antibiotic Sensitivity (AST).

1. INTRODUCTION :

Urinary tract infection (UTI) is the most common bacterial infection worldwide. In UTI *E.coli* infection results life threatening disease in comparison to other bacterial commensalism in gut. In recent times the understanding of host pathogen interaction and activation of the vulnerable response in urinary tract has increased vastly. Females are at higher risk of urinary tract infection.^[1] Short urethra in females as compared to urethra in males is a cause of frequent urinary tract infection in females, the short urethra provides easy entry of organism into urinary tract.^[2-3] Although not only in women, UTI is also found in men, older adults and children. The urinary tract is comprised of kidneys, ureters, bladder and urethra. Most infections involve the lower urinary tract-the bladder and the urethra. The urinary tract consists of the upper and lower urinary tract. UTI infection can affect the kidneys, bladder and urethra. The kidneys and ureters make up upper urinary tract while urethra and bladder forms lower urinary tract system.^[4]

URINARY TRACT INFECTION (UTI)

Urinary infection is defined as bacteriuria, the multiplication of bacteria in urine within the renal tract, with a concentration $>10^5$ organism/ml is regarded as significant bacteriuria. Urinary tract infection is a condition in which bacteria invade and grow in urinary tract (kidneys, bladders, ureters, and urethra).^[5]

URINARY TRACT SYSTEM

Urinary tract makes and store the urine until it's evacuated. The urinary tract is divided into two major divisions: upper, which include (kidney, renal pelvis and ureters) and lower, which include (urinary bladder and urethra) (Koneman et al, 1992).

KIDNEY

Two kidneys function to excrete most of waste products of metabolism, which leave the kidneys as urine. They lie behind the peritoneum on the posterior abdominal wall on either side of vertebral column, the right kidney lie slightly lower than the left one and neuron is the functional unite (Snell, 1995). The kidneys measure about 4 ½ inches long, 2 ½ inches wide, 1 ½ thick (Koneman et al, 1992).

URETERS

The two ureters are muscular tubes that extend from kidney to the posterior surface of the urinary bladder, the urine is propelled along the ureter by peristaltic contractions of muscle coat, each ureter measure about 10 inch in long, ureters have three constrictions along it's course: where the renal pelvis (funnel-shaped) joins the ureter, where it is kinked as it crosses the pelvic brim, and where it pierces the bladder (Snell, 2004).



URINARY BLADDER

Urinary bladder is immediately directly behind the pubic bone within the pelvis, it's receptacle for the storage of the urine, in adult maximum capacity of about 500ml, it's strong muscle and it's shape is vary according the amount of urine, empty bladder is pyramidal. Having apex, base, neck and two inferolateral surface (Snell, 2004).

URETHRA

Urethra is muscular tube for the passage of urine in both sex and semen in male. Extend from the bladder neck to the tip of penis in the male, and the area between the vagina and pubic bone in female (Qurashi and Taher, 1998). In female urethra is about 1.5 inch; in male is about 8 inch (Snell, 2004).

About 40% to 60% women suffer with at least one episode of UTI in their lifetime.

Basically urine does not contain any type of bacteria or germs.it is the waste product of kidneys ,the water is removed from blood in form of urine.Bacteria entered in urinary system from outside and cause infection^[6] Diabetic patients and individuals with weak immune become infected very rapidly. UTI is a term used for an infection in urinary tract in this infection bacteria goes in bladder and cause infection, not all infection cause damage to bladder but they cause infection in kidneys which is more dangerous than UTI. ^{[7][8]}

Although the incidence of bacteruria in pregnant women is similar to that in non-pregnant women , the incidence of acute pylenephritis in pregnant women with bacteriuria is significantly increased.^{[9][10]} Urinary tract infections in pregnancy are classified as either **asymptomatic** or **symptomatic**. Asymptomatic bacteriuria is defined as the presence of significant bacteriuria without the symptoms of an acute urinary tract infection.

Symptomatic urinary tract infections are divided into lower tract(acute cystitis) or upper tract (acute pyelonephritis) infections. Screening for and treatment of asymptomatic bacteriuria in pregnancy has become a standard of obstetric care and most antenatal guidelines include routine screening for asymptomatic bacteriuria.^[11] *E.coli* is the most common aetiologic agent in both infections.

TYPES OF UTIs

Cystitis (bladder)- you might feel like you need to pee a lot or you need or it hurt when you pee.

Pyelonephritis (Kidneys)-causes fever, chills, vomiting, pain in back side.

Urethritis- can cause discharge and burning when you pee.^[12]

RISK FACTORS OF UTI

A number of risk factors for and factors associated with UTI have been described . Common cause that we found can cause UTI are as :

- ❖ Being sexually active
- ❖ Having difficulty fully emptying the bladder
- ❖ Having diabetes
- ❖ Blockage in urinary tract
- ❖ Poor hygiene ^[12]

A study by Hu et al which included women aged between 55-75 years, found the same risk factors for UTI among younger ,postmenopausal women as among older, debilitated women. ^[13]

The symptoms of Urinary infections and UTI are similar and often occur simultaneously which may make it difficult to separate them. ^[14]

Symptoms:-

- Strong persistent to urinate- a frequent need to urinate ,without passing much urine. This is because of bladder get so irritated and you may feel like to urinate.

Other symptoms include

- Pressure in lower pelvis
- Pain in abdomen ,kidney infection cause upper back pain
- Painful in urinating
- Abnormal urine color
- Pain during sex
- Lower back pain



- Fatigue
- Fever
- Vomiting
- Mental changes

Lab diagnosis:-

Specimen collection- collect the sample by instructing patients to clean the area before collecting specimen. then the sample is send to laboratory.

Specimen processing- Urine culture is done on chromagar media with help of loop by semiquantitative method of streaking. Sterile the loop and take about 1 ul urine sample with the loop size 1.3mm and done streaking.

Then the plates are incubated for 24 hours to 48 hours. After 24 hour, we examine plates check the growth of microorganisms and colony count.

Samples which have no growth or minor growth, those plates are reincubated for next 24 hour.

Management of Drugs

Classes of drugs :	
ANTIBIOTIC	FUNCTION
1.Fosfomycin	Inhibit step involving phosphoenolpyruvate synthetase.
2. Nitrofurantoin	Disrupt ribosomal RNA and DNA.
3.Meropenem	Inhibit bacterial wall synthesis
4.Trimethoprim/sulfamethoxazole	Inhibit folic acid synthesis

TABLE-1 ANTIBIOTICS USED TO TREAT UTI WITH THEIR FUNCTION.

FOSFOMYCIN: it is an antibiotic used to treat infections of the urinary tract. Fosfomycin is a bactericidal antibiotic that interferes with cell wall synthesis in both Gram-positive and Gram-negative bacteria by inhibiting the initial step involving phosphoenolpyruvate synthetase.^[15]

NITROFURANTOIN: Nitrofurantoin is activated inside bacteria by reduction via the flavoprotein nitrofurantoin reductase to unstable metabolites, which disrupt ribosomal RNA, DNA and other intracellular components. It is bactericidal, especially to bacteria present in acid urine.^[16]

MEROPENEM: Used to treat serious urinary tract infections, that are caused by bacteria. Meropenem is in class of medications called carbapenem antibiotics.^[17]

TRIMETHOPRIM/SULFAMETHOXAZOLE: Sulfamethoxazole inhibits the synthesis of dihydrofolic acid. Trimethoprim inhibits thymidine and DNA synthesis. These two agents act synergistically in inhibiting folic acid synthesis.^[18]

RATIONALE FOR THIS THESIS

UTI is common bacterial infections in women in all ages but the prevalence increases with increased age. Well known associated factors and risk factors for UTI ,such as urinary incontinence , sexual activity, diabetes have been described in previous research . nevertheless there could be other risk factors among the very old that are important but the research has not been focused on this age group . it is important to be aware that old women might present more atypical symptoms of UTI which may complicate the detection of UTI and delay treatment .it is important to generate increased knowledge and a deeper understanding of UTI and its associated factors and how health and wellbeing is affected in relation to UTI for the purpose of promoting a good old age.^[13]

2. REVIEW OF LITERATURE :

Urinary tract infections have been described since ancient times with first documented description in the EBERS PAPYRUS to c.1550 BC^[19]

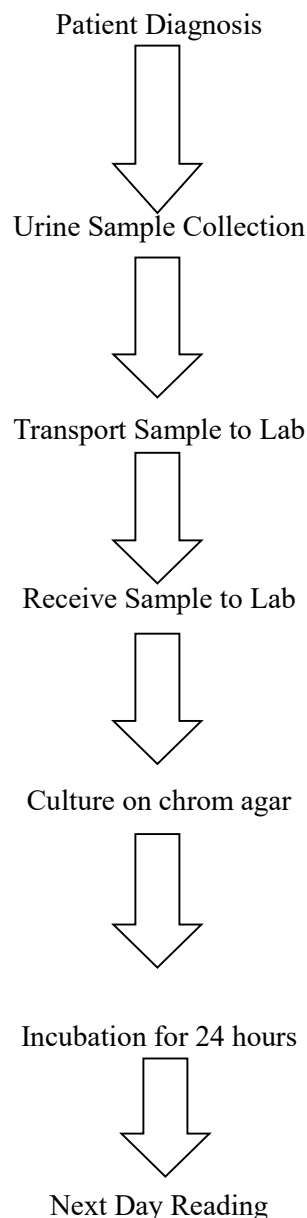


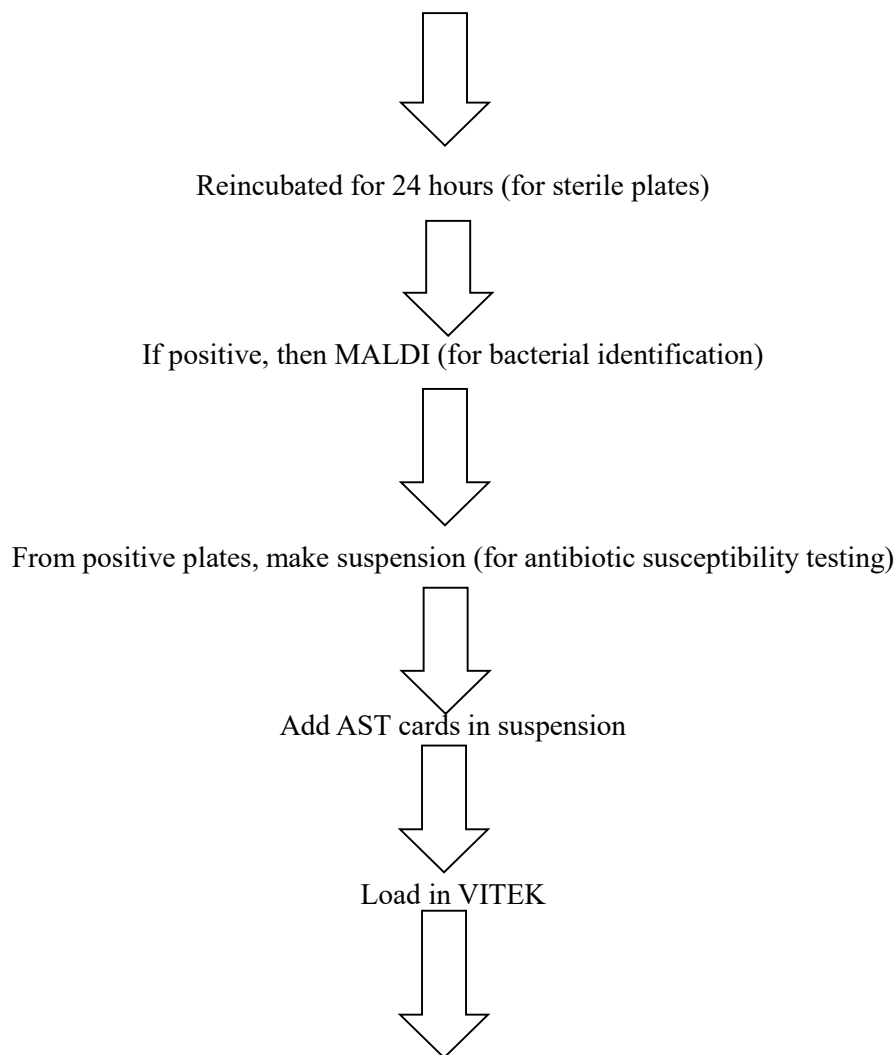
About 150 million people suffered with UTI in a given year and upto 10% of women have this infection in a year and reinfection is common in females mostly and at some point of time every half of women are being diagnosed with UTI. The bacteria that causes UTI enter through the bladder via the urethra but infection may also be secondary from the blood and lymph.^[20] *Escherichia coli* is the single most common microorganism causing UTI. *Klebsiella* and *Proteus spp.* are mostly associated in individuals with stone disease (calculi).

Large number of bacteria live in the area around the vagina and rectum. Women who have gone through menopause have a change in the pH of the vagina and lose the protection that estrogen provides; therefore, they have lower chances of getting UTI. A person who has a low immune system and has any diabetic disease has a higher risk than a normal person.^[21] Pregnant women have a higher rate of getting UTI because during pregnancy the uterus expands due to the growing foetus. This expansion puts pressure on the bladder and ureters and hence leads to an increase in the prevalence of UTI in pregnant females.^[22]

Use of a urinary catheter is also a cause of infection. In catheterized urine, a latex, polyurethane, or silicone tube known as a urinary catheter is inserted into the bladder through the urethra. It allows urine to pass easily, especially for patients having difficulty in passing urine or having bladder problems. It is painful because inserting either type of catheter can be uncomfortable, so an anaesthetic gel may be used on the area to reduce pain. Catheters usually stay in place between 2-12 weeks. Approx 75% UTI are associated with a urinary catheter and 15-25% of hospitalized patients have urinary catheters during their stay in hospital.^[23]

DIAGNOSIS-





For positive samples, identification by MALDI-TOF is performed. The proteomic method ‘**MATRIX ASSISTED LASER DESORPTION IONIZATION**’(MALDI) used for identification of microorganisms. It can identify different microorganisms accurately in short period of time.

PRINCIPLE-

The MALDI TOF process is a two-phase procedure;

- Ionization Phase
- Time of Flight Phase

Ionization Phase: Initially, the samples are fixed in a crystalline matrix on a target plate and are bombarded by a laser. The sample molecules vaporize into the vacuum while being ionized at the same time. High voltage is then applied to accelerate the charged particles.

The second step is the time-of-flight mass spectrometry phase.

- **In the linear mode**, particles will impinge upon the linear detector within a few nanoseconds after ionization. Higher mass molecules will arrive later than lighter ones. Flight time measurement makes it possible to determine molecule masses directly. Each peak in the spectrum corresponds to the specific mass of the particle along the time axis, starting with the ionization moment.
- **In the reflector mode**, the particles are diverted so that they fly towards a second detector. In addition to extending the flight distance, the reflector also focuses on the masses. The combination of these two effects makes for higher resolution than in the linear mode.



The net result is a generation of a mass spectrum that is compared with those of well-characterized organisms available in the reference library database to identify the isolate.

PROCEDURE-

- Pick a bacterial colony and smear it onto a target plate.
- Add 1-2 μ l of a matrix consisting α -Cyano-4-hydroxycinnamic acid (CHCA) dissolved in acetonitrile (50%) and 2.5% trifluoroacetic acid onto it and dry it on the target plate (at room air).
- Place the target plate into the plating chamber of the mass spectrometer, close it and perform the analysis.

Target plate is made of polished or ground stainless steel and has spots for several different samples to be applied. Both ready-to-use disposable and reusable MALDI target plates are available.

As it is, time reduction technology there is also an important tool in analysis of antibiotic susceptibility testing. MALDI will play a great role in future in laboratory. The antibiotic test and detection of drug markers are more reliable in MALDI.^[24]

Most common microorganism found is *E.coli*, *Klebsiella pneumonia* and *Enterococcus. Klebsiella* UTIs occur when the bacteria enters the urinary tract. It is mostly spread through person to person contact. Fosfomycin and Nitrofurantoin are effective antibiotic against *Klebseilla*.

Escherichia coli (E. coli)

E. coli is belong to the large group of gram negative rods referred to as enterobacteria, they are cause primary and opportunistic infections in humans belong mainly to lactose fermenting, often referred to as coliforms, they are aerobes and facultative anaerobes, non sporing and motile (Cheesbrough,2009).

E. coli is the cause of 60-90% of urinary tract infection. Certain serotypes of *E. coli* are particularly common in urinary infection (e.g. 02, 04, 06, 07, 018, 075); this is probably because they are often present in the colon, rather than because of inherently high pathogenicity for the urinary tract.

Some strains are reputed to more invasive than other. Factor associated with virulence include: the possession of K (capsular) antigen, which inhibit phagocytosis and bactericidal effect of normal human serum, the ability to adhere to uro-epithelium due to specialize fimbriae (Sleigh and Timbury, 1998).^[25]

Klebsiella species

Gram-negative and non- motile usually capsulated rods cause UTIs in hospital patients. Antigenic analysis for capsular polysaccharide reveals that more than 80 serotype are recognized (Cheesbrough, 2009).

They grow well on ordinary media, with colonies which are often, but not always, large and mucoid (Sleigh and Timbury, 1998).^[26]

Pseudomonas aeruginosa

Gram-negative motile aerobic bacilli some strain are capsulated have very simple growth requirement and limited fermentation activity (Sleigh and Timbury, 1998).

Ps. aeruginosa being resistant to infections are often difficult to eradicate due to *Ps. aeruginosa* being resistant to many antimicrobials. Infection with *Ps. aeruginosa* usually following catheterization associated with chronic urinary disease (Cheesbrough, 2009).^[27]

3. Materials and Methods:-

Urine sample,

Reagents -

Yeast extract and peptone, chromogenic mix, agar (Titan Biotech Ltd.), CHCA (alpha-cyano-4-hydroxycinnamic acid) and FA (formic acid) (himedia).

Maldi target slide, Maldi-Tof machine.

TABLE -2: Component of chromagar

Components	Concentration (g/l)for 120ml
1. peptone & Yeast extract	17.0
2. Agar	15.0
3. Chromogenic mix	1.0



4. pH	7.0
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Methods-

Collection of specimens

Catheterized and Non-catheterized urine specimens were collected from patients in leak proof containers.

Culturing of specimens

The specimens were inoculated on plates of Chromagar media, by method of semiquantative streaking. Cultures were incubated at 35-37°C aerobically for overnight.

Identification and Antibiotic sensitivity Test

4. RESULT AND DISCUSSION :

Conducted this study over a period of 6 months in Medanta Hospital, Gurugram & included 100 female patient in reproductive age whose urine samples were collected and processed for identification and sensitivity .

4.1. Patients age group distribution-

Observed that female patient having UTI were more in age group 41-45years(34) followed by 31-35 years(21).

4.2. Growth-

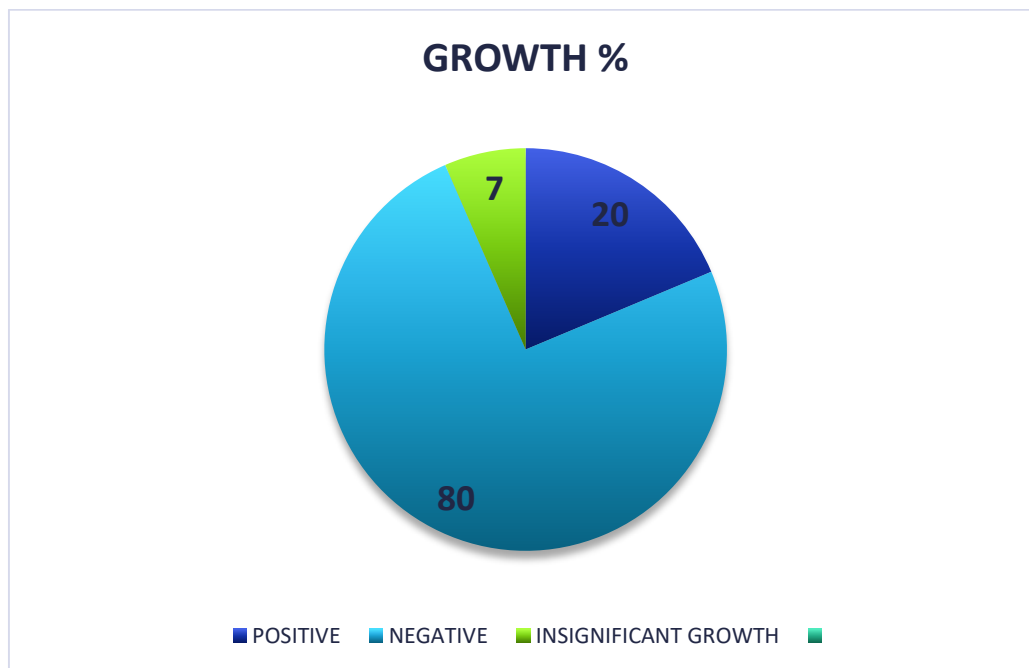


FIGURE 1- MICRO ORGANISMS WHICH HAVE POSITIVE, NEGATIVE AND INSIGNIFICANT GROWTH.

Out of 100 female patients we observed that 20% (20/100) of patient had significant UTI while remaining had no growth in urine culture.

The prevalence of UTI is 20% (20/100).

4.3.DISTRIBUTION OF MICROORGANISMS- [TABLE -3]

MICROORGANISM	NO.OF ISOLATES
<i>E.coli</i>	9
<i>Enterococcus faecium</i>	2
<i>Klebsiella pneumoniae</i>	2
<i>Proteus mirabilis</i>	1
<i>Enterococcus gallinarum</i>	1
<i>Enterococcus faecalis</i>	1
<i>Acinetobacter baumannii</i>	1



<i>Citrobacter koseri</i>	1
<i>Staphylococcus aureus</i>	1
<i>Streptococcus agalactiae</i>	1

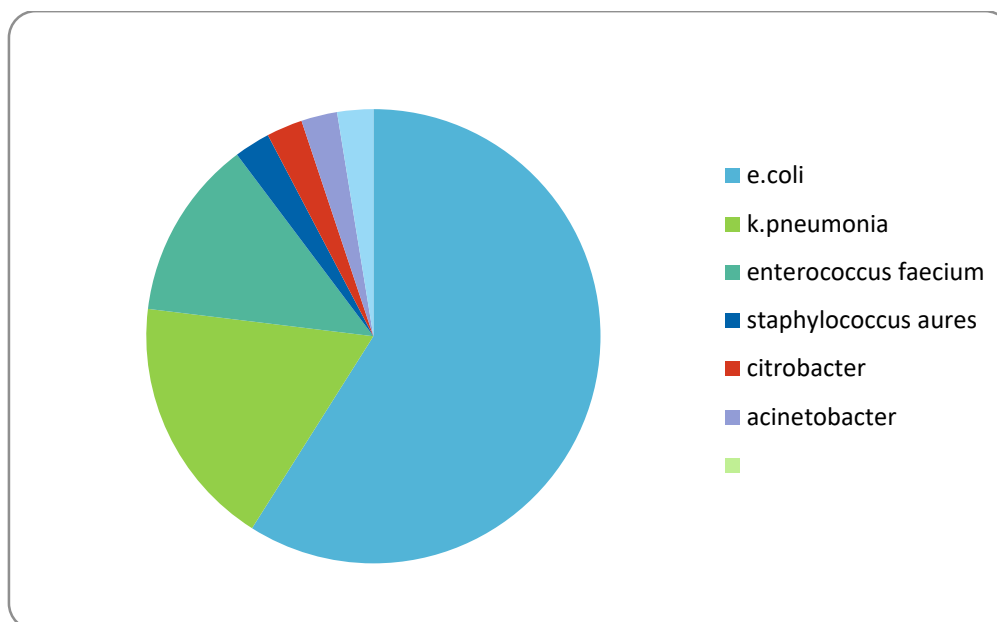


FIGURE 2 – DISTRIBUTION OF MICROORGANISMS SEEN ON URINE CULTURE.

The most common organism grown is *E. coli* (80%) and rest were *K.pneumoniae*, *E.faecium* & *faecalis*, *S.aureus*, *Citrobacter koseri*.

Our present study reveals the overall prevalence rate of UTI is 20%.

In our study we also determine the **Antibiotic Sensitivity** of the microbial organisms isolated from UTI. Most common used antibiotics for GNB is Nitrofurantoin, Fosfomycin and Ertapenem and most common used antibiotics for GPC is Nitrofurantoin, Vancomycin, Benzylpenicillin.

GNB Gram negative bacilli-

Now for 9 isolates of *E. coli*- Nitrofurantoin was 80% Sensitive and Intermediate to 10%, Fosfomycin was 100% sensitive and Ertapenem was Sensitive to 66%; Resistant to 33%.

For 2 isolates of *k.pneumonia* – Nitrofurantoin, Fosfomycin and Ertapenem was Resistant but Sensitive to Ceftriaxome.

For 1 isolate of *P.mirabilis*- Nitrofurantoin and Fosfomycin was Sensitive but Resistant to Ertapenem.

For 1 isolate of *Acine. baumannii*- Fosfomycin was Sensitive and Nitrofurantoin and Ertapenem was Resistant.

For 1 isolate of *Citro. koseri*- Nitrofurantoin, Fosfomycin and Ertapenem was Sensitive to all.

GPC Gram positive cocci-

Now for 2 isolates of *E. faecium*-Nitrofurantoin, Benzylpenicillin was Resistant but Sensitive to Vancomycin.

For 1 isolate of *Ent.faecalis* -Nitrofurantoin, Vancomycin and Benzylpenicillin was Sensitive to all.

For 1 isolate of *S.aureus*- Nitrofurantoin, Vancomycin was Sensitive and Benzylpenicillin was Resistant.

For 1 isolate of *S.agalactiae*- Nitrofurantoin, Vancomycin and Benzylpenicillin was Sensitive to all.

For 1 isolate of *E.gallanirum* - Nitrofurantoin, Benzylpenicillin was Resistant but Sensitive to Vancomycin.

AST- Gram negative bacilli

[TABLE 4]

Isolates	Nitrofurantoin	Fosfomycin	Ertapenem
Isolate 1 <i>E. coli</i>	S	S	S
Isolate 2 <i>E. coli</i>	S	S	S
Isolate 3 <i>E. coli</i>	S	S	S
Isolate 4 <i>E. coli</i>	S	S	-
Isolate 5 <i>E. coli</i>	S	S	S



Isolate 6 <i>E. coli</i>	I	S	R
Isolate 7 <i>E. coli</i>	S	S	-
Isolate 8 <i>E. coli</i>	S	S	S
Isolate 9 <i>E. coli</i>	S	S	S
Isolate 10 <i>K.pneumonia</i>	R	R	R
Isolate 11 <i>K.pneumonia</i>	S	R	R
Isolate 12 <i>P.mirabilis</i>	S	S	R
Isolate 13 <i>Acinetobacter baumannii</i>	R	S	R
Isolate 14 <i>Citrobacter koseri</i>	S	S	S

Gram positive cocci-

[TABLE- 5]

Isolates	Nitrofurantoin	Vancomycin	Benzylicillin
Isolate 1 <i>Ent.faecium</i>	R	S	R
Isolate 2 <i>Ent.faecium</i>	R	S	R
Isolate 3 <i>Ent.faecalis</i>	S	S	S
Isolate 4 <i>S.aureus</i>	S	S	R
Isolate 5 <i>S.aglactiae</i>	S	S	S
Isolate 6 <i>Ent.gallinarum</i>	R	S	R

5. DISCUSSION :

Prevalance, referred to as prevalence rate, is the proportion of persons in a population who have a particular disease at a specified point in time or over a specified period of time. Prevalance measured with proportions of persons with a particular disease or attribute on a particular date.

The patient taken for study are females with reproductive age as their mean age was 18-45. The majority of them live under similar environments, housing conditions water supply, and socioeconomic status. However the UTI is more common in females than in men due to short urethra in females.

Although the microorganism associated with UTI are different but the *E. coli* remains the most prevalent pathogen identify. Commonly used antibiotics to treat UTI found to be Fosfomycin, nitrofurantoin, cefolaxin, ceftriaxome, trimethoprim/sulfamethoxazole. most of the antibiotics found to be resistant against UTI.[30]

The study by Leydon et al revealed that some of the participants were ashamed for their UTI. They expressed that their UTI should be regarded as a result of their poor hygiene and this deterred them from speaking to others, including their general practitioner, about their problems.

UTI was diagnosed if the person had a documented symptomatic UTI with either short or long term ongoing treatment with antibiotic, or symptoms and laboratory tests that were judged to indicate the presence of UTI by responsible physicians.

The main objective of the present study was to isolate the common organisms and finding out prevalence of UTI. Hundred specimens were collected for patients, cultured and different standardized tools and methods for realization of the problem.

The study revealed that gram negative pathogens are commonly isolated from the female patients and *Escherichia coli* was predominant microorganisms recovered (9 out of 20 positive samples) agree with (Purawel et al,2011). *E. coli* is the common pathogen isolated, agree with (Tancheval et al, 2009) whom found that *E. coli* is common causative organism, then *k. pneumonia* (2%) *enterococcus* (4%).

Susceptibility test reported that activity of Nitrofurantoin is active, followed by Fosfomycin and ertapenem agree with (Hayami et al,2013).

Susceptibility test for *Klebsiella pneumoniae* shows that Ceftriaxome is highly active (100%) disagree with (Archana and harsh, 2011) followed with nitrofurantoin and ertapenem.

Susceptibility test for *Enterococcus* GPC Nitrofurantoin is highly active agree with (DMP De Oliveira) whom reported that nitrofurantoin is more reasonable.



Susceptibility test for *Staphylococcus aureus* shows that Nitrofurantoin and Vancomycin were highly sensitive followed by Benzylpenicillin.

Susceptibility test for *Proteus mirabilis* shows that nitrofurantoin and Fosfomycin are sensitive disagree with (Iwon and Stefanin, 2007), followed by Ertapenem disagree with (Iwon and Stefanin, 2007).

In this study 9% of the females with UTI suffered from *E.coli* infection, 4% *Enterococcus*, 2% *K. pneumoniae*. Iram et al's study shows a different result, 33.1% had *E.coli* infection, followed by 7.9% with *Klebsiella pneumoniae*, 2.2% *S.aureus* and 0.7% with *Proteus mirabilis*.

In this study, people with symptoms of UTI are at 23 times more at a risk of getting urine culture positive compared to people who do not have symptoms of UTI. There was no statistical significant association between religion, marital status. In a cohort study conducted by Hoton et al marital history was found to have a statistically significant association with incidence of UTI in one of the groups.^[31]

6. Conclusion :

UTI are the second most common bacterial infections. Women are the most infected subjects in the population. Development of resistance to antibiotics by the bacteria results in problems during the treatment and lead to relapse or recurrence. We have to take proper course of antibiotics to prevent from AMR if we have any disease either UTI or other.

- Out of 20 positive samples *E. coli* are the most frequent.
- Females with age 40-45 years are more infected than 20-40 years.
- Nitrofurantoin, Fosfomycin, Ertapenem for GNB and Nitrofurantoin, Vancomycin and Benzylpenicillin for GPC have good effect against causative agents and recommended as the first line of treatment.

REFERENCES:

1. Stamm WE, Norrby SR. Urinary tract infections: disease panorama and challenges. *J Infect Dis.* 2001;183 (Suppl 1):S1–S4. [[PubMed](#)] [[Google Scholar](#)] [[Ref list](#)]
2. Yamamoto S, Tsukamoto T, Terai A, Kurazono H, Takeda Y, Yoshida O. Genetic evidence supporting the fecal-perineal-urethral hypothesis in cystitis caused by *Escherichia coli*. *J Urol.* 1997;157(3):1127–1129. [[PubMed](#)] [[Google Scholar](#)] [[Ref list](#)].
3. Mitsumori K, Terai A, Yamamoto S, Yoshida O. Virulence characteristics and DNA fingerprints of *Escherichia coli* isolated from women with acute uncomplicated pyelonephritis. *J Urol.* 1997;158(6):2329–2332. [[PubMed](#)] [[Google Scholar](#)] [[Ref list](#)]
4. Delamaire M, Maugeudre D, Moreno M, Le Goff MC, Allanic H, Genetet B. Impaired leucocyte functions in diabetic patients. *Diabet Med.* 1997;14(1):29–34. [[PubMed](#)] [[Google Scholar](#)] [[Ref list](#)]
5. Valerius NH, Eff C, Hansen NE, et al. Neutrophil and lymphocyte function in patients with diabetes mellitus. *Acta Med Scand.* 1982;211(6):463–467. [[PubMed](#)] [[Google Scholar](#)] [[Ref list](#)]
6. Schnarr J, Smaill F. Asymptomatic bacteriuria and symptomatic urinary tract infection in pregnancy. *Eur J Clin Invest.* 2008;38(Suppl. 2):50–7. [[PubMed](#)] [[Google Scholar](#)] [[Ref list](#)]
7. Bolton M, Horvath DJ, Li B, et al. Intrauterine growth restriction is a direct consequence of localized maternal uropathogenic *Escherichia coli* cystitis. *Plos ONE.* 2012;7:1–9. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)] [[Ref list](#)]
8. Ditkoff EL, Theofanides M, Aisen CM, Kowalik CG, Cohn JA, Sui W, Rutman M, Adam RA, Dmochowski RR, Cooper KL. Assessment of practices in screening and treating women with bacteriuria. *Can J Urol.* 2018 Oct;25(5):9486-9496. [[PubMed](#)] [[Reference list](#)]
9. Griebing TL. Urologic diseases in America project: trends in resource use for urinary tract infections in women. *J Urol.* 2005;173:1281-1287.
10. Andersen-Nissen, E., T. R. Hawn, et al. (2007). "Cutting edge: Tlr5-/- mice are more susceptible to *Escherichia coli* urinary tract infection." *The Journal of immunology* 178(8): 4717-4720.
11. Stamm WE, Norrby SR. Urinary tract infections: disease panorama and challenges. *J Infect Dis.* 2001;183 (Suppl 1):S1–S4. [[PubMed](#)] [[Google Scholar](#)].
12. Stapleton A. Prevention of recurrent urinary-tract infections in women. *Lancet.* 1999;353:7–8. [[PubMed](#)] [[Google Scholar](#)]



13. Jackson SL, Boyko IJ, Scholes D, Abraham L, Gupta K, Fihn SD. Predictors of urinary tract infection after menopause. *Am J Med.* 2004;117:903. [[PubMed](#)] [[Google Scholar](#)]
14. Lam TB, Omar MI, Fisher E, Gillies K, MacLennan S (September 2014). "Types of indwelling urethral catheters for short-term catheterisation in hospitalised adults". *Cochrane Database Syst Rev* (9): CD004013
15. Johns Hopkins Health Library: "Escherichia coli O157:H7," "Escherichia coli." National Institute of Allergy and Infectious Disease: "E. coli."
16. Carpenter J L. *Klebsiella* pulmonary infections: occurrence at one medical center and review. *Rev Infect Dis.* 1990;12:672–682. [[PubMed](#)] [[Google Scholar](#)]
17. Aloush, V., S. Navon-Venezia, Y. Seigman-Igra, S. Cabili, and Y. Carmeli. 2006. Multidrug-resistant *Pseudomonas aeruginosa*: risk factors and clinical impact. *Antimicrob. Agents Chemother.* 50:43-48. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)]
18. Bryce Ashley, et al. "Global Prevalence Of Antibiotic Resistance In Paediatric Urinary Tract Infections Caused By Escherichia Coli And Association With Routine Use Of Antibiotics In Primary Care: Systematic Review And Meta-Analysis" *BMJ.* 2016:i939. [[PMC free article](#)] [[PubMed](#)] [[Google Scholar](#)]
19. Neu HC. Optimal characteristics of agents to treat uncomplicated urinary tract infections. *Infection* 1992;20(suppl 4): S266-S271. [[PubMed](#)] [[Google Scholar](#)]

Web References:

- <https://www.webmd.com/women/guide/your-guide-urinary-tract-infections>
- <https://microbiologybook.org>
- <https://www.urologyhealth.org> >
- <https://www.mayoclinic.org/diseases-conditions/urinary-tract-infection/symptoms-causes/syc-20353447>
- <https://my.clevelandclinic.org/health/diseases/913...>
- <http://antimicrobe.org/new/drugpopup/TMP-SMX.htm>
- <https://www.nimh.nih.gov/health/statistics/what-is-prevalence>
- <http://umu.diva-portal.org/>