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Diagnosis Management & Treatment of Urinary Tract Infections: A Recent Perspective

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Abstract

The usual bacterial disease infecting mankind is urinary tract infection (UTI). Any illness that affects ureters, bladder, kidneys, or urethra is referred to UTI, where urinary bladder and urethra are highly affected. The women have been reported to be more prone to UTI, can cause discomfort and annoyance. If UTI spreads to kidneys, it may cause severe damage and dangerous repercussions. A UTI could be controlled by using different antibiotics. However, etiologists have recommended certain precautionary measures, which lower the risk of contracting a UTI in the first place. A significant component of UTI treatment consists of bactericidal antibiotics. However, self-medication and overdoses of these antibiotics given for prolonged periods may cause hamper patient's immune system and causing multiple drug resistance in the pathogenic microbes. The UTI has been reported to be caused by bacteria, fungi and some viruses (as opportunistic pathogen). The incidence of UTI prevails to higher extent in elderly women. The present study has been done extensively to study use of newer approaches in combating UTI, which may prove useful in understanding, preventing, managing, and curing this disease more effectively.

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Introduction

Around 150 million people globally suffer from UTIs, or urinary tract infections, which be amid the most common bacterial illnesses. In 2007 in United State, there will be an estimated 10.5 million doctor visits for UTI symptoms. In elderly men, women, and infant boys UTIs are a major source of morbidity. Prolonged relapses, sepsis-associated pyelonephritis, kidney injury in young infants, preterm birth, and consequences from repeated use of antibiotics, such as high-level antibiotic resistance and Clostridium difficile colitis, are among the grave aftereffects. There are two categories for UTIs: simple or complicated clinically. People who are otherwise healthy and do not have any anatomical or neurological urinary system abnormalities are usually the ones who have simple UTIs Grigoryan *et al.,* 2022). These infections can be distinguished as higher UTIs (pyelonephritis) and lower UTIs (cystitis) (Johnson, 2017). Several risk factors, including female gender, the past UTI, sexual activity, vaginal infection, diabetes, obesity, and genetic vulnerability, are linked to cystitis. Urinary obstruction, neurological disease-related urinary retention, immunosuppression, renal failure, renal transplantation, pregnancy, and the presence of foreign bodies like calculi, indwelling catheters, or other drainage devices

are all considered causes of complex infections of the urinary system (Bader *et al.,* 2017). One million instances of complex UTIs each year in the US is caused by indwelling catheters, accounting for 70–80% of cases. All, catheter associated UTIs (CAUTIs) are the most frequent source of subsequent bloodstream infections and are linked to higher rates of morbidity and mortality. Diabetes, older age, female gender, and prolonged catheterization are probability for developing a CAUTI. Both Gram-positive and Gram-negative bacteria, as well as some fungi, can cause UTIs. Urpathogenic *Escherichia coli* is nearly cause both simple and complex UTIs (UPEC). Following UPEC as the most frequent cause of complicated UTIs, Enterococcus species, *K. pneumoniae, Candida species, S. aureus, P. mirabilis, P. aeruginosa*, and GBS9 (McLellan *et al.,* 2016 & Lewis *et al.,* 2016) are the causative agents order of predominance Urinary tract infections can be caused by both Gram-positive and Gram-negative bacteria, as well as certain fungi. Recent research has directly analysed uropathogens found in female urine with symptomatic UTIs using RNA sequencing.

We now have a better understanding of the molecular mechanisms by which uropathogens adhere, colonize, and adapt to the nutritionally deficient bladder environment; elude immune surveillance; and persist and spread throughout the urinary system. The virulence components that might be addressed to prevent and mitigate the pathogenic mechanisms associated with UTIs (Wiles *et al.,* 2008). We compare the virulence factors employed by the main uropathogens, UPEC, *K. pneumoniae, P. mirabilis, E. faecalis, and P. aeruginosa,* and the pathogenesis's molecular pathways in kidney and bladder infections. We also go into innovative combination therapies, antibiotic resistance mechanisms, current antibiotic treatments, and upcoming therapeutic interventions that target virulence factors with vaccines and small compounds (Giuseppe *et al.,* 2023).

Epidemiology

- ✓ Every year in the US, difficult UTIs report as around 626,000 hospital admissions, or 1.8% of all hospitalizations, with 80% of them being non-catheter related (Zilberberg *et al.,* 2018). Cohorts with more risk factors show an increased incidence of UTIs. Liability factors which include female gender, increasing age, diabetes, obesity, long-term catheters, and frequent intercourse (although UTI is not defined as a sexually transmitted infection).
- ✓ It has been estimated that the annual incidence of simple UTIs in immune-competent non-pregnant females can reach 0.7 infections per person. There are 50% of girls will experience a minimum of one UTI (Ayan & Stephen 2023).
- ✓ There are certain risk factors linked to the prevalence of complicated UTIs. For instance, with indwelling bladder catheters, there is a 10% daily risk of getting bacteriuria and a 25% chance that the bacteriuria will worsen and become a UTI (Tandogdu *et al.,* 2014).
- ✓ About 20 percent of bacteremias linked to medical care come from the urinary system. According to (Gould *et al.,* 2010), the mortality rate for these bacteremias originating from the urinary tract can reach 10%. Up to 14% of female diabetics experience bacteriuria, yet this condition does not often occur more frequently in diabetic males.
- ✓ In females, asymptomatic bacteriuria is prevalent in up to 80% of older females and tends to rise with age. While it is uncommon in younger, healthy males, it can occur in as many as 15% of elderly males.
- ✓ During their hospital stay, a complex UTI developed in around 9.4% of all patients admitted for urology (Zandongodu *et al.,* 2014).
- ✓ It has been reported that people on dapagliflozin (SGLT2i), a medication that treats diabetes by causing glycosuria, had a higher prevalence of UTI. (Donna *et al.,* 2019)
- ✓ The most frequent infections among individuals receiving kidney transplants are UTIs. After a transplant, as much as 25% of these individuals will experience a UTI in the initial year.
- ✓ In the US, UTIs account for over a million ER visits each year, putting them as the sixth most common reason for patient visits. Of these, approximately 22% (220,000) are thought to have complex UTIs, and each year, roughly 100,000 people are admitted to the hospital (Zindberg *et al.,* 2022).

Pathogenesis of UTI

The pathogenic bacteria from the adjacent vaginal tissue and perineum enter the urinary system and cause UTIs. The regions of urethral opening have been found to be well populated with such bacteria, making the urinary system highly susceptible to infection.

These pathogens include enteric or vaginal microflora. Approximately 80% of infections in otherwise healthy women and girls (Gaspari 2009, Stamm *et al.,* 2005) have been reported to be caused by *E. coli*, the most

common cause of UTI. Other bacteria involved in UTI include *Klebsiella*, *Enterococcus*, *group B Streptococcus*, *Proteus*, and *Salmonella saprophyticus*.

Uropathogenic *E. coli*

A vital component of the typical human gut flora, *E. coli*, a Gram-negative rod may transfer from a parturating mother to an infant within hours of delivery (Kaper *et al.,* 2004). Ex-PEC is the abbreviation for extraintestinal illness caused by some *E. coli* isolates (Croxen, 2010). Targeted organs include the lungs, the central nervous system, and the urinary system. The methods by which *E. coli* enter the urinary system demonstrate their extraordinary adaptation capacity to inhabit ecosystems different from the stomach. The adaptations include change in their metabolism (Alteri *et al.,* 2009), accent against the urine's flow, and biofilm formation in the endothelium. Certain components help *E. coli* in successful colonization in the urine system. Uropathogenic *E. coli* or UPEC, is the common name for several strains of *E. coli*. Numerous bacterial elements play a part in the intricate pathophysiology of UTI. Indeed, in 2007, the UPEC-specific genes have been identified involved in virulence. *E. coli* can adhere to structures called flagella, which resemble threads.

A study in mice has shown that the immunological response to *E. coli* in UTI requires essential binding to TLR5 (Andersen *et al.,* 2007). Adhesion is the first stage in a series of incidents that leads to infection and is essential for UPEC to prevent being washed out with the urine. Adherence factors that have been thoroughly examined are called type-1 fimbriae, and they are essential for UPEC adherence and invasion of bladder cells. The protein FimH, which is present ahead of them, is what allows them to communicate with the host cell. It attaches itself to four different uroepithelial cell structures, the most significant of which is uroplakin IA, which coats the bladder's facet cells (Zhou *et al.,* 2001). According to Eto *et al.,* (2007), *E. coli* also binds to β-integrin, which causes cytoskeleton reorganization and bacterial internalization. Complement factor 3, which epithelial cells release during infection, can attach to type 1 fimbriae in renal epithelial cells to form a complex that interacts with CD46 to facilitate internalization (Zhou *et al.,* 2009).

Since attachment of *P fimbriae* to glycosphingolipids on kidney epithelial cells has been discovered to be linked to onset of kidney infections. It's interesting to note that phase variation—a carefully controlled interaction between virulence factors—is necessary for colonization of the urinary system upper segment (Casadesus & Low 2006). The bacteria that are ascending towards the kidneys activate their flagella. Type 1 fimbria are turned off and P fimbriae are turned on to adhere to the renal epithelial cells. When P fimbriae adhere to kidney epithelial cells concurrently with type 1 fimbriae, which oversee inter-bacterial binding in the renal tubule and consequent tubular blockage, complex interactions between type 1 and P fimbrae may be observed (Melican *et al.,* 2011).

Bacteria require methods to survive in their new environment once they have adhered. They have several ways for extracting iron because the urinary system is an environment with low iron levels and iron is a necessary requirement for UPEC survival. Iron-scavenging genes make up a sizable portion of the UPEC genome. For UPECs to penetrate the host tissue, cytotoxic proteins must be generated. Alphahemolysin, a well-characterized virulence factor often expressed by *E. coli* that causes. When bacteria attach to kidney epithelial cells in the early stages of acute pyelonephritis, alpha hemolysin induces intracellular calcium oscillations that activate proinflammatory cytokines IL-6 and IL-8. In the bladder, this causes sloughing about the uroepithelium and the start of bladder hemorrhage (Rasmussen & Smith, 2008). Cytotoxic necrotizing factor 1 is another virulence factor that disrupts the cytoskeleton (CNF1). Alpha-hemolysin is frequently genetically associated with CNF1, a toxin related to the Rho family of GTPase-activating toxins. Uroepithelial cells may have an inflammatory response and apoptosis because of it. However, contradictory findings on its function in vivo have been reported by various research groups based on animal experiments. To shield themselves from immune defense processes, bacteria can also form biofilms. Crucial elements in the production of biofilms are cellulose and curli fimbriae (Kai *et al.,* 2010).

Additionally, bacteria have features on their surface known as pathogen associated molecular patterns, or PAMPs, which the host cells may identify and use to launch a defense. The traditional Gram-negative PAMP, lipopolysaccharide (LPS), has been found on the outer membrane. There has been difference in opinion over LPS's role in the pathophysiology of UTIs. Uroepithelial cells react to LPS moderately, in contrast to myeloid cells, which react quickly. One explanation for this is the absence of membrane-associated CD14, a crucial LPS receptor that functions in conjunction with toll-like receptor (TLR4) and has been found in six biopsies taken

from the urinary tract's epithelium (Samuelsson *et al.,*2004). For defense against the host reaction, such as complement-mediated death, the UPEC capsule is crucial (Buckles *et al.,* 2009).

Symptoms

Signs and symptoms Suprapubic pain, pain during urinating, whether or not it is often, or obvious haematuria are the typical symptoms of lower UTI. Symptoms of an upper urinary tract infection (UTTI) can include fever (>100°F), chills, nausea, vomiting, discomfort at the costovertebral angle, and nausea, with or without cystitis symptoms (Hooton 2012). Fever is typically linked to more complex types of UTIs and is infrequent in lesser UTI (Salvatore *et al.,* 2011). It is important to understand that these symptoms do not infect of the urinary system in the individual. In a primary care setting, there is only a 50–50 chance of patient exhibiting these symptoms is experiencing a UTI. If a patient has a history of recurrent UTI, this likelihood rises to 84%–92%. Moreover, the previously described symptoms are rarely displayed by older women with UTIs (Peach *et al.,* 2017). Urinary incontinence may be the only symptom they have. Low oestrogen levels in the three days following a UTI, urine loss increases dramatically in those women which entered in their menopause. A UTI frequently manifests as fever, burning, itching, blistering in the vaginal region, suprapubic discomfort, and pyuria. Inflammation and a white blood cell (WBC) count of more than 8 cells/mL in the urine are signs of the symptomatic infection. Pyuria, also known as leukocyturia, is the condition when the urine appears cloudy (Mody *et al.,* 2014).

Symptomatic\Asymptomatic UTI

The development and spread of bacteria that are in urinary tract the primary cause of both symptomatic and asymptomatic UTIs. The microorganisms that cause UTIs can either develop asymptomatically or create symptoms when they do (symptomatic). Urinating frequently and strongly, feeling burning in the lower abdomen even while passing modest amounts of pee, passing blood when passing urine, and a stronger than usual urine odor are all signs of UTIs. According to a study, symptomatic UTIs appear to be more common than asymptomatic ones (Mandokhail *et al.,* 2015).

More than 105 bacteria/mL present in urine in two successive cultures, either whether or not pyuria, is known as asymptomatic bacteriuria (ABU). Individuals with the ABU strain may be asymptomatic for months or even a year while harboring the germs. Research has also demonstrated that ABU shields the host from UTI symptoms (Wullt, 2016).

Risk factors of UTI in women

The past studies have suggested that men have higher resistance to UTI. It may be contributed to the women's shorter urethra. that can form quick link between the bladder and the urethra, leading to easy and fast entry of the microorganisms causing UTI. In contrast, men's longer urethras make it easier for urine to flush these bacteria out before their entry into the urino-genital system. It has been reported by the authors that UTI may further be synergized by the microflora colonizing the periurethral mucosa of gut (Dielubanza *et al.,* 2011). Recurrent UTIs have little or no association with passing frequent urine, douching, wiping patterns, delayed voiding behaviors, or wearing tight underwear however, it may be linked to incontinence, cystocele, hernia or postvoidal leftover urine. Apart from physical disadvantages several other factors may contribute towards higher occurrence of UTI rate women in comparison with men, including age-specific factors, genetic factors, behavioral factors, pregnancy-related factors, susceptibility factors, and urinary catheterization (Smithson *et al.,* 2019).

Behavioural factors

Microbes take advantage of behavioral aspects in a feminine body which is already physically sensitive to get infected (Dielubanza *et al.,* 2011). The most significant risk factor for women's recurrent UTIs is their behavior. One such behavior that contributes to the recurrence of UTIs in young women is the frequency of sexual activity (Kodner *et al.,* 2010). The link between sexual activity and recurrent UTIs has been demonstrated by numerous studies. The sexual activity at adolescent age may be the cause of young women higher prowens to UTI.

The frequency sexual intimacy during the previous seven days is correlated with her relative chance of getting an infection in the urinary system. After two days of sexual activity, there was a higher chance of getting an infection in the urinary system compared to days without any sexual activity. Use of spermicides and other forms of contraception, examples of post-intercourse behaviors, also contributes to higher rate of UTI occurrence, The risk of urinary tract infections rises with frequent

spermicide use. either alone or in conjunction with other forms of birth control. Some spermicides, particularly those containing nonoxonol modify the normal vaginal microflora. Periurethral pathogen colonization is facilitated by this process. Consuming antibiotics has also been associated with a higher incidence of UTIs (Arghya and Tuhina, 2015).

It's important to note that there is no advantage to altering hygienic practices such as menstruation cleanliness, front-to-back wiping, postcoital voiding, increasing fluid intake, or using sanitary napkins appropriately. Nonetheless, found in a published study that there is a strong correlation between perineal hygiene and urinary tract infections. According to the study, using the wrong kind of tampon, menstrual cleanliness, inappropriate washing practices, and undergarment material all raise the risk of UTIs (Vyas *et al.,* 2017)**.** There is solid evidence linking genetics to a predisposition to UTIs. Numerous investigations have confirmed a genetic connection to urinary tract infections. Women who experience current urinary system infections frequently have a family history of UTIs. Women who get UTIs frequently have been found to have increased sensitivity to *Escherichia coli* binding. This includes the buccal mucosa in addition to the urethral and vaginal mucosa this could be the result of genetic variations in mucosal characteristics rather than variations in the surrounding environment. The increased uroepithelial receptor density that can bind to bacterial adhesions has linked to non-secretor and recessive phenotypes (Dielubanza, 2011). It was discovered that a strong and the fact of occurring of UTI again in female relatives was a history of the illness and pyelonephritis in research involving women who lived in the community. Stronger past family history indices indicated a higher probability of infection and suggested that a genetic element may be responsible for the increase rate of these infections. (Scholes, 2010). Six of the 14 genes examined in humans—HSPA1B, CXCR1 and 2, TLR2, TLR4, and TGF-β1 have been found directly linked to an increased risk of recurrent UTIs.

Age-specific factors

Some authors have suggested that estrogen act as the most important age-specific risk factor for UTIs in the women. The multiplication of *Lactobacillus* and the acidic pH of the vagina serve as the strongest host defenses against the colonization and biofilm formation by the pathogen. However, as oestrogen levels drop after menopause, the vaginal flora can more easily change from *Lactobacillus* to *E. coli* or other Enterobacteriaceae members, increasing the rate of infection (Hooton 2012).

A study that revealed that intravaginal estriol therapy aids in the restoration of lactobacilli colonization supports this finding. Sixty-one percent of a noteworthy sample of women reported that their lactobacilli colonization had returned after receiving intravaginal estriol treatment, while the group receiving a placebo showed no change in this regard. Comparing intravaginal oestrogen replacement therapy to oral replacement therapy, however, only a significant difference was observed (Dielubanza 2011).

Pregnancy-related factors

The time of conception could be a separate risk factor for the development and spread of UTIs. It is interesting to note that the chances of occurrence of Asymptomatic bacteriuria are similar in both pregnant and non-pregnant women of sexually mature age. However, the psychological changes induced by pregnancy may elevate the risks of upper UTIs. The maternal Group B *Streptococcus* bacteriuria in pregnant women act as an indicator of for genital tract colonisation by pathogenic microflora. The other risk factors contributing towards higher chances of UTIs in women include older age, lower socioeconomic status of the woman, anatomical abnormalities of urinary tract, diabetes, and sickle cell diseases (Matuszkiewicz 2015). 25% to 40% of conceive women with untreated bacteriuria develop pyelonephritis. Pregnant women who have ABU (asymptomatic bacteriuria) are mostly participated in this condition; if left untreated, the infection can progress to pyelonephritis. One of the major causes of newborn mortality in the globe is pyelonephritis. Pregnant women frequently have UTIs, and among those, asymptomatic UTIs are the main cause for concern. For this reason, prompt medical attention is necessary during the pregnant period. Pregnant women report 2%–10% of asymptomatic UTIs worldwide. Preterm births, caesarean deliveries, low birth weights, and pre-eclampsia are among the serious morbidities associated with upper urinary tract infections during pregnancy (Campo *et al.,* 2017).

Urinary catheterization

Clean intermittent catherterisation (CIC) and indwelling urinary catheters have been reported to cause high rates of bacteriuria. Regarding indwelling catheters, the co-occurrence rate of bacteriuria has been reported to be

3%–6% daily and 1%–3% each catheterization with CIC. Foley catheters is widely used indwelling device, according to the study, which found that 17.5% in Europe patients and 23.6% of patients in the USA, respectively, had them in 66 hospitals (Rukweza, 2015). Hospitals now have become common place for acquiring UTIs, with 1%–10% estimated prevalence, representing 30%–40% of nosocomial infections.

The most common risk factor for nosocomial UTIs is the presence of urinary catheters, particularly in situations where long-term critical care is offered (Marra, 2011). It was shown that the major cause of morbidity in patients undergoing surgery for pelvic organ prolapse or stress urinary incontinence is urinary tract infections. According to a study done on patients having this kind of surgery, a history of numerous UTIs, a longer catheterization period, and a greater distance between the urethra and the anus all substantially raise the chance of UTI (Sutkin *et al.,* 2010).

New Trends in Diagnosis of Urinary Tract Infections

Urinary tract infection can be diagnosed using a combination of laboratory testing, imaging techniques, and clinical assessment. Uropathogen identification is the most worrying and most studied global health issue. Significant endeavors are being made to promptly identify, track, and measure uropathogens. When UTIs are not treated in their early stages, they can have major health consequences. By analysing the bacteria that have grown in the patient's urine, When the number of bacteria in a free collection of urine is greater than 105 cfu/mL, it is generally considered a positive marker of a symptomatic UTI.

The different techniques have been proposed to diagnose Urinary tract infection, such culture identification strategy however, these methods gave delayed results due to slow growth rate of bacteria (Hao, 2023). Another technique employs PCR or immunoassay technique, which is rapid and time saving, but has the limitation of being sensitive, requiring specific antigen concentrations and time for sero-conversion.

The gold standard method is quantitative urine culture, which takes around 24 hours to get results and additional 24 hours for antibiotic susceptibility testing. As a result, broad spectrum antibiotics are often prescribed in this case. Surface-enhanced Raman spectroscopy, a rapid diagnostic method based on spectra of bacterial strains grown in urine sample, is the latest technique which is being used to detect UTI (Hao 2023).

Clinical History and Symptoms

Assessment

The initial step involves evaluating symptoms such as dysuria (painful urination), increased frequency, urgency, and lower abdominal pain. For children or elderly individuals, symptoms may be less typical, such as confusion or irritability (Hooton & Gupta 2018).

Non-culture method

Rapid urine test method is the most frequently used method for the diagnosis of UTI using multistix, this technique may identify blood (as an indicator of inflammation), leucocyte esterase, protein, and nitrite, a metabolic byproduct of urinary tract infections. The risk of having a UTI increases if nitrite or leucocyte esterase is found in the sample. However, rapid urine test method for blood and protein has poor sensitivity and specificity in the detection of UTI and may be misleading (Schliemann *et al.,* 2010).

This approach uses Gram staining to detect bacterial growth microscopically in uncentrifuged urine specimens. The Gram staining method yields fast information about the nature and growth of bacteria. Its disadvantage is that this approach is not able to identify bacterial growth of less than 105 CFU/mL in a urine sample (Kumar *et al.,* 2016).

Urine Culture

The one of the oldest methods used for detection of micro-organisms. For every type of microorganism in this, a different culture medium and supplement are needed. For the semiquantitative approach, calibrated loops are used to plate routine urine cultures. This technique yields data for the identification and testing of antibiotic susceptibility as well as the number of colony-forming units per millilitres of the isolated colonies. Typically, blood agar and MacConkey agar are employed as culture media. (Kumar and others, 2016). The gold standard for determining a UTI's diagnosis is a urine culture. It identifies the specific bacteria causing the infection and helps determine the most effective antibiotic for treatment. This test is usually done if the urinalysis suggests a UTI or if symptoms persist despite initial treatment (Gupta & Roberts, 2017).

Imaging Studies

Indications

Imaging studies like ultrasound and computerized tomography (CT) may be used if there are concerns about structural abnormalities or if UTIs are recurrent or complicated. These tests help to rule out the other potential causes or complications of urinary symptoms (Sokoll, 2019).

Cystoscopy

Special Cases

For patients with recurrent or complicated UTIs, a cystoscopy may be performed to visually inspect the bladder and urethra for abnormalities (Kaufman, 2017).

Additional Tests

Special Circumstances

In cases where standard tests are inconclusive, or in patients with atypical symptoms or complex medical histories, additional tests like a bladder scan or specific urine tests may be performed (Nicolle 2014). These are the techniques which are in use for several years and include culturing and non-culturing methods, ELISA, isothermal microcalorimetry and PCR.

PCR

Urine, blood, and other clinical samples have been used to identify bacteriuria using the PCR technique. In this method, DNA is amplified and used for analysis using either universal or specific primers. Two semiquantitative real-time PCRs were assessed for the purpose of uropathogen detection. In this, both PCRs and single gene targets are chosen for bacterial quantification and identification in urine samples. (van *et al.,* 2016) In a recent study, reported the use of multiple PCR to the detection of bacterial UTIs in symptomatic patients. They further revealed that multiplex PCR is a better technique as compared with conventional urine culture method (Wojno *et al.,* 2020). Urinary molecular testing, which employs next-generation sequencing or PCR amplification, has revealed a wide range of organisms in the "healthy" bladder, refuting the widespread belief that pee is sterile at birth. Thomas (2016). It is now evident that the old idea of urine being sterile was based, at least in part, on urine culture's limits. There have been questions raised about the use of molecular testing to diagnose urinary tract infections (UTTIs), despite previously published research demonstrating that PCR enhances organism detection. These worries include the potential to find organisms in the presenting clinical episode that are not pathogenic, the lack of uniformity in urine molecular panels, and the expense of these innovative tests. According to our results, the advantages for patients with cUTI outweigh these drawbacks. These patients have treatment and diagnostic issues, and conventional UC may not be a suitable or sufficient diagnostic procedure. Each diagnostic step helps in confirming the presence of a UTI and ensuring appropriate treatment. Always consult a healthcare provider for diagnosis and management tailored to individual health needs.

Treatment

Home remedies

Parsley

It flushes your kidneys and serves as a diuretic, which helps to get rid of bacteria and speed up the healing process for a urinary tract infection. Add around one cup of fresh parsley or two tablespoons of dried parsley to a boiling pot of one to two cups of water. Simmer it, strain it, and enjoy. You can chill it in the summer and then consume it.

Celery seeds

These also act as a diuretic and chewing a handful of them can help increase the production of urine. Once or twice a day you can snack on celery seeds after your meal.

Cucumbers

They have high water content, and it is a great way to get that extra fluid through your system when you are having a hard time drinking enough water. Have cucumber juice with a dash of ginger juice or include cucumbers in your salad.

Garlic

Enriched with several properties, garlic serves as a rich source of allicin due to which it exhibits antibacterial properties. Daily intake of garlic clove has been found to be beneficial in averting such infections.

Botanicals used for UTI

Plants and their derivatives with medical significance are referred to as therapeutic botanicals. Indigenous plants are used by humans for a high range of illnesses from the beginning of time. It's likely that we gained this skill from animals, as they are naturally able to employ natural goods for a variety of health issues. Numerous bioactive chemicals found in these natural products serve as a foundation for the creation of novel medications. Using medicinal botanicals has many benefits, including fewer adverse effects, greater patient acceptance, lower costs, and the ability to renew naturally (Gur *et al.,* 2006). Numerous publications have shown that phytochemicals enhance the effects of widely used antibiotics by acting as multi-drug resistance modulators or inhibitors (Ahmad *et al.,* 2007). Diuretics, such as the herb *Solidago* spp. (goldenrod), the root of *Levisticum officinale* (lovage), the fruit *Petroselinum crispus* (parsley), and the nettle *Urtica dioica* (stinging nettle), raise urine volume in both healthy and sick individuals, helping to flush out potential dangers. Individuals who eat antiseptic and anti-adhesive herbs, such as *Vaccinium macrocarpon* (cranberry), *Arctostaphylos* uva-ursi, and Juniperus spp leaf, which releases antimicrobial chemicals that can either directly destroy microorganisms or stop them from attaching to epithelial cells, protecting against both acute and long-term urinary tract infections. (Arnell, 2005).

The roots of *Mahonia aquifolium* (Pursh) Nutt. (Oregon grape) and *Hydrastis canadensis* L. (Goldenseal) (Ranunculaceae) are rich in berberine (Berberidaceae). Berberine is an effective drug that fights infections and many other germs by preventing bacteria from adhering to the host cell, indicating that it has a great therapeutic promise for UTIs. Without causing any adverse effects, giving UTI patients an aqueous extract of corn (*Zea mays* L) silk—the exterior thread-like portion of the plant—significantly decreased their symptoms by lowering their urine's concentration of RBCs and crystals. (Sahib *et al.,* 2012). It has a wealth of different medicinal chemicals (Wang *et al.,* 2012). It has been discovered that plants from the Apiaceae, Fabaceae, and Malvaceae families are the most efficient against urinary tract infections.

Cranberry

Cranberries have been utilized as a urinary tract remedy for long times, and they have antibacterial properties. More than 80% made up of water, 10% made up of carbohydrates (fructose and glucose) and the remaining 10% made up of additional phytoconstituents such as anthocyanins, flavonoids, terpenoids, catechins, and organic acids (citric, malic, and quinic acids, among others) in trace amounts along with glucuronic, ascorbic, and benzoic acids. Hippuric acid, an antibacterial agent that can also make urine acidic, has been hypothesized to be excreted in considerable quantities in urine by quinic acid. Furthermore, a new avenue for understanding the mechanism of action cranberries as an anti-adhesive prophylactic and therapeutic drug for UTIs has been made possible by the clarification of the etiology of UTIs (Singh *et al.,* 2016). When compared to *Escherichia coli* strains is isolated from other experimental sources such as feces, sputum, or wounds, urine-derived strains (UPEC) adhered to uroepithelial cells three times more efficiently. This demonstrates that a particular strain of *E. coli* causes UTIs. The power of cranberry juice cocktail in treating UTIs has been demonstrated by antiadherence activity against Gram-negative bacteria isolated from urine and other medical sources in volunteers given the cocktail or urine and uroepithelial cells acquired after drinking the cocktail. Both young and old women benefited from the prevention and protection against UTI provided by consuming various cranberry products (Shmuely *et al.,*2012). After using cranberry-based compounds, young and the middle-aged women experienced a 35% decrease in the recurrence of UTIs. However, it was unclear how potent cranberries were in populations with difficult UTI (i.e., young, and elderly patients, patients with neurogenic bladder, or patients with persistent indwelling catheters). However, due to their negative side effects, which include weight gain, gastrointestinal issues, and dangerous drug interactions, these substances should not be taken for an extended period (Guay, 2009). In patients with complex UTI, clinical studies were frequently complex and yielded unsatisfactory results; however, in high-risk females, cranberry absorption dramatically avoided acute cystitis.

Cinnamom verum J. Presl. (cinnamon)

Patients requiring urinary catheters experienced chronic recurring UTIs because of MDR UPEC biofilm development Trans-cinnamaldehyde (0%, 1%, 1.25%, or 1.5%) has been demonstrated to stop UPEC biofilm from growing on both indwelling catheters and plate cultures. Catheter lock solution containing trans-cinnamaldehyde inhibited the growth of UPEC biofilm on catheters Because the test doses had no cytotoxic effects on human bladder epithelial cells, it could be used as a catheter surface coating or in catheter lock solution to prevent UTIs (Amalaradjou, 2010). By suppressing the

expression of key genes linked to uroepithelial cell attachment and penetration of host tissue, trans-cinnamaldehyde dramatically decreased uroepithelial cell attachment and invasion by UPEC (Amalaradjou *et al.,* 2012). These findings support the use of cinnamon as a DIY urinary tract infection remedy.

Arctostaphylos uva-ursi (L.) Spreng (bearberry)

Bearberry, sometimes called upland cranberry or Arctostaphylos uva-ursi (uva ursi), is a helpful herb for bladder infections. Because to their high arbutin content and diuretic qualities, bearberry leaves and prepares produced from them have strong antibacterial action (particularly against *E. coli*) and astringent activity. In double-blind research with 57 women, after a year, five out of 27 experienced a recurrence in the placebo group and none of the thirty in the uva ursi group (Agbagwa *et al.,* 2015).

Probiotics

Numerous *in vivo* and *in vitro* studies have demonstrated the benefits of probiotics is to restore and preserving the normal ecology of the vagina, urethra, and bladder as well as a proper bladder pH and preventing recurrent UTIs. Many lactobacilli are found in the urogenital flora of women in good reproductive health. However, the flora becomes altered after long-term antibiotic use, both momentarily after menstruation and permanently in postmenopausal women. The best supplement for lowering the risk of intestinal and urogenital infections seems to be a combination of *Lactobacillus fermentum* RC-14 and *Lactobacillus rhamnosus* GR-1. Using various tests, the antagonistic activity of two *Bifidobacteria* (*Bifidobacterium lactis, B. longum*) and five probiotic lactobacilli (*Lactobacillus fermentum, Macrobacterium acidophilus, Lactarum*, and *L. paracasei*) against six target pathogens was determined. Both bifidobacterial strains and *L. rhamnosus* significantly inhibited the growth of pyelonephritic *E. coli* (Hutt *et al.,*2006). Comparison was made between 179 women (mean age: 30.5 years) who had an acute UTI and 185 women of the same age who had not experienced a UTI episode in the previous five years.

Those women who are reproductive and have regular intake of fermented milk products contain probiotic bacteria and fresh juices, particularly berry juices, reduced the likelihood of recurrent UTIs. That means that nutritional supplements can be utilized to stop UTIs (Kontiokari *et al.,* 2003).

Vaccines

Adhesin-based vaccinations were particularly successful in avoiding the development of illness by obstructing host-pathogen interactions (Asadi *et al.,* 2013). Apart from the UPEC adhesins (pili, fimbriae), adhesins originating from *P. mirabilis* and *E. faecalis* have also been documented as potential targets for vaccination (Cusumano *et al.,* 2011). Although it was unable to stop UPEC colonization of the kidneys, vaccination with the UPEC pore-forming toxin HlyA decreased the incidence of renal scarring when compared to controls Several urease inhibitors, such as phosphoramidites, benzimidazoles, and acetohydroxamic acid (AHA), have been employed as effective medications to treat UTIs caused by urease-producing bacterial species such *P. mirabilis and S. saprophyticus* (Kosikowska *et al.,* 2011). Inhibiting UPEC colonization, invasion, and biofilm formation, mannosides—a pilus function inhibitor—and pilicides—a type 1 pilus assembly inhibitor—thus prevent UTIs.

Pharmacological Treatment

Urinary tract infections are often treated with antibiotics first. Which medication is used and for how long depends on your health and the kind of bacteria in your urine.

The latest FDA antibiotic approvals for UTIs include:

Vabomere

- ✓ Vabormere, also known as meropenem and vaborbactam, is a beta-lactamase inhibitor and carbapenem combination antibiotic.
- ✓ August 2017 saw the initial approval of vabotere. Vabomere is administered as an intravenous infusion every eight hours to adult patients suffering from complex urinary tract infections (including pyelonephritis, a kidney infection) caused by susceptible *Escherichia coli*, Klebsiella pneumoniae, and Enterobacter cloacae species complex.
- ✓ Differential dose adjustments are necessary for patients with different levels of renal impairment (Devanand 2012).

Zemdri

An aminoglycoside antibiotic called Zemdri (plazomicin) is used to treat pyelonephritis and other severe urinary tract infections (Ahmad 2014).
The initial approval for Zemdri came in February 2015.

Zemdri is given as a once-daily intravenous infusion and is used against certain Enterobacteriaceae in patients with few or no other therapeutic alternatives. Renal impairment necessitates dosage modifications (Wayne 2017).

Avycaz

Avycaz (ceftazidime and avibactam) is a combination of beta-lactamase inhibitor and cephalosporin antibiotics used to treat adult and pediatric patients 3 months of age and older who have complex UTIs, including pyelonephritis, and no other available treatment alternatives. The initial approval for Avycaz came in February 2015. It is also used to treat other stomach or lung infections, such as pneumonia (Dash *et al.,*2013).
Escherichia coli, Klebsiella pneumoniae, Enterobacter cloacae, Citrobacter freundii complex, *Proteus mirabilis*, and *Pseudomonas aeruginosa* are susceptible Gram-negative microorganisms that can cause complicated UTIs.
Avycaz is administered as an intravenous infusion every eight hours. Differential dose adjustments are necessary for patients with different levels of renal impairment (Mehta *et al.,* 2013).

Zerbaxa

A combination of beta-lactamase inhibitors and cephalosporins, Zerbaxa (ceftolozane and tazobactam) is used to treat complex UTIs, such as pyelonephritis. It can also be used to treat stomach or lung infections. The first approval for Zerbaxa came in December 2014.
Every eight hours, zerbaxa is infused intravenously. Differential dose adjustments are necessary for patients with different levels of renal impairment (Asrat *et al.,* 2014).

Fetroja

The cephalosporin ferrofloxacine, also known as cefiderocol, is prescribed to adults who have few or no other alternatives for treating complex urinary tract infections, including kidney infections brought on by Gram-negative bacteria that are responsive to therapy. Adults who have developed pneumonia while in the hospital or on a ventilator are also treated with it. First approved in November of 2019.

Fetroja can reach significant densities of bacterial cells and has a distinct mechanism.

Fetroja is administered intravenously once every eight hours. It binds to ferric iron to penetrate the outer cell membrane of Gram-negative infections, taking advantage of the bacteria's need for iron to survive (Mulugeta *et al.,* 2014).

Progress in Treating UTIs Resistant to Antibiotics

Antibiotic prescriptions, which are recognized to be a major factor in the spread of antimicrobial resistance, are frequently written for UTIs (Li *et al.,* 2022 and Biondo *et al.,* 2023). Therefore, the creation of new drugs to combat antibiotic resistance and the expansion of scientific research to find new treatment paths have become urgent issues. Recent study provided the first detailed account of the growth and dissemination of UPEC bacteria (Soderstrom *et al.,* 2022). Using a human bladder cell infection model, the researchers found that during the UTI infection cycle, UPECs form spaghetti-like filaments that measure several hundred times their initial length before going back to their original rod shape (Mike *et al.,* 2022). This work has opened the door for the development of novel treatment options for the management of UTIs brought on by UPECs, even though further research is required to understand why the bacteria carry out this transition. This is crucial since uropathogenic *E. coli* is responsible for nearly all UTIs (80% of them) (Shah *et al.,* 2019). Additional research is required to ascertain the effectiveness of these vaccines, even though the toxins and proteases of several uropathogens have been investigated as possible vaccine targets for UTI prevention (Flores-Mireles *et al.,* 2015).

Numerous siderophore systems have been investigated as potential targets for vaccine development since uropathogens need an iron supply to survive during colonization. These investigations have demonstrated that siderophore vaccinations can lessen the number of bacteria that colonize mice's bladders during infection, making them important antigens to assess in upcoming research (Mike *et al.,* 2016).

There are no effective vaccinations against urinary tract infections, even though several vaccines have been studied for this purpose with limited success up to this point. A new strategy was recently reported in a study published by (Wu *et al.,* 2021). To boost the recruitment of bacterial elimination cells and avert further infections, the authors immediately injected the vaccine into the bladder along with an adjuvant.

Table.1 Key classification of UTIs (Medina, 2019)

Classification	Definition
Uncomplicated UTI	A UTI there are none that are pertinent function or anatomical abnormalities in the urinary tract, no relevant kidney function impairment, and no relevant concomitant diseases promoting the UTI or risk pf developing serious complications.
Acute uncomplicated cystitis	A lower UTI in which the acute symptoms involve only the lower urinary tract, for example, urgency, painful (dysuria), pollakiuria, and pain above the symphysis.
Acute uncomplicated pyelonephritis	An upper UTI with persistent symptoms including flank pain, flank tenderness or fever (>38°C).
Asymptomatic bacteriuria	A positive urine culture (>105 colony forming units/ml) without
Recurrent uncomplicated UTIs	urinary symptoms.

Table.2 Body parts which are affected by UTIs.

Parts	Signs
Kidney	Back or side pain High fever Shaking and chills Nausea Vomiting
Bladder	Pelvic pressure Lower belly discomfort Frequent, painful urination Blood in urine
Urethra	Burning with urination

Table.3 Symptoms and their meaning (Kour & Kour, 2020)

Symptoms of UTI	MEANING
Urgency	An unstoppable urge to urinate due to sudden involuntary contraction of the bladder muscles
Frequency	Urinating too often and at frequent intervals
Bacteriuria	Urine containing bacteria is known as bacteriuria, and substantial bacteriuria is defined as having more than 105 bacterial colonies per millilitres of urine.
Pyuria	Presence of pus cells (WBCs) in the urine
Dysuria	Feeling of pain, uncomforted or hrated sensation while urinating
Nocturia	Frequently waking up at night to urinate because of UTI or bladder infection
Urinary incontinence	Loss of control of the bladder from a slight loss of urine following coughing, sneezing, or laughing

Table.4 Mode of action of antibody

Mode of action of antibody	Mechanism	Antibiotic group	Examples of antibiotics
Inhibitor of cell wall synthesis	Knowing the fact that eukaryotic cells do not have cell walls, we found that this structure is critical for the life and survival of bacterial species. A drug that targets cell walls can therefore selectively kill or inhibit bacterial growth.	Beta-lactam antibiotics (penicillins)	Cefadroxil Cefuroxime Ceftriaxone Ceftazidime Cefepime Cefpirom
Inhibitor of nucleic acids	DNA and RNA contain cell's genetic information and intelligence to carry out all the activities. DNA replication followed by cell division is an important factor for new bacterial cell formation. Some of the antibiotics attack this characteristic and prevent DNA formation; hence these antibiotics are called bactericidal.	Quinolones	Nalidixic acid
Inhibitor of protein synthesis	It targets bacterial protein synthesis by binding to either the 30S or 50S subunits of the intracellular ribosomes. This results in the disruption of normal cell metabolism of bacteria and consequently leads to inhibition of its growth and multiplication.	Aminoglycosides	Amikacin Tobramycin Gentamicin
Inhibitor of metabolic processes	Bacteria produce their own folate, in contrast to mammals, which is necessary for DNA synthesis in cells. Certain antibiotics function by preventing the synthesis of folate, which halts cell division.	Sulfonamides	Cotrimoxazole
Inhibitor of membrane function	Important barriers, cell membranes separate and control substances' movement both within and outside of cells. Any alteration or damage to this structure may cause significant solutes that are necessary for the cell to survive to leak out.	Polymyxins	Polymyxin B

Table.5 Ideals in handling UTI

	Description	Main challenge	Successful intervention strategies
Diagnose	Make and document the right dignosis	Determining which patients have UTI	Clinical decision aids Appropriate collection of cultures Refex urine culture Computerized decision support systems Selective reporting of urine culture results Text accompanying results to provide interpretation
Drug	Use the right empiric antibiotic	Rising resistance make empiric treatment challenging	Local susceptibility and stratified antibiograms. Selective and cascade Reporting of antibiotic susceptibility.
Dose	Use the right dose of antibiotic based on site of infection and renal or hepatic dysfunction	Doasade errors are common	Computerized decision supports. Systems electronic order sets. Audit and feedback.
Duration	Use antibiotics for the recommended duration	Many studies show a “longer is better” mentality	Computerized dicision support systems. Electronic order sets Audit and Feedback.
De-escalation	De-escalate therapy based on susceptibilities and when urine cultures and negative	Labor intensive and occurs too with UTI to make much impact.	Post-prescription review by pharmcists.

Figure.1 Pathogenesis of UTI (Giuseppe *et al.*, 2023)

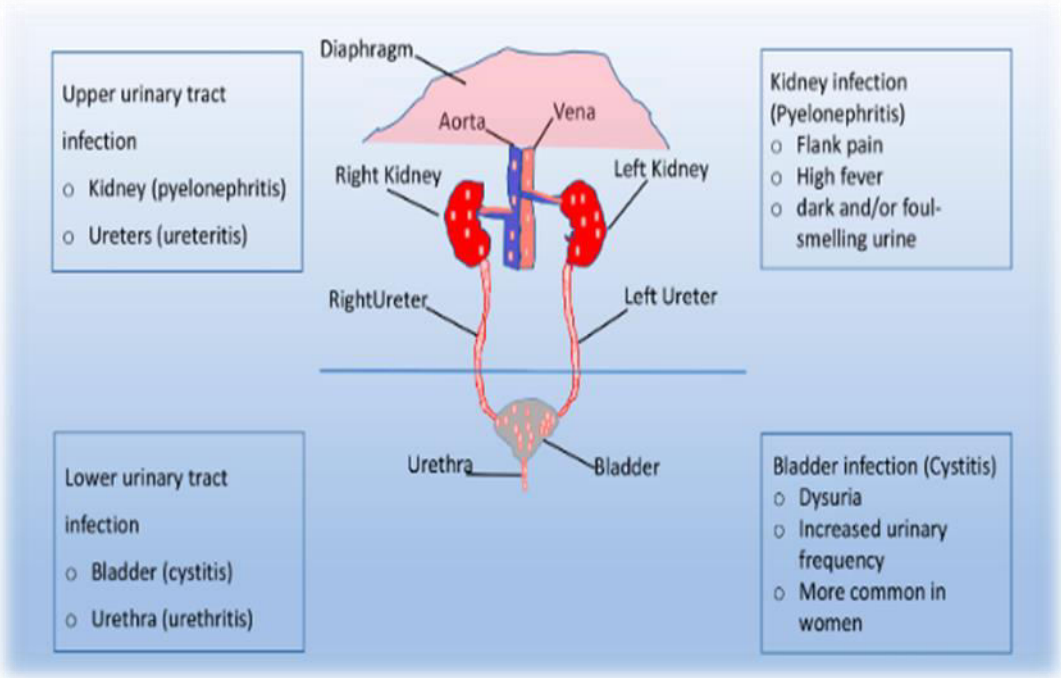

Figure.2 Mechanism of bacterial attachment (Das, 2020)

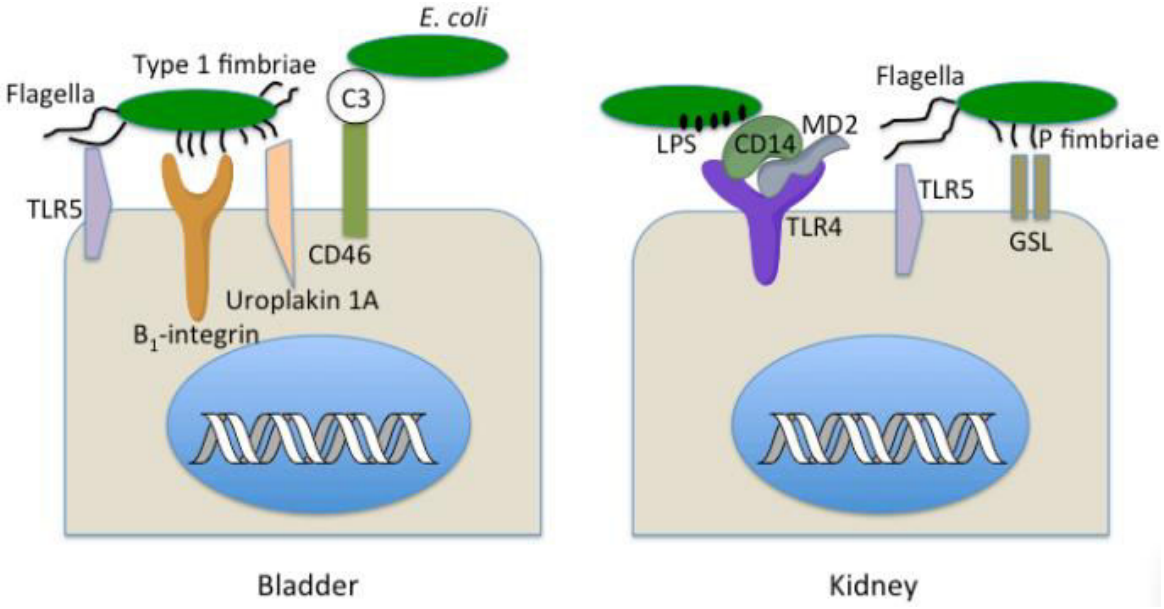

Figure.3 Detection of bacteria ((Premasiri *et al.,* 2017)

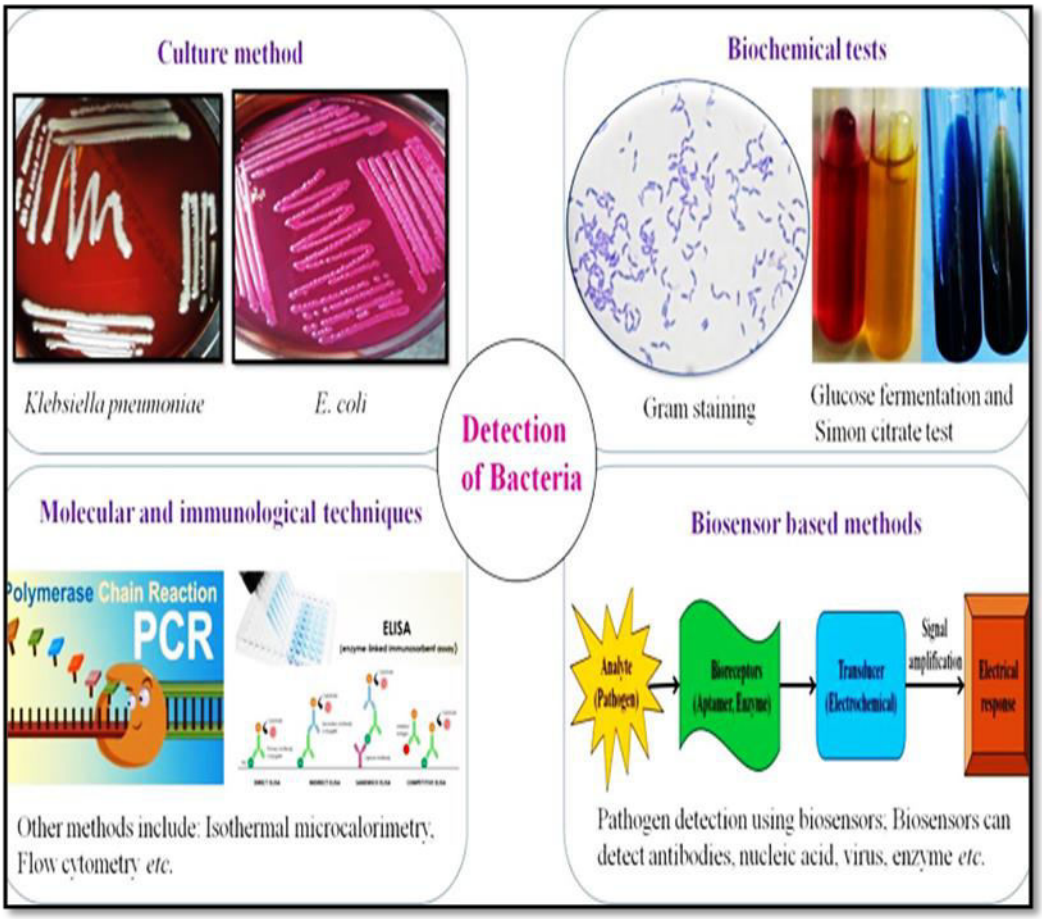

Figure.4 Alternative methods (Rajanbir, 2020)

The most promising new antibiotics being developed for the treatment of UTIs are gepotidacin and the two oral carbapenems, sulopenem and tebipenem. A member of the pyranopyridine class, gepotidacin specifically prevents bacterial DNA replication, while tebipenem and sulopenem are being developed for use in the treatment of both severe and simple urinary tract infections (Scangarella *et al.,* 2022).

Preventions

- ✓ **Wash hands before wiping:** Patients should wash their hands before urinating or using the toilet. They should also wash their hands before they get into the shower to avoid passing germs from their hands back to their body near the vaginal area (Anger, 2019).
- ✓ **Wipe front to back:** Always wipe from the front to the back after urinating. The patient should start from the front and push down and away towards the rectum. Most urinary infections are from bacteria that normally live around the rectum and anus. Therefore, wiping motion that starts near the rectum and then approaches the urethral area will move potentially dangerous bacteria closer to the bladder and urinary tract. Patients should also wipe the same way, front to back, after a bowel movement (Zhong *et al.,* 2011).
- ✓ **When wiping, wipe only once:** Use toilet paper after urination is acceptable. However, the patient must clean once, or they may add more bacteria to the urethral area. Sterile baby wipes are cleaner than toilet paper and can be carried in their purse outside the home. As a rule, anything safe for babies can also be utilized in the delicate area around the vagina and urethral opening (Glover *et al.,* 2014).
- ✓ **Avoid baths:** Bathwater is full of dirt and bacteria from the skin. Remind the patient that the water they wouldn't drink shouldn't be used to clean their urethra. Suppose the patient absolutely must take a bath instead of a shower. In that case, they should avoid any bubble baths or other cosmetic bath additives, which tend to be irritating to the delicate skin of the vaginal mucosa. Instruct the patient must take bath instead of shower (Bent *et al.,* 2002).
- ✓ **Avoid luffas and all reusable sponges:** Luffas and other reusable sponges, including nylon, cannot be adequately cleaned or sterilized, so they retain bacteria. They are also utilized repeatedly for days, weeks, or months, during which they can accumulate more and more bacteria and germs. Women susceptible to infections, particularly UTIs, should avoid using reusable items that are heavily contaminated (Hooton *et al.,* 2013).
- ✓ **Use a gentle liquid soap when washing:** Bar soap will always have bacteria due to exposure to the air and bathroom environment. A body wash is fine for regular skin cleaning, but regular body wash is too harsh for the gentle tissue of the vagina and urethral area. Steer clear of products that contain needless astringents, perfumes, lotions, or other irritating ingredients. For the urethral area, the patient may use a mild baby shampoo or soap (Mody *et al.,* 2014).
- ✓ **Use washcloths:** Using a soft, clean cotton or microfiber washcloth is the most hygienic and

optimal method for applying soap. The washcloths are cleanest just out of the dryer, so after washing and drying, they can be put into a fresh, resealable plastic bag right away. The patient may want a second washcloth to finish their shower after adequately cleaning the urethral area (Bono *et al.,* 2023).

- ✓ **Clean the urethral area first:** The bladder is the only body area that could get infected without proper cleaning. The bladder should be washed before a washcloth or hands pick up dirt, germs, or bacteria from other body parts. When surgeons perform surgery, they clean the surgical site before moving to the surrounding area. The same principle applies to cleaning the bladder area (Larcombe *et al.,* 2015).
- ✓ **How to wash—summary:** Wash your hands before showering. After wetting the washcloth and adding some fresh liquid soap, be sure to wipe the urethral area one time from front to back. Rinse well without directly spraying the area. The washcloth to clean the urethral area should be used only once before laundering and not for any other purpose (Banker *et al.,* 2022).
- ✓ **Douches and other personal hygiene products:** In most cases, a vinegar and water douche or a douche with iodine or benzalkonium chloride is helpful if carried out correctly at appropriate intervals. The patient should not use any feminine hygiene sprays, cosmetics, perfumes, medicated towelettes, or similar products in the vagina or urethral area unless approved by the clinician (Mestrovic *et al.,* 2020).
- ✓ **Use tampons for periods:** Tampons are advised during menstrual periods rather than sanitary napkins or pads. A tampon can help maintain better hygiene and reduce bacterial growth compared to a sanitary pad (Gupta *et al.,* 2011).
- ✓ **Avoid long intervals between urinations:** The patient should try to empty their bladder every 4 hours during the day, even if they don't feel the urge to void. If possible, the urge to void should be promptly answered.
- ✓ **Don't wear tight clothes:** Patients should avoid wearing pantyhose, bathing suits, or tight slacks for prolonged periods. All of these can cause the skin around the vagina to fold into the body, introducing more bacteria around the urethra (Stein *et al.,* 2025).
- ✓ **Drink more water:** Recommend starting with 1 extra glass with each meal. If the patient's urine appears any darker than a very pale yellow, this could mean that they are not drinking enough and should increase their fluid intake. While cranberry juice can be replaced with other beverages, it is beneficial for individuals with UTIs.
- ✓ **Take vitamin C and drink cranberry juice:** Suggest taking extra vitamin C. This could strengthen the body's defences against infection. Extra vitamin C that the body cannot use right away is excreted into the urine, where it inhibits the growth of bacteria. As noted earlier, cranberry juice or pills may be of benefit in reducing UTIs (Bremnor *et al.,* 2002).
- ✓ **Avoid irritating foods like caffeine:** Symptoms of bladder irritation may be aggravated by caffeine, regular coffee, tea, alcohol, "hot" spices, aspartame, chocolate, cola drinks, and high-potassium foods like bananas and oranges.
- ✓ **Avoid activities that increase the risk of bladder infections:** Prolonged bicycling, motorcycling, horseback riding, and similar physical activities and exercises may increase the risk of bladder infections. When engaging in physical activity and exercise, patients should frequently empty their bladders and drink plenty of water and other fluids. Sexual activity may also increase the risk (Lim *et al.,* 2023).
- ✓ **Take special precautions after sexual activity:** After intercourse, instruct the patient to empty their bladder and drink 2 extra glasses of water. After sexual activity, clinicians may advise some patients to take a urinary antiseptic or antibiotic.
- ✓ **An oestrogen vaginal cream may increase resistance to bladder infections:** Clinicians may suggest an estrogen cream for the vagina if the patient is in menopause. The vaginal cream will help keep the tissues around the urethra healthy and more resistant to infection (Mehta *et al.,* 2023).
- ✓ **Take antibiotics only as prescribed:** If the clinician has prescribed medication or antibiotics as prophylaxis, patients should follow their instructions carefully. They must be aware that medications may be necessary for up to 1 year or more, depending on the nature and severity of the UTI. Some patients can avoid most urine infections, allow their bladders to heal, and regain their natural resistance by taking a little quantity of an antiseptic or urinary antibiotic every day at bedtime. Antibiotics might only be necessary for certain patients if they suspect they have an illness.
- ✓ **If patients follow these suggestions and still get an infection:** Patients should seek medical help promptly if they have an infection. A clinician typically requests a urine specimen. Patients should seek prompt help for excessive vaginal discharge or other signs of vaginal inflammation and infection.

Patients may begin an antibiotic at this time, and compliance is crucial. Sometimes, the clinician may request additional tests such as kidney x-rays or a direct bladder examination with a telescope (cystoscopy). Sterilization of washcloths may be the next step where more straightforward measures are inadequate (Lawrentschuk *et al.,*2006).

Sterilizing Washcloths for Home Use

The clinician may recommend sterilizing washcloths for washing and personal hygiene to help prevent recurrent UTIs. This extra step is probably unnecessary for most patients with recurrent infections but can benefit the more severe or resistant cases (Arnold *et al.,* 2016). Patients should use only those washcloths purchased for this purpose and remember to wipe correctly from front to back. The following are recommended steps for sterilization:

- ✓ Wash the washcloths with hot water and soap or detergent. If the patient doesn't have a washer, they can use soap and hot water in a sink.
- ✓ Boil the washcloths in water for at least 20 minutes.
- ✓ Take the washcloths out of the water and allow them to dry or use the clothes dryer.
- ✓ When dry, place each washcloth in a separate, sealable, microwave-safe plastic bag such as a ziplock bag.
- ✓ The bags should be left open and not sealed yet.
- ✓ Place the bags in the microwave. In the centre of the microwave, put a large glass of cold water. The washcloths should not be placed in the water.
- ✓ Put the microwave on high for 5 minutes. Replace the glass of cold water (now very hot) with a new glass of cold water and microwave on high for 5 minutes.
- ✓ Let the bags cool, then close them. The washcloths are now sterile inside a sterile bag.
- ✓ This technique kills the germs and bacteria on the washcloths by sterilizing them with microwave radiation. Without the glass of cold water to absorb the heat, the bags would melt, and the washcloths would catch fire (Graninger *et al.,*2023).

Preventing Infections

- ✓ Wipe in the correct direction, from front to back.
- ✓ Wash hands before using washcloths, tissues, or toilet paper for wiping or washing.
- ✓ Use a clean, gentle liquid soap because that is cleaner than bar soap.
- ✓ Only wipe once with each washcloth or tissue.
- ✓ When washing, clean the bladder area first to prevent bacteria contamination from other body parts.
- ✓ Don't use these washcloths for anything except to clean the area around the urethra.
- ✓ Drink more water and take vitamin C. Drink cranberry juice or take cranberry pills.
- ✓ The patient can consider using an estragon cream twice a week (or as prescribed by the clinician) if they are past menopause (Bono *et al.,* 2023).

Conclusion

Urinary tract infections present significant global health challenge, primarily caused by bacteria like *E. coli* originating from nearby vaginal and perineal areas. Despite their prevalence, the effectiveness of traditional remedies such as cranberry in preventing or treating UTIs remains debated due to inconsistent clinical outcomes. While cranberry and other natural compounds show potential in inhibiting bacterial adhesion and infection, rigorous scientific exploration into their specific molecular actions against diverse uropathogens is crucial. Probiotics have also emerged as promising agents for UTI management, showing efficacy in both acute and recurrent cases. However, their widespread adoption requires robust clinical trials to substantiate their therapeutic benefits conclusively. Accurate diagnosis through rapid diagnostic tests is pivotal in navigating the complexities of UTI treatment. This approach facilitates targeted antibiotic therapy, minimizes unnecessary antibiotic use, and mitigates the risk of antimicrobial resistance. Such strategies not only enhance patient care but also uphold antibiotic stewardship principles, ensuring optimal treatment outcomes while safeguarding antibiotic efficacy for future generations. Advancing our understanding of UTI pathophysiology and refining diagnostic and therapeutic strategies are essential for effectively addressing this common yet burdensome health issue. Integrating evidence-based practices and innovative technologies allows healthcare providers to optimize UTI management, thereby improving patient outcomes and enhancing overall quality of life.

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