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An overview on urinary tract infections and effective natural remedies

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Abstract

Urinary tract infections are the most commonly occurred disease in male and females in 1:8 ratio. It affects people throughout their lifespan. UTIs are caused by pathogenic bacteria such as *Escherichia coli*, *Staphylococcus saprophyticus*, *Klebsiella pneumoniae*, *Proteus mirabilis* and fungi *Candida albicans*. Antibiotics can be used to treat UTIs but it is not the proper solution. The use of antibiotics kills beneficial bacteria; which are critical components of an optimally functioning immune system. High rate of antibiotics use increase resistant bacterial strains and decreases antibiotic efficiency. Hence it is advised to use antibiotics judiciously. Antimicrobial agents of nature act as affordable and safe alternative remedy to treat UTIs without increasing the risk of antibiotic resistance. Therefore the present study describes the effective natural remedies to treat UTIs.

Keywords: UTIs, pathogens, antibiotic therapy, antibiotic resistance, natural remedies

Introduction

Urinary tract infection is defined as presence of microbial pathogens in the urinary tract with associated symptoms. The infection affects both lower and upper urinary tracts and is known as acute cystitis and polynephritis respectively. The most common bacterial infections seen in primary care are predominantly UTIs and then respiratory tract infections. Urinary tract infection is an infection in any part of our urinary system like kidneys, ureters, bladder and urethra. The infection involves the lower urinary tract, the bladder and urethra. Urine is end product of blood filtration. The process of blood filtration takes place in the kidneys. Urine that is produced in the kidney is carried to urinary bladder through the ureters and excreted out of the body via the urethra. Any infection sees along the ureter, urinary bladder and urethra are called urinary tract infection.

Women are at greater risk of developing a urinary tract infection than men. It is common among the women of all age groups and the incidence and prevalence increases with the age^[1, 2]. Incidence of infection in females increases directly with sexual activity and child-bearing. Most of the women will have a history of incidence of UTI in their lifetime and the risk of occurrence increases in postmenopausal women^[3, 4].

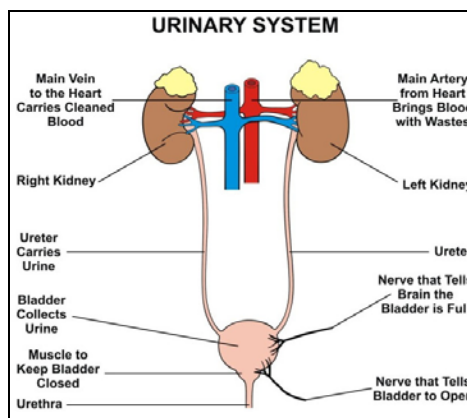


Fig 1: Urinary System

Types of urinary tract infection

Two types of urinary tract infection

1. Upper urinary tract infections are acute pyelonephritis, chronic pyelonephritis, interstitial pyelonephritis, renal abscess, perirenal abscess.

a. Pyelonephritis (kidney infection): An infection of kidney is usually a result of an infection that has spread up the urinary tract or from an obstruction in the urinary tract. An obstruction in urinary tract causes urine to back flow into the ureters and kidneys.

b. Acute pyelonephritis: Infection of one/both kidneys, sometimes lower tract also. Ex:- Pyuria, fever.

c. Chronic pyelonephritis: Particular type of pathology of kidney; may/may not be due to infection.

2. Lower urinary tract infections are cystitis, prostatitis and urethritis.

a. Cystitis: A bacterial infection in the bladder that often has moved up from urethra (Bladder infection).

b. Urethritis: An infection of urethra, the hollow tube that drains urine from the bladder to outside of the body.

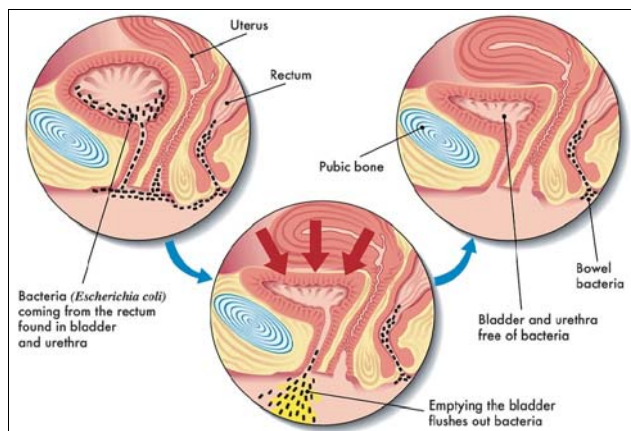


Fig 2: Cystitis

Both upper and lower urinary tract infections are further divided into complicated and uncomplicated.

Complicated UTI –It is an infection in a urinary tract with functional or structural abnormalities (ex. in dwelling catheters and renal calculi). The predisposing factors of host such as age, catheterization, diabetes mellitus and spinal cord injury cause complicated UTIs. During complicated UTI cystitis of long duration or hemorrhagic cystitis occurs.

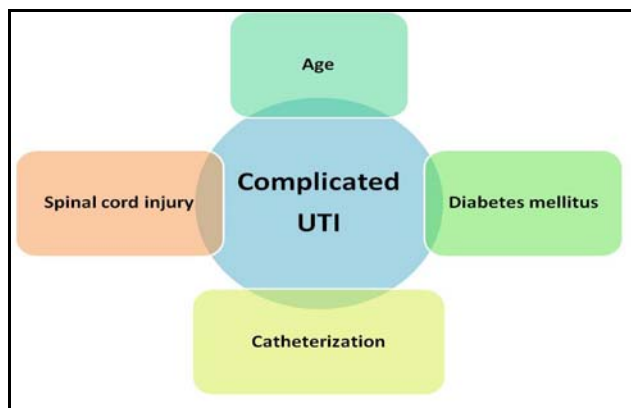


Fig 3: Predisposing factors of host for complicated UTIs

Uncomplicated UTI – Infection in a structurally and neurologically normal urinary tract. Simple cystitis of short (1-5 day) duration. Urinary tract infections usually develop first in lower urinary tract (urethra, bladder). If these infections are not treated, they may progress to upper urinary tract (ureters, kidneys).

Microbes that cause urinary tract infection

Escherichia coli is one of the most common pathogen that causes UTI, followed by *Staphylococcus saprophyticus* [5]. Other pathogens such as *Proteus mirabilis*, *Klebsiella pneumoniae* and *Enterococcus faecalis* are the commonest cause of uncomplicated and complicated UTIs [6].

Uncomplicated UTIs	Complicated UTIs
<ul style="list-style-type: none"> • <i>Escherichia coli</i> • <i>Klebsiella pneumoniae</i> • <i>Staphylococcus aureus</i> • <i>Enterococcus faecalis</i> 	<ul style="list-style-type: none"> • <i>Escherichia coli</i> • <i>Klebsiella pneumoniae</i> • <i>Proteus mirabilis</i> • <i>Proteus vulgaris</i> • <i>Pseudomonas aeruginosa</i> • <i>Serratia marcescens</i> • <i>Enterococcus faecalis</i>

Fig 4: Causative agents of UTI

Stages of urinary tract infection

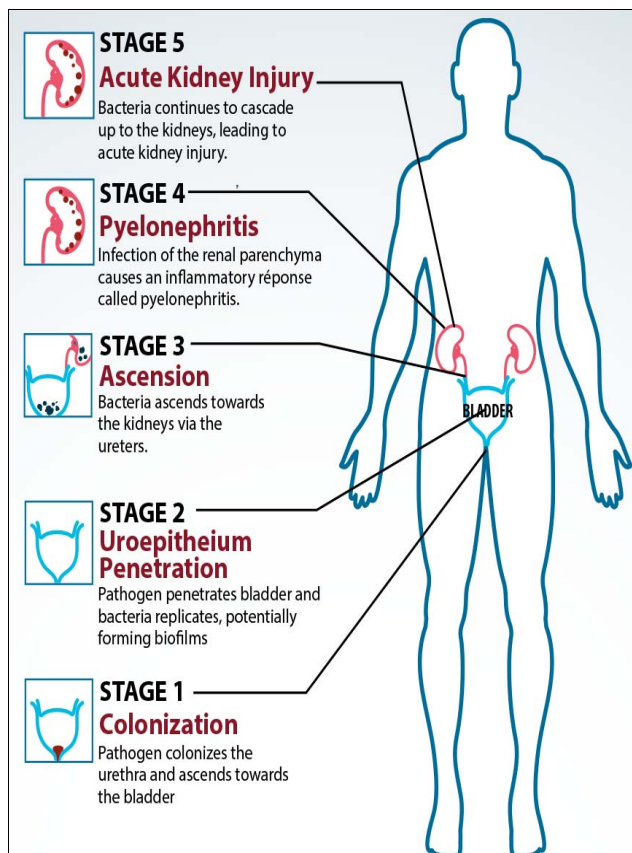


Fig 5: Stages of UTI

Causes of urinary tract infection

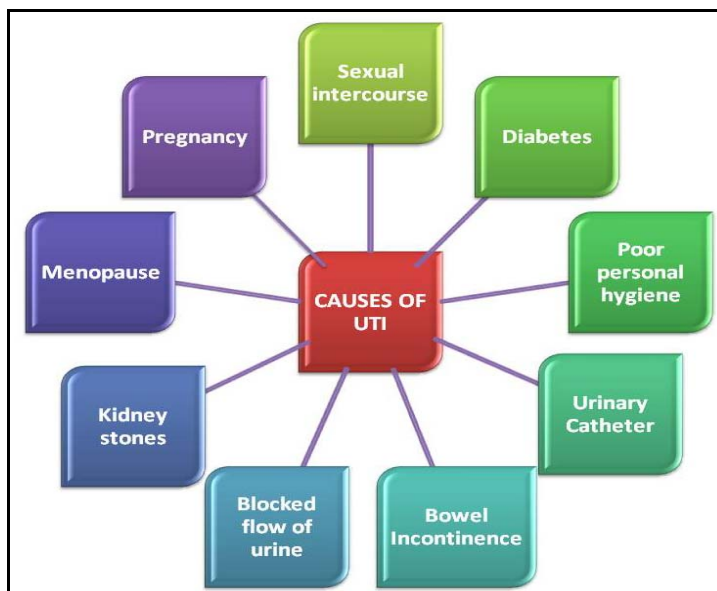


Fig 6: Causes of UTI

Table 1: Risk factors for urinary tract infections and prevalence for certain age groups

Age in years	Females (% prevalence)	Males (% prevalence)
<1	Anatomic or functional urologic abnormalities (1%)	Anatomic or functional urologic abnormalities (1%)
1-5	Congenital abnormalities; Vesicoureteral reflux (4.5%)	Congenital abnormalities, Uncircumcised penis (0.5%)
6-15	Vesicoureteral reflux (4.4%)	Vesicoureteral reflux (0.5%)
16-35	Sexual intercourse, diaphragm use, spermicidal jelly, previous urinary tract infection (20%)	Anatomic urologic abnormality. Insertive rectal intercourse (0.5%)
36-65	Gynecologic surgery, bladder prolapse. Previous urinary tract infection (35%)	Prostate hypertrophy, obstruction, catheterization, surgery (20%)
>65	Estrogen deficiency and loss of vaginal lactobacilli (40%)	All of the above, incontinence, long-term catheterization, condom catheters (35%)

Symptoms of urinary tract infection (UTI)

The symptoms of a urinary tract infection can depend on age, gender, the presence of a catheter, and what part of the urinary tract has been infected.

Common symptoms of urinary tract infection include: [7-10]

- Strong and frequent urge to urinate
- Cloudy, bloody or strong smelling urine
- Pain or burning sensation when urinating
- Urine with blood or pus
- Nausea and vomiting
- Muscle aches and abdominal pains
- Fever

Symptoms of Urinary Tract Infection (UTI)	
<p>Pyelonephritis (Kidney infection)</p> <ul style="list-style-type: none"> • Flank pain • High fever • Malaise • WBC's and bacteria in urine • Urinary symptoms similar to cystitis 	<p>Cystitis (Bladder infection)</p> <ul style="list-style-type: none"> • Increased urinary frequency • Urgency • Dysuria (painful urination) • Pain above the pubic region • WBC's and bacteria in urine • More common in women

Fig 7: Symptoms of UTI

Pathophysiology

There are two important routes by which bacteria can invade and spread within the urinary tract: The ascending and hematogenous pathways. There is little evidence to support a lymphatic spread of infection to the urinary tract with any regularity.

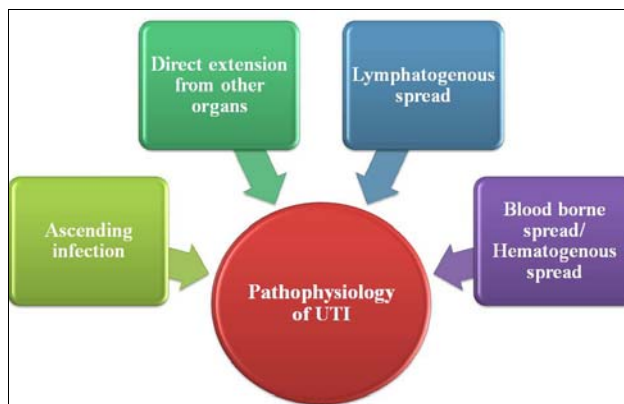


Fig 8: Pathophysiology of UTI

Four routes of bacterial entry to urinary tract

1. Ascending infection: Ascending route of infection is most common. Urinary tract infections in women develop when uropathogens from the fecal flora colonize the vaginal introitus and displace the normal flora (diphtheroids, lactobacilli, coagulase-negative

staphylococci, and streptococcal species). Colonization of the vaginal introitus with *E.coli* seems to be one of the critical initial steps in the pathogenesis of both acute and recurrent UTI. Most uropathogens originate in the rectal flora and enter the bladder via the urethra

2. **Blood borne spread/ Hematogenous spread:** Urinary tract infection is more common in women than men. Hematogenous spread is blood borne spread to kidneys. It occurs in bacteraemia mostly *Staphylococcus aureus*. Infection of the renal parenchyma by blood-borne organisms occurs in humans, albeit less commonly than by the ascending route. The kidney is frequently the site of abscesses in patient with bacteremia or endocarditic caused by a Gram positive organism, *Staphylococcus aureus*; infections of the kidney with Gram negative bacilli rarely occur by the Hematogenous route.

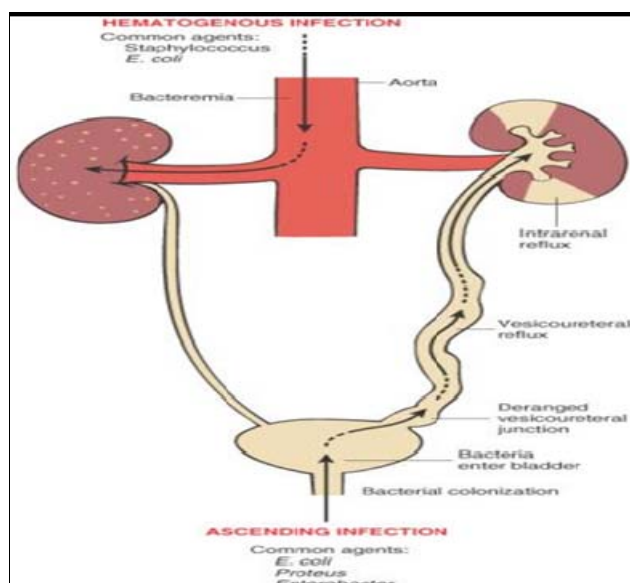


Fig 9: Haematogenous spread of UTI

3. **Lymphatogenous spread:** Man through rectal and colonic lymphatic vessels to prostate and bladder. Woman- through periuterine lymphatic's to urinary tract.
4. **Direct extension from other organs:** Once in the bladder uropathogens multiply, then pass up the ureters to the renal pelvis and parenchyma cause's pelvic inflammatory diseases and genito-urinary tract fistulas.

Treatment of urinary tract infection with antibiotics

UTIs are usually treated empirically with antibiotics as recommended by primary guidelines. Treatment with antimicrobials aims to eradicate the bacteria causing infection. The chosen antimicrobial depends on extent of infection (complicated/uncomplicated) common local pathogens and resistance patterns.

Examples of antibiotic for urinary tract infection include

- Trimethoprim/sulfamethoxazole (Bactrim, Septra, others)
- Fosfomycin (Monurol)
- Nitrofurantoin (Macrochantin, Macrobid)
- Ciprofloxacin (Cipro)
- Levofloxacin (Levaquin)
- Cephalexin (Keflex)
- Ceftriaxone (Rocephin)
- Azithromycin (Zithromax, Zmax)
- Doxycycline (Monodox, Vibramycin, others)

Antibiotics for empiric treatment of uncomplicated UTI include

First-line antibiotic: Trimethoprim or sulfamethoxazole in communities with resistance rates for *E.coli* <20%. This antibiotic should be avoided in women who have been treated within six months, as they are more likely to have resistant organisms.

Second-line antibiotic or first-line in resistant communities: Fluroquinolones- Ciprofloxacin, Levofloxacin, Norfloxacin, Ofloxacin.

Table 2: Classification of Antibiotics used in the therapy of UTIs

Antibiotic	Dose	Side effects	Contraindications
Amoxicillin	375mg every 8hr	Nausea, Diarrhoea, Rashes, Hepatitis	Penicillin hypersensitivity
Trimethoprim	200mg every 12hr	Nausea, vomiting, rashes	Severe renal failure, neonates
Ciprofloxacin	250mg every 12hr	Nausea, vomiting, dizziness, convulsions, hallucinations, hepatitis, blood disorders, photosensitivity	CNS disorders Pregnancy Children G6PD deficiency
Nitrofurantoin	100mg every 12hr	Nausea, vomiting, peripheral neuropathy, pulmonary reactions	Renal failure Neonates Porphyria G6PD deficiency

Although, antibiotic treatment supports clinical cure in individual patient but also leads to emerging resistance rates in the population. Resistance has increased to various antimicrobials and more than one-quarter of *E.coli* strains causing acute cystitis are resistant to amoxicillin, sulfa drugs and Cephalexin and resistance to co-trimoxazole is now approaching these levels. Resistance to Fluroquinolones is also rising. To prevent resistance, antibiotics should be used judiciously.

Natural Remedies

Nature's best ways to maintain the health of urinary system is usage of natural diuretics and antimicrobial agents.

1. **Cranberry (*Vaccinium macrocarpon* or *Vaccinium***

oxycoccus): Cranberry juice is the traditional home remedy to treat UTIs; cranberry concentrate prevents *E.coli* bacteria adhering to the surface of urinary tract. Hence it reduces the incidence of recurrent UTIs. It contains a flavonoid proanthocyanidin-A which have antibacterial effect. It assists in regulating urine P^H , relieves discomfort while urination, activates macrophages to improve wound healing and reduce inflammation^[11] and boosts immune system. It decreases risk of asymptomatic bacteriuria^[12]. The society of obstetricians and gynecologists of Canada recommends cranberry products to prevent recurrent UTIs.

2. **Apple cider vinegar:** It is a rich source of enzymes potassium and other minerals. They prevent the bacteria

- causing UTI from multiplying and growing. It acts as a natural antibiotic to treat the infection. It possesses acetic acid which is one of the best natural disinfecting compounds that kills resistant bacteria [13]. It strengthens the immune system by boosting body's detoxification. Drinking apple cider vinegar daily increases acidic environment in urinary tract and discourages the growth of UTI causing bacteria. To get rid of infection, two spoons of apple cider vinegar are mixed with one spoon of honey in a glass of water. It is recommended to take thrice a day for faster results.
3. **Tea Tree oil (*Melaleuca alternifolia*):** It possesses antibacterial property and can be used to fight against the bacteria that cause bladder infections. This cannot be taken orally hence ten drops of tea tree oil is mixed in bath water and use this water to clean urethra opening. It is mixed with sandalwood oil and rub the mixture on the abdominal region and on the area near the bladder. This is a very effective way to get rid of UTIs associated with pain. It is recommended to use daily for 3-4 days to get positive results.
 4. **Pine apple (*Ananas comosus*):** It possesses an enzyme Bromelian that have anti-inflammatory property which reduces UTI symptoms. Daily intake of one cup of pine apple juice helps to cure urinary tract infection. It is advised to take fresh pine apple instead of canned one, because they contain preservatives. It is recommended to take prescribed antibiotics along with pine apple juice.
 5. **Blue berries (*Vaccinium corymbosum*):** They have bacteriostatic property that is useful in the treatment of urinary tract infection. Drink blueberry juice daily in morning and night for quick results. Blue berry juice is rich in vitamin C and proanthocyanidins. This provides extra fluid which helps in flushing out of bacteria. It boosts immune system and prevents growth of bacteria causing UTI.
 6. **Uva ursi (*Arctostaphylos uva-ursi*):** It is an herb that is used traditionally for certain types of urinary tract infection. It possesses several chemicals and antiseptic properties that help in treating UTIs. It contains significant amounts of tannins. People suffering with kidney and liver diseases and pregnant women or nursing women or children should not take Uva ursi. Adverse effects of this herb are brown/green coloured urine, nausea, ringing in the ears, indigestion, cancer or even death when taken in large amounts for long periods of time.
 7. **Dandelion (*Taraxacum*):** This herb is potent diuretic used to flush the bladder and relieve symptoms. It is a good source of vitamins, minerals, antioxidants and mineral salts. The dried leaves and roots are used as tea or coffee to boost immune system. The root is a natural diuretic and used to treat UTI.
 8. **Corn silk (*Zea mays*):** Corn silk has soothing mucilaginous or demulcent properties. This soothes the irritated mucous membrane. It also has a diuretic effect. Rich in silica and other minerals, which help in strengthen the tissues.
 9. **Horse tail (*Equisetum arvense*):** Horse tail is used when there is suppressed urination that is accompanied by blood and severe pain with urination. This diuretic and astringent plant is also pain relieving when the bladder feels full yet unable to be relieved by urination.
 10. **Marsh mallow root (*Althea officinalis*):** Original marsh mallow candy was made from this plant. Marsh mallow has a softening demulcent effect on irritated mucous membrane of urinary tract.
 11. **Goldenseal (*Hydrastis canadensis*):** Goldenseal is potent antibacterial and mucous membrane healer indicated for inflammation of urinary tract walls.
 12. **Grapefruit (*Citrus paradisi*):** The grape fruit seed extract (GSE) is derived from seed and pulp of grape fruit. It has been found to contain natural antiseptic, antifungal and antiviral properties. The antibacterial agents of grape fruit seed extract resemble synthetic antibacterial drugs. It possess broad spectrum of activity that effects growth of both gram-positive and gram-negative organisms. It possesses potent components that decrease the growth of pathogenic organisms such as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Klebsiella* species in urine. The extract is shown to destroy pathogenic bacteria within 15 minutes of contact with a diluted solution [14]. The grape fruit seed extract along with berberine and zinc is recommended 2 caps – every 2 waking hours until the infection is eradicated.
 13. **Garlic (*Allium sativum*):** Garlic has long been known to contain antibacterial properties as attributed to its ability to suppress inflammation and provide immune support. It is an excellent source of the powerhouse antioxidant glutathione and is high in the sulfur compound allicin which enhances detoxification [15]. The recurrent UTI can be treated with garlic extract. Its use is also reported to decrease the urge and frequency to urinate as well as pain associated with the pubic region [16].
 14. **Echinacea (*Echinacea purpurea*):** It is recognized as a potent medicinal herb exhibiting wide variety of health benefits. Native Americans have used Echinacea as a natural antibiotic for over 400 years. Echinacea stimulates the immune system to overcome infection. Today the German government regulates the use of Echinacea as an approved treatment for urinary tract infections. It contains several plant compounds and can be taken in pill form or as an herbal extract in a tincture or tea. The infusions, extracts, tinctures and poultices are used in stimulating immunity and speedy recovery of various diseases.
 15. **Clove (*Syzygium aromaticum*):** Clove oil is a well known best essential oil used to treat microbial infections. It possesses antimicrobial, antifungal, antiviral, analgesic and immune boosting properties. It is perfect to use in conjunction with antibiotics to prevent yeast infections and UTI therapy. It promotes quick healing and reduces inflammation caused by the infection.
 16. **Cinnamon (*Cinnamomum zeylanicum*):** Cinnamon is a well known spice for its anti-inflammatory, anti-oxidant, antimicrobial, anti-diabetic and anti-tumor properties. It will stop the bacteria breeding at the same time as reducing the inflammation causing pain during urination. It has been shown to work against two of the biggest UTI culprits, *Staphylococcus aureus* and *E.coli*. Cinnamon stops breeding of bacteria by taking 1-4 gms of bark powder or 1 tsp a day of cinnamon oil. A combination of clove and cinnamon oils were shown to have a synergistic effect on inhibiting the growth of *E. coli* [17]. Clove oil contains anti-inflammatory properties which support pain relief while cinnamon oil possesses anti-septic properties inhibiting bacteria overgrowth [18, 19].
 17. **Oregano (*Origanum vulgare*):** The plant extract possess powerful anti-inflammatory property and also upregulates

cytokines activity to fight infection ^[20]. Oregano oil contains carvacrol, a volatile oil and powerful antibacterial agent that fight against *E.coli* and *Salmonella*. Oregano essential oil contains antibacterial property which inhibits the growth of *E. coli* and *P. aeruginosa* bacterial strains. Its antimicrobial property has been found to target drug resistant *E. coli*, which is common causative agent of UTI. It also fights against *Streptococcal* infections. One of the studies showed oregano oil as “alternative antibacterial remedies enhancing healing process in bacterial infections and as an effective means for the prevention of antibiotic-resistant strain development.”

18. Lemongrass (*Cymbopogon citratus*): The essential oil of lemongrass is an effective fighter of many different types of bacteria including *E.coli*. It also possess the ability to fight against “drug resistant organisms” One of the study found that lemongrass oil was effective in killing off the harmful pathogens such as *Staphylococcus aureus*, *Bacillus cereus*, *Bacillus subtilis*, *Escherichia coli* and *Klebsiella pneumoniae*. Boil a cup of water and steep 3 or 4 blades of lemongrass into it for 10 min., strain the tea and drink for 3-4 times daily. It eliminates all harmful bacteria from the bladder.

19. Myrrh (*Commiphora myrrha*): Like many of these other essential oils, myrrh oil has been shown to have antibacterial, antiparasitic, and antifungal properties. This is ancient oil used to treat infections for times immemorial. Myrrh oil helps provide relief when mixed with other oils to create a foot blend. This may sound odd, but it works. Remember your body is a whole system, each part connected to each other.

Best use: Mix 5 drops oregano oil with 10 drops each of clove and myrrh oils and pour the mixture into a roller bottle. Rolling the blend to your feet before sleeping, and wearing sock helps target and treat the urinary system area and gives relief.

20. Eucalyptus (*Eucalyptus globulus*): The lemon-scented variety of eucalyptus oil may help naturally treat bladder infections with its soothing and healing properties. It can also be used for treating thrush, which is a side effect of taking antibiotics for UTI.

21. Application: Just mix 2-3 drops of the oil with carrier oil (coconut or olive oil), or other essential oils used for treating cystitis, and apply to the bladder region. Keep on massaging till symptoms reduce.

22. Zinc: It is one of the major micronutrient that boosts immune system. Many individuals have deficiency of zinc due to use of medication and anti-inflammatory drugs. Most of the enzymes rely on zinc for their function. In case of zinc deficiency, these enzymes cannot function that leads to immune dysfunction and metabolic disturbances. It protects us from infection. Zinc boosts the immune system by reducing bacterial infection by many ways ^[21].

- Enhances the production of antioxidant compounds such as superoxide dismutase enzyme
- Provides protection against oxidative damage
- Suppress inflammation and pain

23. Vitamin C: It is a nutrient that fights infection by upregulating biological agents. It increases absorption of bioflavonoids in diet and equips the body to handle tissue trauma and stress ^[22]. Red or yellow bell peppers, citrus fruits, cauliflower, broccoli, kale, spinach, leeks, chives

and tomatoes are rich sources of vitamin C. It is recommended 2 grams of vitamin C every hour until UTI knocks out.

24. Baking soda: It neutralizes acidic urine and gives relief from the pain. It prevents spreading of infection. Mix one teaspoon of baking soda to a glass of water and drink once or twice a day. It is useful in preventing recurrent UTI.

25. Water: In case of suffering from urinary tract infection, drink plenty of water. At least drink eight to ten glasses of water in a day to urinate more that flushes out bacteria. Take fruit juice, vegetable juice, vitamins and minerals along with water to fight against the infection.

Prevention of urinary tract infection

- The risk of acquiring a urinary tract infection can be reduced by various ways
- Drink plenty of fluids, water is best, enough to pass clear dilute urine 4 to 6 times per day (about 8 glasses).
- Go to the bathroom when you have the urge; don't hang on too long.
- Cleanse your genital area daily but not too frequently or vigorously. Too much scrubbing and cleaning may slightly damage your genital skin. Bacteria thrive better on damaged skin.
- Avoid potential irritants such as perfumed bath oils and vaginal deodorants.
- Avoid sexual intercourse ‘from behind.’
- Lubricate adequately during sexual intercourse - it will decrease urethral irritation.
- Wear loose-fitting cotton clothes so air can keep the urethra area dry.
- In case of diabetes, keep the blood sugar under control.
- Drink lots of water and urinate frequently
- Avoid fluids such as alcohol and caffeine that can irritate the bladder
- Urinate shortly after sex
- Wipe from front to back after urinating and bowel movement
- Keep the genital area clean
- Showers are preferred to baths and avoid using oils
- Sanitary pads or menstrual cups are preferred to tampons
- Avoid using a diaphragm or spermicide for birth control
- Avoid using any perfumed products in the genital area

Conclusion

Bacterial infections are one of the most serious health issues globally. The constant use of antibiotics has drawbacks such as high expense, possible liver and kidney damage and develops antibiotic resistant bacteria. The emergence of antibiotic resistant bacterial strains is a major health problem. Therefore, it is critical to develop new antibiotics with novel mechanism of action to overcome these problems. Hence a new and effective approach is needed to treat urinary tract infections. Plants have scientifically proven to possess novel compounds with antimicrobial properties can be of great therapeutic significance for treatments.

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