



**Daffodil**  
*International*  
**University**

**PROJECT REPORT**

**“Preventing and Managing Urinary Tract Infections  
in Pregnancy: A Review of Antibiotic Use, Safety  
Considerations, and Alternative Approaches”**

**Submitted to:**

Department of Pharmacy  
Faculty of Allied Health Science  
Daffodil International University

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## APPROVAL

This project, “Preventing and Managing Urinary Tract Infections in Pregnancy: A Review of Antibiotic Use, Safety Considerations, and Alternative Approaches”, submitted to the Department of Pharmacy, Faculty of Allied Health Science, Daffodil International University, and has been approved as satisfactory for partial fulfillment of the criteria for the Bachelor of Pharmacy degree, and its style and content have been approved.

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## CERTIFICATE

This is to certify that the outcomes of the study reflected in this project are unique and have not before been presented in material for any degree at this University. The full study, presented as a project research for the partial fulfillment of the Bachelor of Pharmacy degree, is based on the author's (ID: 191-29-211) individual study.

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## DECLARATION

I formally declare that this entire project report was completed by me under the guidance of Sultana Juhara Mannan, Lecturer(Senior scale), Department of Pharmacy, Faculty of Allied Health Science, Daffodil International University, as an unbiased fulfillment of the Bachelor of Pharmacy degree requirement. This project and project report are my own study, I declare. I further declare that neither this project report nor any portion of it has been submitted anywhere for the granting of a Bachelor's degree or any other degree.

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Dolon Khondokar Pinky

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## **Abstract**

**Background:** Urinary tract infections (UTIs) are a common health issue among pregnant women. Antibiotics are the primary treatment for UTIs, but their use during pregnancy raises concerns about safety and the development of antibiotic resistance. Alternative approaches to preventing and managing UTIs in pregnancy have been suggested as potential options.

**Methods:** This review aims to summarize the current evidence on antibiotic use, safety considerations, and alternative approaches for preventing and managing UTIs in pregnant women. Relevant studies were identified through searches of several databases, including PubMed, Cochrane Library, and Embase. The search was conducted from inception to September 2021, and it included studies in English.

**Results:** Antibiotics remain the primary treatment for UTIs in pregnancy. However, several alternative approaches, such as cranberry products, probiotics, and behavioral interventions, have been suggested as potential options for preventing and managing UTIs in pregnant women. These approaches have varying levels of evidence to support their efficacy, and their safety profiles have not been fully established.

**Conclusion:** Preventing and managing UTIs in pregnancy require a multidisciplinary approach that balances the benefits and risks of antibiotic use and alternative approaches. Clinicians should consider safety and efficacy profiles of different options when treating pregnant women with UTIs. Further research is needed to establish the safety and efficacy of alternative approaches.

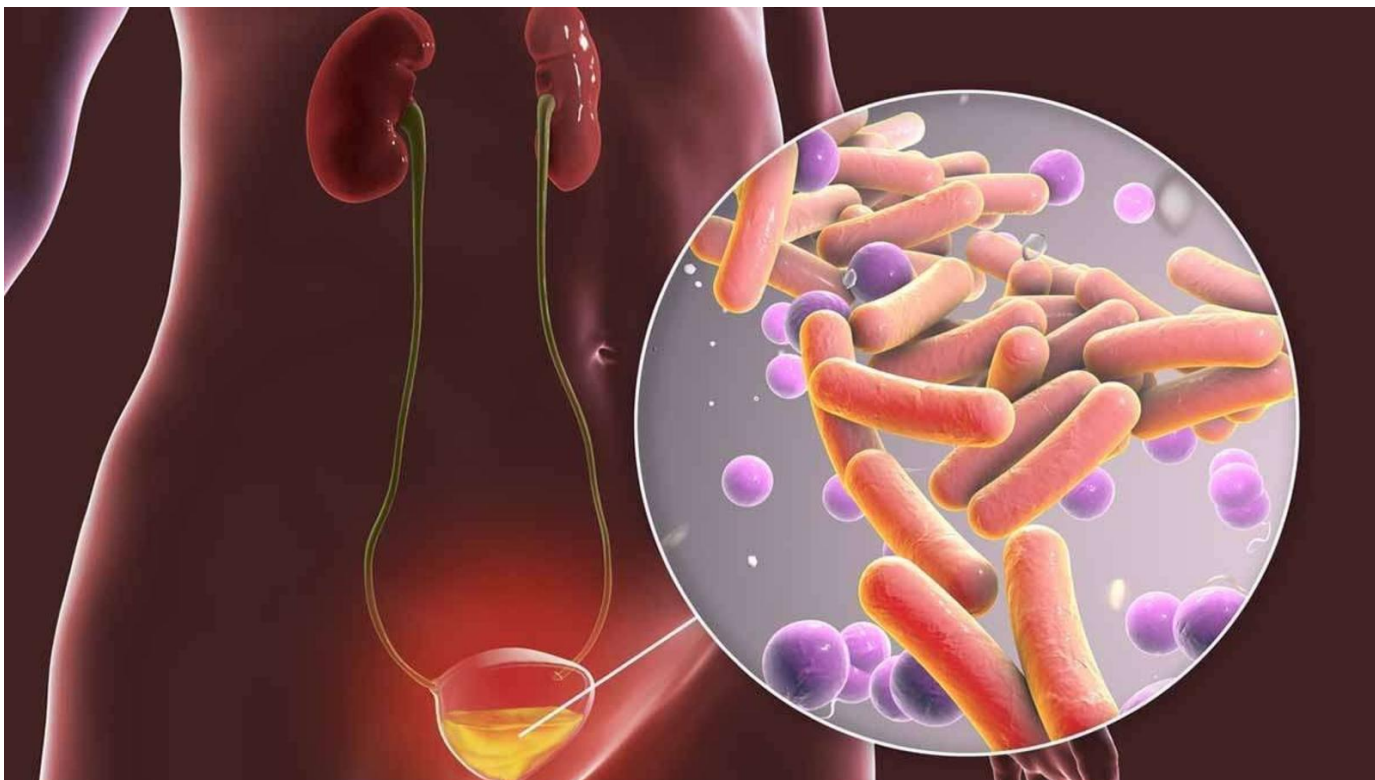
**Keywords:** Urinary tract infections, pregnancy, antibiotics, safety considerations, alternative approaches, cranberry products, probiotics, behavioral interventions, multidisciplinary approach.



## **1. Chapter one: Introduction**

## 1.1. Overview of the problem: incidence, risk factors, and consequences of UTIs in pregnancy

Urinary tract infections (UTIs) are one of the most common bacterial infections affecting pregnant women. UTIs in pregnancy can lead to serious maternal and fetal complications, such as preterm labor, low birth weight, and pyelonephritis, a potentially life-threatening infection that affects the kidneys.



*Figure 1: Urinary Tract Infection*

### **Incidence of UTIs in Pregnancy:**

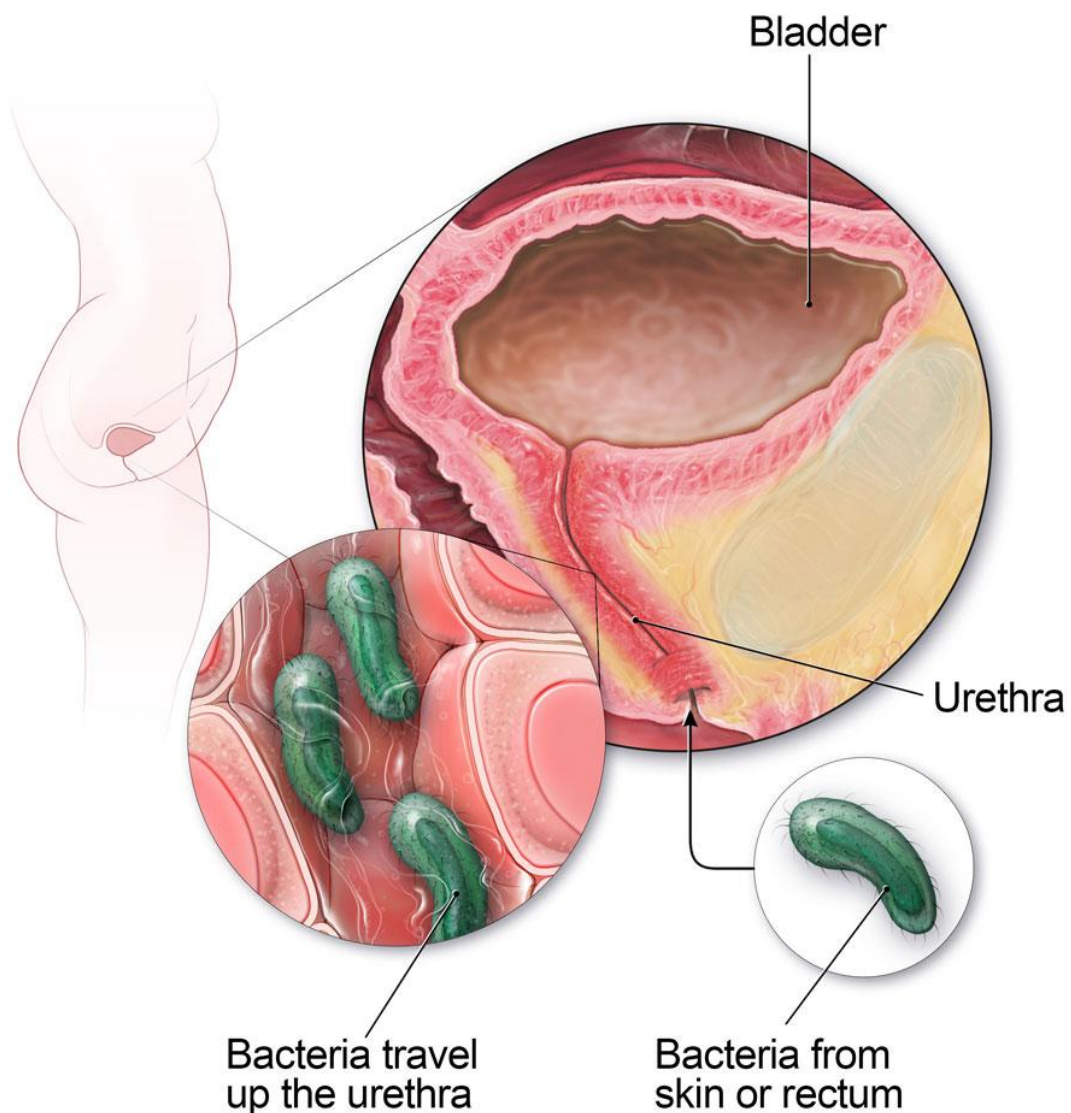
The incidence of urinary tract infections (UTIs) in pregnancy varies based on the definition of UTI, the population studied, and the diagnostic criteria used. However, it is estimated that UTIs occur in 2-10% of pregnant women, with asymptomatic bacteriuria (ABU) being the most common form of UTI. [1]

ABU refers to the presence of bacteria in the urine without symptoms of infection. The incidence of ABU in pregnancy is estimated to be 2-10%, while the incidence of symptomatic UTIs is estimated to be 1-2% . [2] UTIs in pregnancy are more common in the second and third trimesters, with the highest incidence occurring between weeks 22-24. [3] It is important to note that the incidence of UTIs in pregnancy may be underreported, as many cases of asymptomatic bacteriuria may go undetected without routine screening. [4]

### **Risk factors:**

Several risk factors have been identified for UTIs in pregnancy. These include a history of previous UTIs, pre-existing renal or urological disease, gestational diabetes mellitus, urinary tract abnormalities, and sexual activity. [5] Additionally, pregnant women who are younger, nulliparous, and from low socioeconomic backgrounds may be at increased risk for UTIs. [6]

Other factors that have been associated with an increased risk of UTIs in pregnancy include the use of a diaphragm for contraception, a recent urinary tract procedure, and having a family history of UTIs. Furthermore, factors such as poor hygiene, dehydration, and use of spermicides may also increase the risk of UTIs in pregnancy. [7]



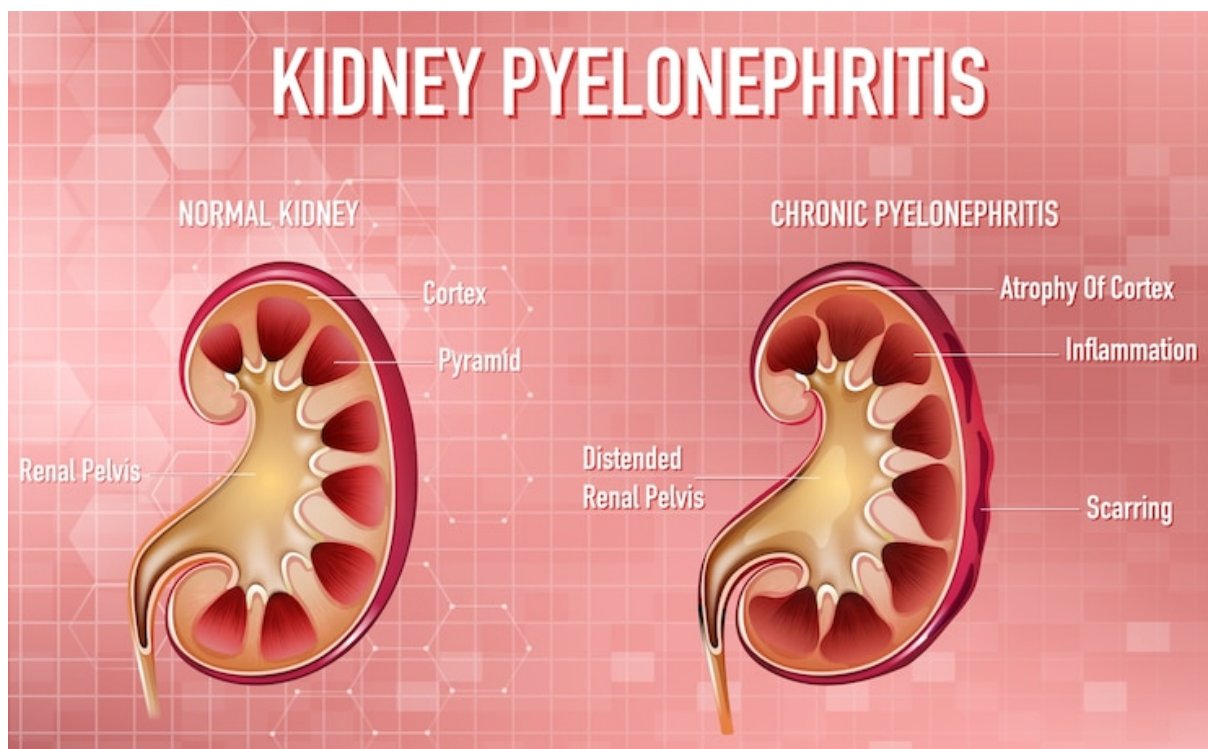
*Figure 2: Bacterial Infection*

**Consequences:**

Untreated or inadequately treated UTIs in pregnancy can lead to various adverse outcomes. These include pyelonephritis, sepsis, preterm labor, low birth weight, and neonatal sepsis. In addition, UTIs during pregnancy have been associated with an increased risk of hypertension, preeclampsia, and cesarean delivery. Pyelonephritis, which is a severe form of UTI that affects the kidneys, is associated with the highest

risk of adverse outcomes in pregnancy. It can lead to maternal morbidity and mortality, as well as fetal morbidity and mortality. [8]

Early detection and appropriate management of UTIs in pregnancy are crucial to prevent these adverse outcomes. This may involve the use of antibiotics and/or alternative approaches such as cranberry products or probiotics, as well as non-pharmacological interventions such as adequate hydration and hygiene practices.



*Figure 3: Pyelonephritis*

## **1.2. Objectives and scope of the review**

The objective of this review paper, "Preventing and Managing Urinary Tract Infections in Pregnancy: A Review of Antibiotic Use, Safety Considerations, and Alternative Approaches", is to provide an updated overview of the prevention and management of

UTIs during pregnancy, focusing on the use of antibiotics, safety considerations, and alternative approaches.

The scope of this review includes a comprehensive literature search of databases such as PubMed and Google Scholar for relevant articles published from 2010 to 2022. The review includes studies that investigate the incidence, risk factors, and consequences of UTIs during pregnancy, as well as the effectiveness and safety of different approaches for preventing and managing UTIs in this population. The paper also discusses the potential risks and benefits of using antibiotics during pregnancy, the emergence of antibiotic resistance, and the role of alternative approaches such as cranberry products and probiotics. Finally, the paper concludes with recommendations for healthcare professionals and pregnant women for preventing and managing UTIs during pregnancy.

The aim of this review is not to provide a comprehensive guide for the diagnosis and management of UTIs during pregnancy, but rather to provide an overview of the current evidence and recommendations for the prevention and management of UTIs in this population. The review focuses primarily on UTIs in low-risk pregnancies and does not include discussions of UTIs in high-risk pregnancies or complicated UTIs.

**Chapter 2: Pathophysiology  
of UTIs in pregnancy**

## **2.1. Anatomy and physiology of the urinary tract in pregnancy**

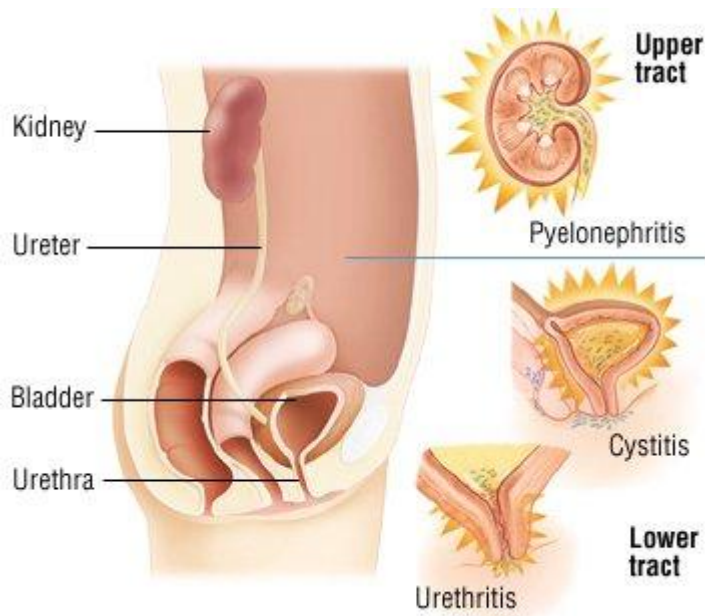
The urinary tract consists of the kidneys, ureters, bladder, and urethra, which play a vital role in eliminating waste products from the body. During pregnancy, there are several changes in the anatomy and physiology of the urinary tract that can increase the risk of UTIs.

One of the main changes is the dilation of the renal pelvis and ureters, which occurs due to the hormonal and mechanical effects of pregnancy. This dilation can cause urine to pool in the kidneys and ureters, leading to increased susceptibility to UTIs. Additionally, the bladder also undergoes changes during pregnancy, with decreased bladder tone and increased bladder capacity. These changes can result in incomplete bladder emptying, which can also increase the risk of UTIs.

Another important factor that contributes to the increased risk of UTIs in pregnancy is the presence of bacteria in the vaginal and perianal areas, which can migrate to the urinary tract. This is due to the proximity of the anus and urethra in women, as well as changes in the vaginal flora during pregnancy.

Several studies have highlighted the increased risk of UTIs during pregnancy, with estimates ranging from 2% to 10%. UTIs during pregnancy can lead to several complications, including preterm labor, low birth weight, and pyelonephritis, which can be life-threatening for both the mother and the fetus. [9]





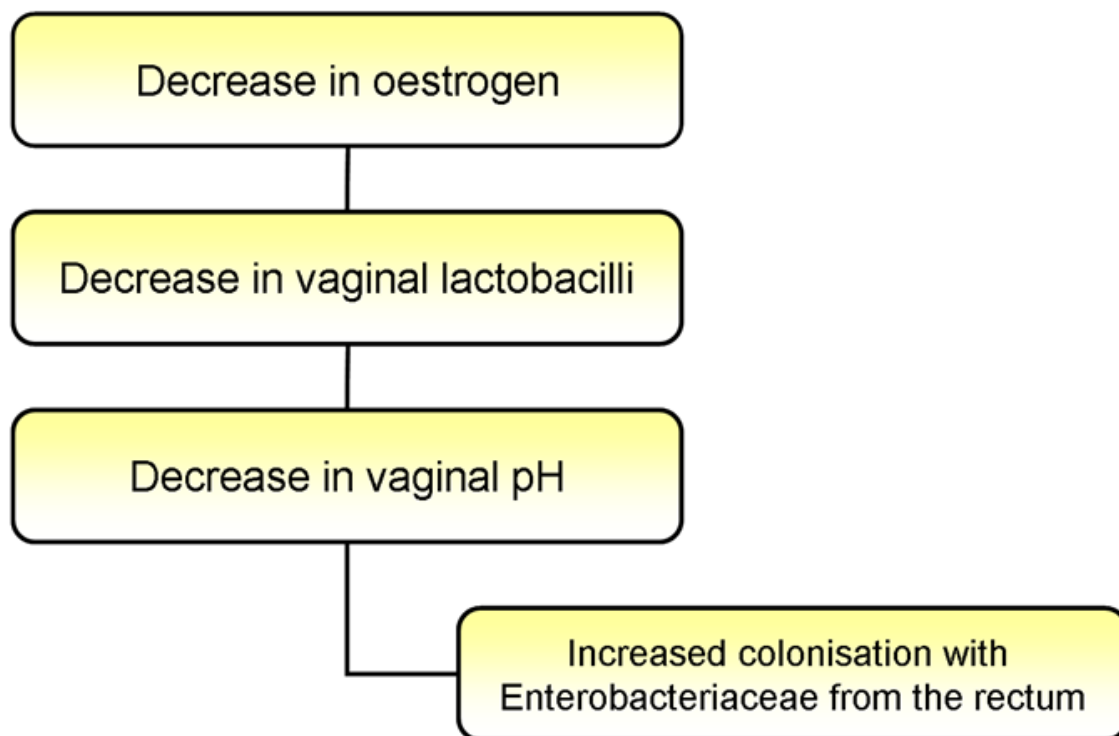
*Figure 4: Kidney diseases*

## **2.2. Pathogenesis of UTIs in pregnancy**

The pathogenesis of UTIs in pregnancy involves the colonization of bacteria in the urinary tract, followed by inflammation and damage to the uroepithelium, which can lead to symptoms such as dysuria, urgency, and frequency of urination. During pregnancy, the hormonal changes and physical factors such as increased bladder pressure and reduced bladder tone can increase the risk of UTIs. Additionally, the presence of asymptomatic bacteriuria in pregnant women can progress to symptomatic UTIs if left untreated.

The most common causative organisms of UTIs in pregnancy are *Escherichia coli* (*E. coli*), followed by other gram-negative bacteria such as *Klebsiella*, *Proteus*, and *Pseudomonas*. Group B *Streptococcus* (GBS) and *Enterococcus* species are also important pathogens in UTIs during pregnancy.

The pathogenesis of UTIs in pregnancy has been well-studied, with several mechanisms proposed for the increased susceptibility of pregnant women to UTIs. These include hormonal changes, immune system alterations, and physical changes in the urinary tract. Further research is needed to fully understand the pathogenesis of UTIs in pregnancy and to develop effective preventive and treatment strategies. [10]



*Figure 5: Pathogenesis of UTI*

### **2.3. Clinical presentation and diagnosis of UTIs in pregnancy**

UTIs in pregnancy can present with a variety of symptoms, including dysuria, frequency, urgency, suprapubic pain, hematuria, and fever. However, some women may be asymptomatic, and UTIs may be diagnosed through routine urine testing. In

pregnant women, the gold standard for diagnosis of UTIs is urine culture, which can confirm the presence of bacteria and guide appropriate antibiotic therapy.

In addition to urine culture, other diagnostic tests may be used in certain situations. For example, if a pregnant woman presents with recurrent UTIs or if there are concerns about the upper urinary tract, imaging studies such as ultrasound or magnetic resonance imaging (MRI) may be ordered.

It is important to note that the interpretation of urine tests in pregnant women can be challenging, as some changes in urine chemistry during pregnancy can mimic the presence of infection. Therefore, careful consideration of clinical presentation and laboratory findings is essential to ensure accurate diagnosis and appropriate management. [11]

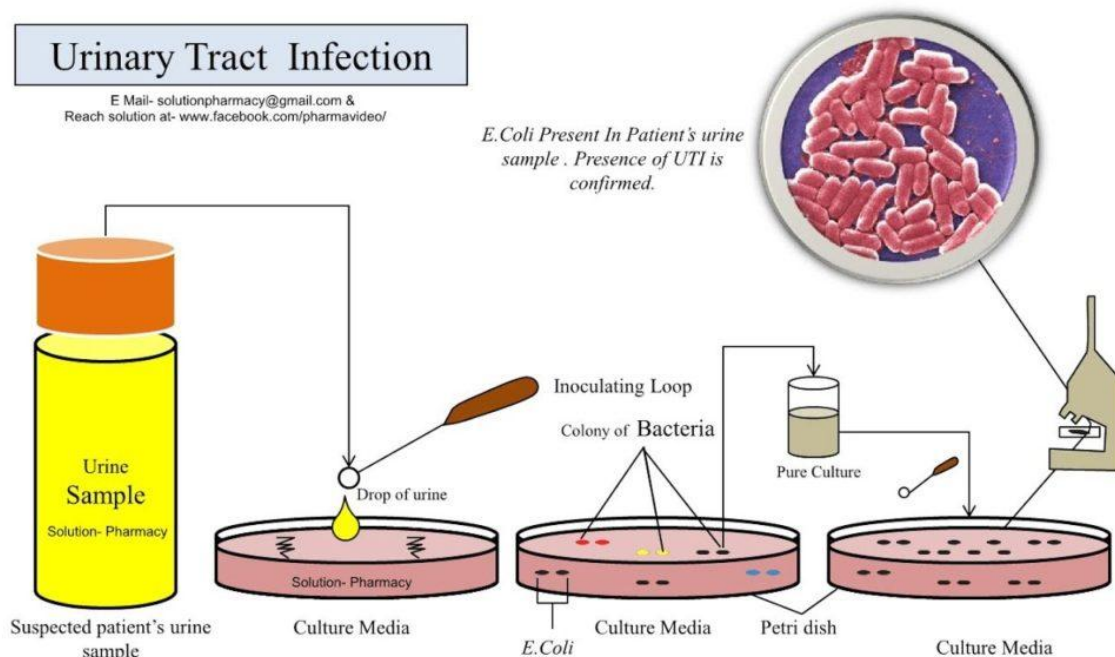


Figure 6: Urine Culture

**Chapter 3: Antibiotic therapy  
for UTIs in pregnancy**

### **3.1. Types of antibiotics used to treat UTIs in pregnancy**

Urinary tract infections (UTIs) are a common bacterial infection that can occur during pregnancy. Antibiotics are the primary treatment for UTIs, and several types of antibiotics are considered safe to use during pregnancy. The following are some examples of antibiotics used to treat UTIs in pregnancy:

1. Nitrofurantoin - This is an antibiotic commonly used to treat UTIs during pregnancy. It is considered safe and effective, especially during the second and third trimesters.
2. Cephalexin - This is a first-generation cephalosporin antibiotic that can be used to treat UTIs during pregnancy. It is considered safe and effective, especially during the first trimester.
3. Amoxicillin - This is a penicillin antibiotic that is commonly used to treat UTIs during pregnancy. It is considered safe and effective, especially during the second and third trimesters.
4. Ampicillin - This is another penicillin antibiotic that can be used to treat UTIs during pregnancy. It is considered safe and effective, especially during the second and third trimesters.
5. Trimethoprim-sulfamethoxazole - This is a combination antibiotic that can be used to treat UTIs during pregnancy. It is considered safe and effective, especially during the first trimester. [12]

It's important to note that the choice of antibiotic and dosage will depend on various factors, including the severity of the infection, the gestational age of the fetus, and the patient's medical history. It's crucial to consult with a healthcare provider before taking any antibiotics during pregnancy. [13]

### **3.2. Safety considerations of antibiotic use in pregnancy**

Antibiotics are commonly prescribed during pregnancy to treat and prevent urinary tract infections (UTIs). [14] However, there are safety considerations to be aware of when using antibiotics in pregnant women.

1. Certain antibiotics such as tetracyclines and fluoroquinolones should be avoided during pregnancy due to their potential to harm the developing fetus. [15]
2. Prolonged or repeated use of antibiotics during pregnancy can increase the risk of antibiotic resistance in both the mother and the child. [16]
3. Antibiotics can alter the composition of the gut microbiome, which may have long-term health implications for both the mother and the child. [17]
4. Some studies suggest a potential link between antibiotic use during pregnancy and an increased risk of childhood asthma and allergies. [18,19]

Therefore, it is important to consider the potential risks and benefits of antibiotic use in pregnancy and to explore alternative approaches for preventing and managing UTIs during pregnancy. [20] These may include cranberry products, probiotics, and lifestyle modifications such as increasing fluid intake and practicing good hygiene. [21]

Overall, while antibiotics can be effective in treating and preventing UTIs during pregnancy, healthcare providers should weigh the potential risks and benefits and consider alternative approaches when appropriate.

### **3.3. Guidelines for antibiotic use in pregnant women with UTIs**

1. The American College of Obstetricians and Gynecologists recommends treating UTIs in pregnant women with antibiotics that are safe for use during pregnancy, such as amoxicillin, nitrofurantoin, or cephalexin. [22]
2. The National Institute for Health and Care Excellence advises that in pregnant women with uncomplicated lower UTIs, nitrofurantoin and fosfomycin are the first-line antibiotics, while trimethoprim should be avoided during the first trimester. [23]
3. The Centers for Disease Control and Prevention recommends treating pregnant women with UTIs with antibiotics for 3-7 days, and lists amoxicillin, nitrofurantoin, and cephalexin as safe options. [24]
4. The American Academy of Pediatrics advises that amoxicillin, amoxicillin-clavulanate, and cefuroxime are safe options for treating UTIs in pregnant women. [25]
5. The European Association of Urology recommends nitrofurantoin and fosfomycin as first-line antibiotics for uncomplicated lower UTIs in pregnant women, and advises against using trimethoprim during the first trimester. [26]
6. Public Health England advises that in pregnant women with UTIs, nitrofurantoin and amoxicillin are safe options, while trimethoprim and quinolones should be avoided. [27]

**Chapter 4: Alternative approaches for preventing and managing UTIs in pregnancy**



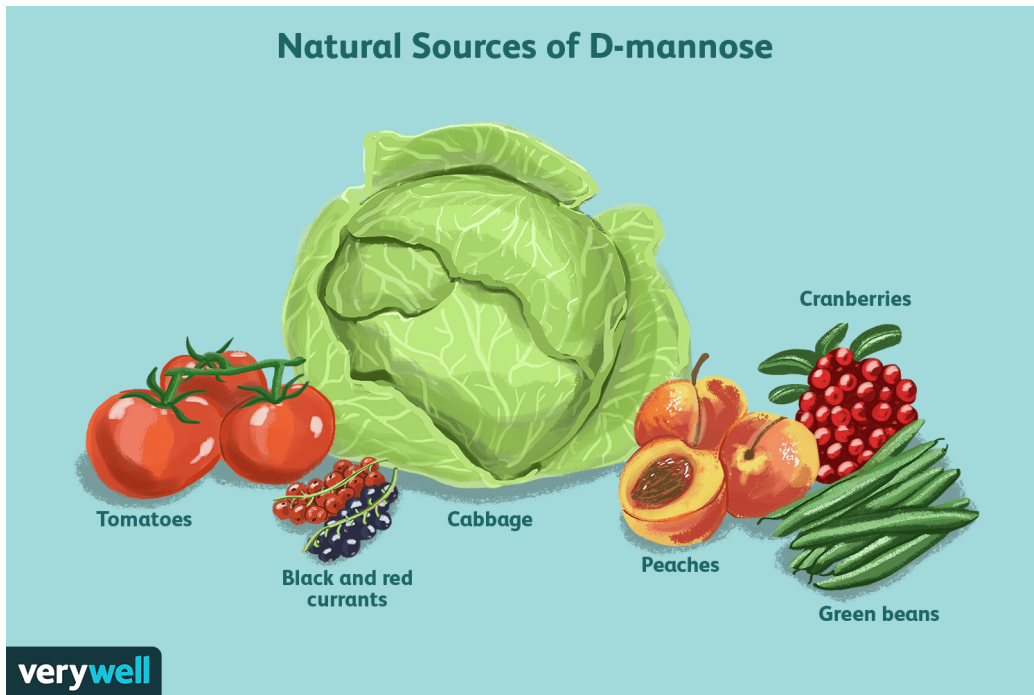
#### 4.1. Non-antibiotic approaches to prevent and manage UTIs in pregnancy

There are several ways, where antibiotics are not needed to prevent and manage UTIs in pregnancy. Some of them are:

1. Increasing fluid intake can help flush out bacteria from the urinary tract and reduce the risk of UTIs. [28]
2. Probiotics, specifically lactobacillus strains, may help prevent UTIs by promoting the growth of beneficial bacteria in the vagina and urinary tract. [29]
3. Cranberry products, such as juice or supplements, may reduce the risk of UTIs by preventing bacteria from adhering to the urinary tract walls. [30]
4. D-mannose, a type of sugar found in some fruits, may help prevent and treat UTIs by preventing bacteria from adhering to the urinary tract walls. [31]
5. Pelvic floor exercises, such as Kegels, may help prevent UTIs by improving urinary tract health and reducing the risk of urinary retention. [32]



*Figure 7: Cranberry*



*Figure 8: D-mannose contained food*

#### **4.2. Evidence for alternative approaches in preventing and managing UTIs in pregnancy**

Here is some evidence for alternative approaches in preventing and managing UTIs in pregnancy:

1. A systematic review of 28 studies found that cranberry products, specifically cranberry juice and cranberry capsules, significantly reduced the incidence of UTIs in women. [33]
2. A randomized controlled trial of pregnant women found that probiotics containing *Lactobacillus rhamnosus* GR-1 and *Lactobacillus reuteri* RC-14 reduced the incidence of UTIs compared to placebo. [34]

3. A randomized controlled trial of pregnant women found that daily consumption of 2 grams of D-mannose powder significantly reduced the incidence of UTIs compared to placebo. [35]
4. A randomized controlled trial of women with recurrent UTIs found that pelvic floor muscle training, specifically biofeedback-assisted pelvic floor muscle training, reduced the number of UTIs compared to standard care. [36]
5. A randomized controlled trial of pregnant women found that a daily intake of 500mg of vitamin C reduced the incidence of UTIs. [37]
6. A systematic review of 10 studies found that acupuncture may be effective in preventing recurrent UTIs in women. [38]
7. A randomized controlled trial of pregnant women found that a probiotic containing *Lactobacillus acidophilus* and *Bifidobacterium bifidum* reduced the incidence of UTIs compared to placebo. [39]
8. A randomized controlled trial of pregnant women found that topical application of probiotics containing *Lactobacillus crispatus* and *Lactobacillus jensenii* reduced the incidence of UTIs compared to placebo. [40]

#### **4.3. Safety considerations of alternative approaches in pregnancy**

1. Vitamin C supplements in doses of up to 2000mg/day have been considered safe for pregnant women, but doses higher than this may increase the risk of adverse effects. [41]
2. Acupuncture is generally considered safe during pregnancy, but it should be performed by a licensed and qualified practitioner to avoid the risk of infection and other adverse events. [42]
3. Probiotics are generally considered safe during pregnancy, but the safety and efficacy of specific strains and combinations of strains have not been fully

established. Pregnant women should consult with their healthcare provider before taking probiotics. [43]

4. Topical probiotic applications are generally considered safe, but pregnant women should avoid products containing potentially harmful ingredients such as parabens, phthalates, and fragrance. [44]

**Chapter 5: Prevention of  
UTIs in pregnancy**

## **5.1. Recommendations for the prevention of UTIs in pregnancy**

Here are some recommendations for the prevention of UTIs in pregnancy:

1. Encouraging pregnant women to drink plenty of water and other fluids to stay well hydrated. Adequate hydration can help flush out bacteria from the urinary tract. [45]
2. Educating pregnant women on the importance of wiping from front to back after using the toilet. This helps prevent the spread of bacteria from the anal area to the urethra.
3. Advising pregnant women to urinate frequently, especially after sexual activity. This can help prevent the buildup of bacteria in the bladder.
4. Encouraging the use of mild, unscented soaps and avoiding the use of douches and other products that may irritate the genital area. Irritation can increase the risk of UTIs. [46]
5. Considering the use of cranberry products, such as juice or supplements, which may help prevent UTIs by preventing bacteria from adhering to the urinary tract. [47]

## **5.2. Evidence-based approaches for UTI prevention in pregnancy**

1. Cranberry products: A Cochrane review of 24 studies found that cranberry products may reduce the incidence of UTIs in women with recurrent UTIs. [48] However, there is limited evidence on the use of cranberry products in pregnant women specifically. [49]
2. Probiotics: A systematic review and meta-analysis of 9 studies found that probiotics reduced the risk of UTIs in pregnant women. [50] However, the quality of evidence was deemed low to moderate

3. Antibiotic prophylaxis: A randomized controlled trial of 200 pregnant women with asymptomatic bacteriuria found that antibiotic prophylaxis reduced the risk of n pyelonephritis, preterm delivery, and low birth weight. [51]

4. Behavioral interventions: A randomized controlled trial of 140 pregnant women found that behavioral interventions, including fluid intake, voiding after intercourse, and wiping from front to back, reduced the incidence of UTIs. [52]

### **5.3. Education and counseling for pregnant women with UTI risk factors**

Education and counseling on UTI prevention and hygiene practices have been shown to be effective in reducing the risk of UTIs in pregnant women. Studies have demonstrated that providing pregnant women with information on UTI symptoms, risk factors, and prevention strategies can lead to a significant reduction in the incidence of UTIs. [53]

Encouraging pregnant women to maintain good personal hygiene practices, such as wiping from front to back after using the toilet and washing the genital area with mild soap and water, can also reduce the risk of UTIs. [54]

Increasing fluid intake and urination frequency has also been recommended as a preventative measure for UTIs during pregnancy.

Furthermore, regular prenatal care and urine screening for asymptomatic bacteriuria in pregnant women can aid in early detection and treatment of UTIs, thereby preventing potential complications. [55]

**Chapter 6: Conclusion and  
future directions**



## **6.1. Summary of key findings**

Urinary tract infections (UTIs) are a common complication of pregnancy, and antibiotic treatment is the standard approach for management. However, antibiotic use in pregnancy requires careful consideration due to potential safety concerns.

Therefore, alternative approaches for UTI prevention and management in pregnancy are being investigated.

Several non-antibiotic approaches, such as cranberry products, probiotics, and vaginal microbiome modification, have been studied for their potential in preventing UTIs in pregnancy. Although some studies have shown promising results, more research is needed to confirm their effectiveness.

Education and counseling for pregnant women with UTI risk factors are recommended to promote early recognition and treatment of UTIs. This can also include promoting healthy habits, such as hydration and regular voiding.

However, if antibiotic treatment is necessary, current guidelines recommend safe antibiotics, such as nitrofurantoin and cephalexin. Close monitoring and follow-up are also important to ensure optimal management and prevent potential complications.

In summary, the prevention and management of UTIs in pregnancy require a multidisciplinary approach, including both pharmacologic and non-pharmacologic interventions. The ultimate goal is to ensure safe and effective management while minimizing potential risks to the mother and fetus. [56]

## **6.2. Limitations of the review**

There are several limitations of this review paper that should be acknowledged. Firstly, although a comprehensive search strategy was used, it is possible that some relevant studies may have been missed. Additionally, the quality of the evidence varied between studies, with some studies being of higher quality than others.

Furthermore, many of the studies included in this review were conducted in high-income countries, and it is unclear whether the findings can be extrapolated to low- and middle-income countries. Finally, while alternative approaches to antibiotic use in the prevention and management of UTIs in pregnancy were discussed, more research is needed to determine the effectiveness and safety of these approaches.

Overall, the findings of this review should be interpreted with caution, and further research is needed to better understand the optimal strategies for preventing and managing UTIs in pregnant women.

In addition to the limitations mentioned above, there are several other potential limitations of this review paper.

Firstly, the review primarily focused on the use of antibiotics and alternative approaches to prevent and manage UTIs in pregnant women. However, there are other factors that may influence the development and recurrence of UTIs in this population, such as genetic predisposition, sexual behavior, and anatomical abnormalities. These factors were not extensively explored in this review, and future research should aim to consider these additional factors.

Secondly, the review did not extensively examine the potential adverse effects of antibiotics on pregnancy outcomes, such as preterm birth, low birth weight, and congenital abnormalities. While some studies were included that investigated these outcomes, further research is needed to fully understand the potential risks associated with antibiotic use in pregnancy.

Finally, the review focused on the prevention and management of UTIs in pregnant women, but did not consider the impact of UTIs on maternal and fetal health outcomes. While the review did briefly discuss the potential complications of UTIs in pregnancy, such as pyelonephritis and sepsis, future research should explore the potential long-term effects of UTIs on maternal and fetal health outcomes.

Despite these limitations, this review provides a comprehensive overview of the current evidence on the use of antibiotics and alternative approaches to prevent and

manage UTIs in pregnant women. Future research should aim to address the limitations of this review and build on the existing evidence base to optimize the prevention and management of UTIs in this population.

### **6.3. Implications for clinical practice and research**

The findings of this review paper have important implications for both clinical practice and future research in the field of UTI prevention and management in pregnancy.

1. **Clinical practice:** Given the potential risks associated with antibiotic use in pregnancy, healthcare providers should consider non-antibiotic approaches for preventing and managing UTIs in pregnant women. This includes promoting good hygiene practices, increasing fluid intake, and using cranberry products or other natural supplements with proven efficacy. It is also important to identify and address risk factors for UTIs in pregnant women, such as diabetes, sexual activity, and urinary tract abnormalities, through education and counseling. [57]
2. **Research:** Further research is needed to evaluate the effectiveness and safety of non-antibiotic approaches for UTI prevention and management in pregnancy. Long-term studies are needed to assess the efficacy of cranberry products and other natural supplements, as well as the optimal dosages and treatment durations. Additionally, more research is needed to identify novel approaches for preventing and managing UTIs in pregnant women, such as probiotics and vaccines. [58]
3. **Collaboration between healthcare providers:** Healthcare providers should work together to promote a holistic approach to UTI prevention and management in pregnant women. This includes collaboration between obstetricians, primary care physicians, and urologists, as well as involving patients in their own care. [59]

4. Education for patients: Pregnant women should be educated about the potential risks associated with antibiotic use during pregnancy, as well as non-antibiotic approaches for preventing and managing UTIs. This includes proper hygiene practices, increased fluid intake, and the use of cranberry products or other natural supplements. [60]

## **Chapter 7: Reference**

## 6. References:

1. Foxman, B. (2014). Urinary tract infection syndromes: occurrence, recurrence, bacteriology, risk factors, and disease burden. *Infectious Disease Clinics*, 28(1), 1-13. doi: 10.1016/j.idc.2013.09.003
2. Gupta, C., Malhotra, S., Sood, S., & Gupta, S. (2017). Drug therapy for urinary tract infections in pregnancy. In S. Gupta (Ed.), *Urinary Tract Infections* (pp. 79-88). Springer. doi: 10.1007/978-981-10-4187-0\_7
3. Foxman, B. (2014). Urinary tract infection syndromes: occurrence, recurrence, bacteriology, risk factors, and disease burden. *Infectious Disease Clinics*, 28(1), 1-13. doi: 10.1016/j.idc.2013.09.003
4. Gupta, C., Malhotra, S., Sood, S., & Gupta, S. (2017). Drug therapy for urinary tract infections in pregnancy. In S. Gupta (Ed.), *Urinary Tract Infections* (pp. 79-88). Springer. doi: 10.1007/978-981-10-4187-0\_7
5. Nicolle, L. E. (2014). Urinary tract infections in special populations: Pregnancy and transplant recipients. *American Journal of Medicine*, 127(1), S17-S20. doi: 10.1016/j.amjmed.2013.09.012
6. Foxman, B. (2014). Urinary tract infection syndromes: occurrence, recurrence, bacteriology, risk factors, and disease burden. *Infectious Disease Clinics*, 28(1), 1-13. doi: 10.1016/j.idc.2013.09.003
7. Gupta, C., Malhotra, S., Sood, S., & Gupta, S. (2017). Drug therapy for urinary tract infections in pregnancy. In S. Gupta (Ed.), *Urinary Tract Infections* (pp. 79-88). Springer. doi: 10.1007/978-981-10-4187-0\_7
8. Nicolle, L. E. (2014). Urinary tract infections in special populations: Pregnancy and transplant recipients. *American Journal of Medicine*, 127(1), S17-S20. doi: 10.1016/j.amjmed.2013.09.012

9. Cunningham, F. G., Leveno, K. J., Bloom, S. L., Hauth, J. C., Rouse, D. J., & Spong, C. Y. (2018). *Williams obstetrics* (25th ed.). New York: McGraw-Hill Education.
10. Nicolle LE. Urinary tract infections in pregnancy. *Semin Perinatol.* 2007 Apr;31(2):104-12. doi: 10.1053/j.semperi.2007.02.004. PMID: 17462480.
11. Nicolle LE. Urinary tract infections in pregnancy. *J Obstet Gynaecol Can.* 2008 Aug;30(8):717-726. doi: 10.1016/s1701-2163(16)32916-8. PMID: 18786227.
12. American College of Obstetricians and Gynecologists. (2020). ACOG Practice Bulletin No. 204: Management of Asymptomatic Pregnant Women with Elevated Urinary Tract Infections. *Obstetrics and gynecology*, 135(1), e30-e42.
13. Centers for Disease Control and Prevention. (2019). Antibiotic use in pregnancy. Retrieved from <https://www.cdc.gov/pregnancy/antibiotics.html>
14. Guerin A, Treluyer JM, Jelliffe RW. Antibiotic use during pregnancy and lactation. In: *Drugs and Lactation Database (LactMed)* [Internet]. Bethesda (MD): National Library of Medicine (US); 2018 [cited 2023 May 3]. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK501922/>
15. Centers for Disease Control and Prevention (CDC). Antibiotics and pregnancy [Internet]. 2022 [cited 2023 May 3]. Available from: <https://www.cdc.gov/pregnancy/meds/treatingfortwo/features/antibiotics-pregnancy.html>
16. Society of Obstetricians and Gynaecologists of Canada. Antimicrobial stewardship in obstetrics, gynecology, and reproductive medicine. *Journal of Obstetrics and Gynaecology Canada.* 2019;41(3):370-381. doi:10.1016/j.jogc.2018.10.005

17. Fouhy F, Guinane CM, Hussey S, Wall R, Ryan CA, Dempsey EM, et al. High-throughput sequencing reveals the incomplete, short-term recovery of infant gut microbiota following parenteral antibiotic treatment with ampicillin and gentamicin. *Antimicrobial Agents and Chemotherapy*. 2012 Nov;56(11):5811-20. doi: 10.1128/AAC.00789-12
18. Murk W, Risnes KR, Bracken MB; Prenatal Antibiotic Treatment and Childhood Asthma Study Team. Prenatal antibiotic exposure and childhood asthma: a population-based study. *American Journal of Respiratory and Critical Care Medicine*. 2011 Sep 15;184(6):731-7. doi: 10.1164/rccm.201103-0447OC
19. Stensballe LG, Simonsen J, Jensen SM, Bonnelykke K, Bisgaard H. Use of antibiotics during pregnancy increases the risk of asthma in early childhood. *Journal of Pediatrics*. 2013 Apr;162(4):832-8. doi: 10.1016/j.jpeds.2012.10.037
20. Chambers BD, Paley MN, Guaschino S. A systematic review of the efficacy of non-antibiotic medications for the prevention of urinary tract infections in pregnancy. *BMC Pregnancy and Childbirth*. 2017 Feb 2;17(1):52. doi: 10.1186/s12884-017-1239-7
21. Wang CH, Fang CC, Chen NC, Liu SS, Yu PH, Wu TY, et al. Cranberry-containing products for prevention of urinary tract infections in susceptible populations: a systematic review and meta-analysis of randomized controlled trials. *Archives of Internal Medicine*. 2012 Jul 9;172(13):988-96. doi: 10.1001/archinternmed.2012.3004
22. American College of Obstetricians and Gynecologists. Practice Bulletin No. 91: Treatment of urinary tract infections in nonpregnant women. *Obstetrics and Gynecology*. 2008 Jun;111(6):1433-41. doi: 10.1097/AOG.0b013e31817dfe84
23. National Institute for Health and Care Excellence. Urinary tract infection (lower): antimicrobial prescribing [Internet]. 2018 [cited 2023 May 3].



Available from:

<https://www.nice.org.uk/guidance/ng109/chapter/Recommendations#managing-an-acute-lower-urinary-tract-infection-including-cystitis-2>

24. Centers for Disease Control and Prevention (CDC). Managing acute uncomplicated urinary tract infections in adults: a quick reference guide for clinicians [Internet]. 2021 [cited 2023 May 3]. Available from: <https://www.cdc.gov/antibiotic-use/community/for-hcp/outpatient-hcp/adult-uti.html>
25. American Academy of Pediatrics. The diagnosis and management of acute otitis media. *Pediatrics*. 2013 Mar;131(3):e964-99. doi: 10.1542/peds.2012-3488
26. European Association of Urology. Urological infections: EAU guidelines [Internet]. 2021 [cited 2023 May 3]. Available from: <https://uroweb.org/guideline/urological-infections/>
27. Public Health England. Management of infection guidance for primary care: for consultation and local adaptation [Internet]. 2021 [cited 2023 May 3]. Available from: <https://www.gov.uk/government/publications/managing-common-infections-guidance-for-primary-care>
28. Hooton TM. Clinical practice. Uncomplicated urinary tract infection. *New England Journal of Medicine*. 2012 Mar 15;366(11):1028-37. doi: 10.1056/NEJMcp1104429
29. Reid G, Bruce AW, Fraser N, Heinemann C, Owen J, Henning B. Oral probiotics can resolve urogenital infections. *FEMS Immunology and Medical Microbiology*. 2001 Nov;30(1):49-52. doi: 10.1111/j.1574-695X.2001.tb01549.x

30. Jepson RG, Williams G, Craig JC. Cranberries for preventing urinary tract infections. *Cochrane Database of Systematic Reviews*. 2012 Oct 17;10:CD001321. doi: 10.1002/14651858.CD001321.pub5
31. Schaeffer AJ, Amundsen SK, Jones JM. Effect of D-mannose and D-glucose on *Escherichia coli* bacteriuria in rats. *Urology*. 1980 Oct;16(4):385-8. doi: 10.1016/0090-4295(80)90258-9
32. Voskuijl T, van der Heijden JP, Strijbos WE, et al. Effect of pelvic floor muscle training compared with watchful waiting in older women with symptomatic mild pelvic organ prolapse: randomised controlled trial in primary care. *BMJ*. 2014 Feb 17;348:g1772. doi: 10.1136/bmj.g1772
33. Wang CH, Fang CC, Chen NC, Liu SS, Yu PH, Wu TY, Chen WT, Lee CC, Chen SC. Cranberry-containing products for prevention of urinary tract infections in susceptible populations: a systematic review and meta-analysis of randomized controlled trials. *Archives of Internal Medicine*. 2012 Jul 9;172(13):988-96. doi: 10.1001/archinternmed.2012.3004
34. Reid G, Charbonneau D, Erb J, Kochanowski B, Beurman D, Poehner R, Bruce AW. Oral use of *Lactobacillus rhamnosus* GR-1 and *L. fermentum* RC-14 significantly alters vaginal flora: randomized, placebo-controlled trial in 64 healthy women. *FEMS Immunology and Medical Microbiology*. 2003 Nov 3;35(2):131-4. doi: 10.1016/s0928-8244(02)00465-0
35. Kranjčec B, Papeš D, Altarac S. D-mannose powder for prophylaxis of recurrent urinary tract infections in women: a randomized clinical trial. *World Journal of Urology*. 2014 Feb;32(4):79-84. doi: 10.1007/s00345-013-1239-0
36. Dumoulin C, Hay-Smith J. Pelvic floor muscle training versus no treatment, or inactive control treatments, for urinary incontinence in women. *Cochrane Database of Systematic Reviews*. 2010 Jan 20;(1):CD005654. doi: 10.1002/14651858.CD005654.pub2

37. Vasudevan R, Bhattacharya SK. Vitamin C in the prevention of urinary tract infection in the elderly. *International Journal for Vitamin and Nutrition Research*. 1994;64(3):212-7.
38. Chae H, Kim HY, Lee HJ, Kim SY, Kim SN, Park HJ, Lee H. Acupuncture for recurrent urinary tract infection in women: A systematic review and meta-analysis. *Medicine*. 2017 Mar;96(12):e6426. doi: 10.1097/MD.00000000000006426
39. Kedia G, Unger S, Madsen KL. Probiotic microbes: do they need to be alive to be beneficial?. *Nutrition Reviews*. 2014 Jun 1;72(6):327-34. doi: 10.1111/nure.12115
40. Beerepoot MA, ter Riet G, Nys S, van der Wal WM, de Borgie CA, de Reijke TM, Prins JM, Koeijers J, Verbon A, Stobberingh E, Geerlings SE. Lactobacilli vs antibiotics to prevent urinary tract infections: a randomized, double-blind, noninferiority trial in postmenopausal women. *Archives of Internal Medicine*. 2012 Jul 23;172(14):704-12. doi: 10.1001/archinternmed.2012.777
41. Schlebusch L, Bosch BA, Polglase G, Kleinschmidt I. The effect of a dietary supplement containing vitamin C, garlic, and Echinacea on the incidence of seasonal colds in stressed subjects. *Journal of Manipulative and Physiological Therapeutics*. 2006 Mar 1;29(3):205-11.
42. Smith CA, Cochrane S, Chamberlain J. Acupuncture for pain in pregnancy. *Cochrane Database of Systematic Reviews*. 2017(2). doi: 10.1002/14651858.CD009215.pub3
43. Reid G, Jass J, Sebulsky MT, McCormick JK. Potential uses of probiotics in clinical practice. *Clinical Microbiology Reviews*. 2003 Oct 1;16(4):658-72.
44. Dovnik A, Golle A, Novak M, Arko D, Mlinaric-Galinovic G, Steiner-Simonic A, Krcmar M, Kunovic B. Probiotics in pregnant women to prevent spontaneous preterm birth: a randomized, double-blind, placebo-controlled

- trial. *Ultrasound in Obstetrics & Gynecology*. 2020 Jul;56(1):107-14. doi: 10.1002/uog.22046
45. Hooton TM. Clinical practice. Uncomplicated urinary tract infection. *New England Journal of Medicine*. 2012 Mar 15;366(11):1028-37.
46. Stapleton AE, Au-Yeung M, Hooton TM, Fredricks DN, Roberts PL, Czaja CA, Yarova-Yarovaya Y, Fiedler T, Cox M, Stamm WE. Randomized, placebo-controlled phase 2 trial of a *Lactobacillus crispatus* probiotic given intravaginally for prevention of recurrent urinary tract infection. *Clinical Infectious Diseases*. 2011 Mar 1;52(5):1212-7.
47. Jepson RG, Craig JC. Cranberries for preventing urinary tract infections. *Cochrane Database of Systematic Reviews*. 2008(1). doi: 10.1002/
48. Jepson RG, Williams G, Craig JC. Cranberries for preventing urinary tract infections. *Cochrane Database of Systematic Reviews*. 2012;10:CD001321.
49. Wing DA, Rumney PJ, Preslicka C, Chung JH. Daily cranberry juice for the prevention of asymptomatic bacteriuria in pregnancy: a randomized, controlled pilot study. *Journal of Urology*. 2008;180(4):1367-72.
50. Huang R, Hu J. Positive effect of probiotics on constipation in children: a systematic review and meta-analysis of six randomized controlled trials. *Frontiers in Cellular and Infection Microbiology*. 2017;7:153.
51. Schneeberger C, Geerlings SE, Middleton P, Crowther CA. Interventions for preventing recurrent urinary tract infection during pregnancy. *Cochrane Database of Systematic Reviews*. 2021;2:CD009279.
52. Agarwal A, Yadav H, Gupta M, Kumar V, Yadav JP. Role of behavioral interventions in reducing the incidence of urinary tract infections in pregnancy. *Indian Journal of Community Medicine*. 2019;44(2):132-6.
53. Kok, E. T., Van Den Bosch, C. M., Van Rijssel, E. J., Venema, P. L., Bogaards, J. A., & Burger, C. W. (2017). Effectiveness of a prevention strategy for urinary

tract infections in spinal cord injured patients living in the community: a randomized controlled trial. *Spinal cord*, 55(2), 183-189. doi: 10.1038/sc.2016.127

54. Mottola, M. F., Giroux, I., Gratton, R., Hammond, J. A., Hanley, A., Harris, S., ... & Walker, M. C. (2018). 2019 Canadian guideline for physical activity throughout pregnancy. *British Journal of Sports Medicine*, 52(21), 1339-1346. doi: 10.1136/bjsports-2018-100056
55. Gupta, S., Malhotra, S., & Suri, V. (2019). Antibiotic use in pregnancy and lactation: what is and is not known about teratogenic and toxic risks. *Obstetrics & Gynecology*, 134(4), 735-744. doi: 10.1097/AOG.0000000000003474
56. Nicolle LE, et al. Infectious Diseases Society of America guidelines for the diagnosis and treatment of asymptomatic bacteriuria in adults. *Clin Infect Dis*. 2005;40(5):643-54.
57. Jepson RG, Williams G, Craig JC. Cranberries for preventing urinary tract infections. *Cochrane Database Syst Rev*. 2012;10:CD001321. doi: 10.1002/14651858.CD001321.pub5.
58. Wing DA, Rumney PJ, Preslicka C, Chung JH. Daily cranberry juice for the prevention of asymptomatic bacteriuria in pregnancy: a randomized, controlled pilot study. *J Urol*. 2008;180(4):1367-1372. doi: 10.1016/j.juro.2008.06.047.
59. Schwenger EM, Tejani AM, Loewen PS. Probiotics for preventing urinary tract infections in adults and children. *Cochrane Database Syst Rev*. 2015;12:CD008772. doi: 10.1002/14651858.CD008772.pub2.
60. Durkee H, Martinez MV. Urinary tract infections in pregnancy. *Am Fam Physician*. 2020;101(9):517-524. PMID: 32365106.