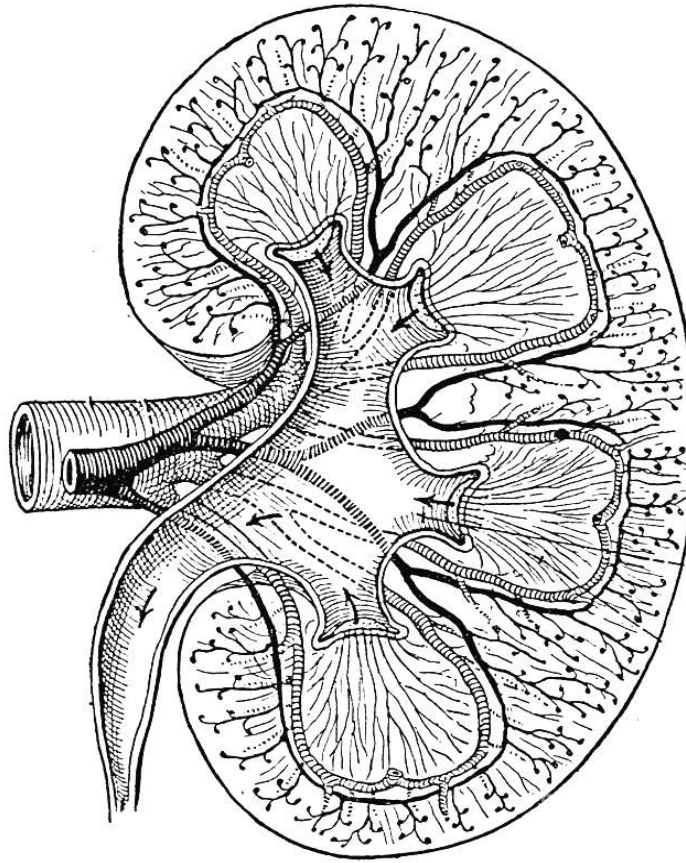


# Microbiology

435's Teamwork  
Renal Block

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- 
- Please contact the team leaders for any suggestion, question or correction.
  - Pay attention to the statements highlighted in **bold** and/or **red**.
  - Extra explanations are added for your understanding in grey.
  - **Footnotes color code:** General | **Females** | **Males**.

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# Management of Urinary Tract Infections

- Lecture Two -

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## Learning Objectives:

- Know the principal goal of management in UTI.
  - Understand that the management of UTI depends on several factors.
  - Know that antibiotics are the main treatment of UTI.
  - Know the management/treatment of different conditions of UTI.
- 



## Recall:

Urinary tract infections (UTIs) are a common type of infection caused by bacteria (most often *E. coli*) that travel up the urethra to the bladder. A bladder infection is called cystitis. If bacterial infection spreads to the kidneys and ureters, the condition is called pyelonephritis. Cystitis is considered a lower urinary tract infection. Pyelonephritis is an upper urinary tract infection and is much more serious.<sup>1</sup>

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<sup>1</sup> Milton S. Hershey Medical Center.

## What is the goal of managing UTIs?

- The principal goal of management of UTI is to **eradicate**<sup>2</sup> the offending organisms from the urinary bladder and tissues by using **antibiotics**.

## What does the choice of antibiotics depends upon?

1. Whether the infection is **complicated** or **uncomplicated**.
2. Whether the infection is **primary** or **recurrent**.
3. **Type of patient** (pregnant, child, hospitalized or not, diabetic... etc.)
4. **Bacterial** count.<sup>3</sup>
5. Presence of **symptoms**.

## Relapsing<sup>4</sup> infection:

- Caused by **treatment failure**<sup>5</sup>, **structural abnormalities**<sup>6</sup> or **abscesses**<sup>7</sup>.
- Antibiotics that were used at the **initial infection**.
- Treatment for **7-14 days**.

## When to consult the doctor?

- If **symptoms** are persisting<sup>8</sup>, or change occurs in symptoms.
- **Pregnant women**.
- More than **4 infections** per year.
- **Impaired** immune system.<sup>9</sup>
- Previous kidney infections.
- **Structural abnormalities** of urinary tract.
- **History** of infection with antibiotic resistant bacteria.

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After we have known the management's basics, we will address the antibiotics used for each case.

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<sup>2</sup> Destroy.

<sup>3</sup> Done by Quantitative Culture, the quality of the sample is very important.

<sup>4</sup> Getting worse.

<sup>5</sup> Resistant.

<sup>6</sup> Obstruction or stones.

<sup>7</sup> Collection of pus, do Ultrasound to see collection or aspirate or CT to confirmed the diagnoses.

<sup>8</sup> When not responding to treatment.

<sup>9</sup> Diabetic and Immunocompromised patients.

Uncomplicated UTIs <sup>10</sup>	
<ul style="list-style-type: none"> <li>● <b>Low-risk for recurrent</b> infection<sup>11</sup>. Cure rate = 94%.</li> <li>● 3 days antibiotic without urine test.</li> <li>● Choice of antibiotic depend on susceptibility pattern of bacteria.</li> </ul>	
<b>Amoxicillin</b>	With or without clavulanate
<b>Cephalosporins</b>	First or second generation
<b>Fluoroquinolone</b>	Ciprofloxacin or Norfloxacin - <b>Not for pregnant women or children.</b> <sup>12</sup> - <u>First choice if other antibiotics are resistant.</u>
<b>TMP-SMX</b>	Trade names: Bactrim, Septra, Cotrimoxazole
<b>Nitrofurantoin<sup>13</sup></b>	For long term usage

Recurrent infections <sup>14</sup> <a href="#">Video</a>	
<ul style="list-style-type: none"> <li>● Patients with <b>two or more symptomatic UTIs within 3-6 months</b> or over a year.</li> <li>● Need preventive (<b>prophylactic</b>) therapy.</li> <li>● Antibiotic should be taken as soon as symptoms develop.</li> <li>● If infection occurs for less than twice a year, a clean catch urine test should be taken for culture and treated as initial attack for 3 days.</li> </ul>	
Postcoital antibiotics	Prophylactic antibiotics
<ul style="list-style-type: none"> <li>- If recurrent UTI is <b>related to sexual activity</b> and episodes recur <b>more than 2 times within 6 months.</b></li> <li>- A single preventive dose must be taken <b>immediately</b> after intercourse.</li> </ul>	<ul style="list-style-type: none"> <li>- Optional for patients who do not respond to other measures.</li> <li>- Reduces recurrence by up to 95%.</li> <li>- <b>Low dose</b> antibiotic taken <b>continuously for 6 months or longer.</b></li> <li>- Antibiotic taken at bedtime more effective.</li> </ul>
<b>TMP-SMX</b>	
<b>Cephalexin</b>	
<b>Ciprofloxacin</b>	<b>Nitrofurantoin</b>

<sup>10</sup> Usually in women. Nonpregnant, young, healthy, sexually active females.

<sup>11</sup> If the patient relapses in uncomplicated infection, we should consider it a complicated infection.


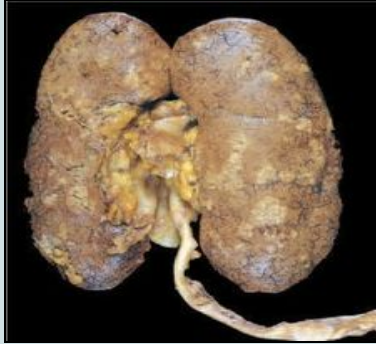
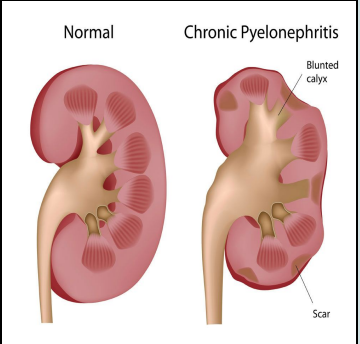
<sup>12</sup> Less than 8 years.

<sup>13</sup> Usually used as prophylaxis.

<sup>14</sup> 2 times per 6 months or 3 times per year.

What we do is : 1- Look for the causes 2- Investigate (X-ray) 3- Check for antibiotic susceptibility then give prophylaxis (minimal dose for a longer period of time). **Many clinicians choose nitrofurantoin.**

## Pyelonephritis<sup>1516</sup>

Uncomplicated	Moderate to severe	Chronic <sup>17</sup>
<ul style="list-style-type: none"> <li>● Patients with <b>fever, chills</b> and <b>flank pain</b><sup>18</sup>.</li> <li>● Non-pregnant, not nauseous or vomiting and have <b>no signs</b> of kidney involvement.</li> <li>● Can be treated at home with <b>oral antibiotics for 14 days</b> with one of the followings:               <ul style="list-style-type: none"> <li>- <b>First dose</b> may be given by <b>injection</b>.</li> <li>- A urine culture may be obtained within one week of completion of therapy and again after 4 weeks.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>● <b>Patients need hospitalization.</b></li> <li>● Antibiotic given by IV route for 3-5 days until symptoms are relieved for 24-48 hours.</li> <li>● If <b>fever and back pain</b> continue after 72 hours of antibiotic, imaging and tests must be indicated to exclude abscesses, obstructions or other abnormalities.</li> </ul>	<p style="text-align: center;">Those patients need long-term antibiotic treatment even during periods when they have <b>no symptoms</b>.</p>
<b>Cephalosporins</b>		
<b>Amoxicillin-Clavulanate</b>		
<b>Ciprofloxacin</b>		
<b>TMP-SMX</b>		
		

<sup>15</sup> Sometimes the urine will contain staph. Aureus which entered the kidney from the blood. Staph. Aureus will not usually cause UTI but we must tell the clinician that the patient has bacteremia. So we advise the doctor to order a blood culture.

<sup>16</sup> Very bad type. The patient will come in very sick and vomiting and you will have to give him/her IV antibiotic and will need admission if they can't eat or drink. Then you can give them the oral antibiotics for a longer period of time (up to 2 weeks).

Some patients will still have fever after the antibiotic treatment. These patients need to be evaluated by an ultrasound to see if there is any accumulation of pus in the kidney. If there is pus, it needs to be drained (it will not be treated by antibiotics)

<sup>17</sup> Very dangerous and will cause scarring. It may cause renal failure.

Pyelonephritis is considered chronic if it lasts 1-2 weeks.

<sup>18</sup> Pain or discomfort in your upper abdomen or back.

Pregnant women <sup>19</sup>	
<ul style="list-style-type: none"> <li>● <b>High risk</b> of UTIs and <b>complications</b><sup>20</sup>.</li> <li>● Should routinely be screened for UTIs.<sup>21</sup></li> <li>● Pregnant women with asymptomatic bacteriuria (<b>evidence of infection but no symptoms</b>) have 30% risk for <b>acute pyelonephritis</b> in the second or third trimester.</li> <li>● Screening and <b>3-5 days</b> of antibiotic are needed.</li> <li>● For uncomplicated UTI, <b>7-10 days</b> of antibiotic are needed.</li> </ul>	
Amoxicillin	
Ampicillin	
Cephalosporins	
Nitrofurantoin	
Quinolones	<b>Should never</b> <u>be taken by a pregnant woman</u>

Diabetic patients <sup>22</sup>
<ul style="list-style-type: none"> <li>● Have more frequent and more <b>severe UTIs</b><sup>23</sup>.</li> <li>● Treated for <b>7-14 days</b> with antibiotics, even those who have <b>uncomplicated</b> infections.</li> </ul>

Urethritis in men <sup>24</sup>	
<ul style="list-style-type: none"> <li>● Patients should also be tested for accompanying <b>sexually transmitted disease</b> (STD).</li> </ul>	
Doxycycline <sup>25</sup>	Require <b>7 days</b> regimen
Azithromycin	A single dose may be effective but not recommended to avoid spread to the prostate gland

<sup>19</sup> In pregnant women, hormones cause changes in the urinary tract, which predispose women to infections.

<sup>20</sup> Might cause abortion due to bacteremia or chorioamnionitis (Group B streptococci will cause fever and rupture of the membrane prematurely).

<sup>21</sup> It is very important to screen pregnant women for UTIs because they are at high risk of acquiring pyelonephritis.

<sup>22</sup> Asymptomatic UTI .Increases with longer duration and greater severity of diabetes.

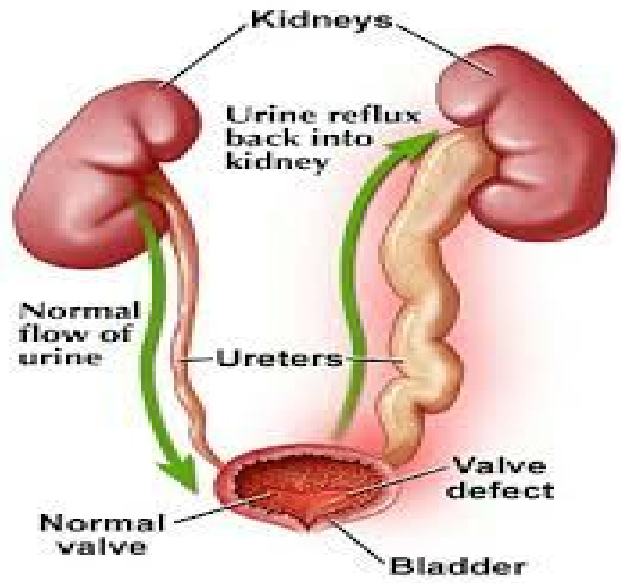
<sup>23</sup> Because they have diabetic nephropathy and their kidney function is not that great so they develop renal failure more easily than normal people.

<sup>24</sup> Sexually transmitted disease accompanied with Pus and urethral discharge **But** some patients present dysuria. If the culture was negative or the patient was symptomatic we have to suspect STD. Because the lab does not routinely check for Neisseria unless the doctor suspects urethritis and specifically asks for it.

<sup>25</sup> It will treat Neisseria and Chlamydia.

Children with UTI <sup>26</sup>	
<ul style="list-style-type: none"> <li>Treatment is sometimes given as IV.</li> </ul>	
TMP-SMX	
Cephalexin	
Gentamicin	Recommended as resistance to Cephalexin is increasing.

Vesicoureteral reflux (VUR)	
<p>Is the backward flow of urine from the bladder into the kidneys. Normally, urine flows from the kidneys through the ureters to the bladder. The pressure of urine in the bladder prevent urine from flowing backward through the ureters. VUR allows bacteria, which may be present in the urine in the bladder, to reach the kidneys. This can lead to kidney infection, scarring, and damage.</p> <ul style="list-style-type: none"> <li>Common in children with UTI.</li> <li>Can lead to <b>pyelonephritis</b> and <b>kidney damage</b>.</li> <li>Long-term antibiotic and <b>surgery</b> are used to correct VUR and prevent infections.</li> </ul>	
Cefixime (Suprax)	Use for 2-4 days for acute kidney infection
Gentamicin	One daily dose oral antibiotic then follows IV



<sup>26</sup> Very serious especially in males. You have to rule out vesicoureteral reflux. You have to admit the patient and do a radiological study, evaluate it and see what stage the patient is in and then treat accordingly (either medically or surgically to prevent complications)

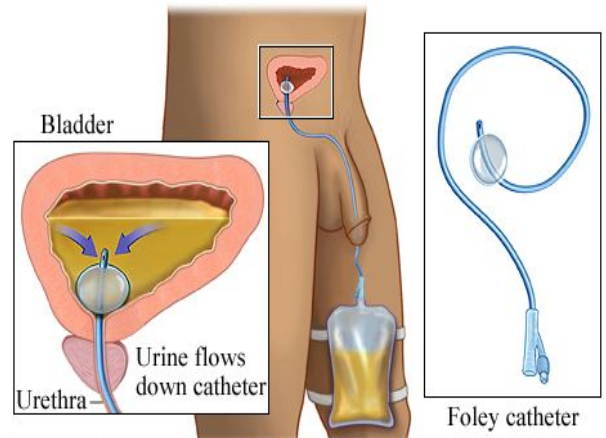
## What are urinary catheters<sup>27</sup>?

A urinary catheter is a tube placed in the body to drain and collect urine from the bladder when the patient is not able to do so, or if delicate urinary measures are required.

## Catheter-induced UTI<sup>28</sup>:

Catheter-related urinary tract infection (UTI) occurs because urethral catheters inoculated organisms into the bladder and promote colonization by providing a surface for bacterial adhesion and causing mucosal irritation. The presence of a urinary catheter is the most important risk factor for bacteriuria.

29



- Very common.
- Preventive measures are important.
- Catheter should not be used **unless absolutely necessary**.
- They should be **removed** as soon as possible.

## Intermittent<sup>30</sup> use of catheters:

- If catheter is required for long periods, it is best to be used **intermittently**.
- Daily hygiene<sup>31</sup> and use of **closed system** to prevent infection.
- May be replaced every 2 weeks to reduce risk of infection and irrigating bladder with antibiotics between replacements.

## Catheter induced infections:

Catheterized patients who develop UTI with symptoms<sup>32</sup> or at risk for sepsis<sup>33</sup> should be treated for each episode with antibiotics and catheter should be removed, if possible.

- Associated organisms<sup>34</sup> are constantly changing.
- May be multiple species of bacteria.
- Antibiotic therapy has little benefit if the catheter is to remain in place for long period.
- Antibiotic use for prophylaxis is **rarely** recommended since high bacterial counts present and patients do not develop symptomatic UTI.

<sup>27</sup> جهاز القسطرة البولية.

<sup>28</sup> If the catheter is not needed, we should remove it.

<sup>29</sup> Medscape.

<sup>31</sup> By using antisepsis and washing hands.

<sup>32</sup> Sepsis will induce fever.

<sup>33</sup> We have to get a blood culture, and get urine from the bladder **not** from the bag.

<sup>34</sup> Could be Acinetobacter, E.coli, Pseudomonas **but usually** it's Multiple resistant bacteria.

<sup>30</sup> بشكل متقطع. عدم الاستمرارية.



## Asymptomatic Bacteriuria:

Patients might come in **without any symptoms** and for some reason the clinician took a urine sample and found a significant number of bacteria in the urine.

**Asymptomatic bacteriuria is treated in 3 cases only:**

1. In case of **kidney transplant**; because the patients will not develop any symptoms since they are **immunosuppressed**.
2. **Pregnant Ladies**; because if you do not treat the infection they will develop **chorioamnionitis**<sup>35</sup> and have an abortion. Pregnant ladies should be screened from the first visit to the doctor.
3. **Patients going for cystoscopy**; because the scope is going to enter the urinary tract so it might **introduce the infection to the ureter or the kidney**.

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### Resources:

Prof. Hanan Habib's 2016 lecture.

Dr. Ali Someli's 2016 lecture.

### Helpful read:

<http://www.webmd.com/a-to-z-guides/antibiotics-for-urinary-tract-infections-uti>

### Additional Videos:

[UTIs in children](#)

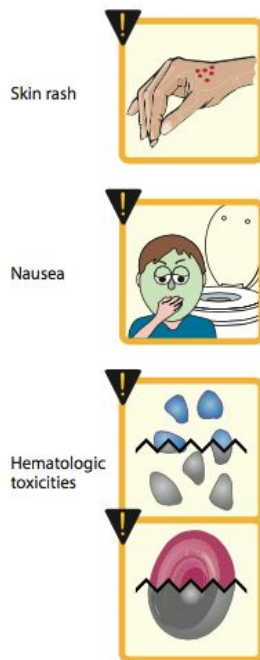
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<sup>35</sup> Also known as intra-amniotic infection (IAI) is an inflammation of the fetal membranes (amnion and chorion) due to a bacterial infection.

## VI. URINARY TRACT ANTISEPTICS/ANTIMICROBIALS

UTIs are prevalent in women of child-bearing age and in the elderly population. *E. coli* is the most common pathogen, causing about 80% of uncomplicated upper and lower UTIs. *Staphylococcus saprophyticus* is the second most common bacterial pathogen causing UTIs. In addition to *cotrimoxazole* and the quinolones previously mentioned, UTIs may be treated with any one of a group of agents called urinary tract antiseptics,



**Figure 40.14**  
Some adverse reactions to *cotrimoxazole*.

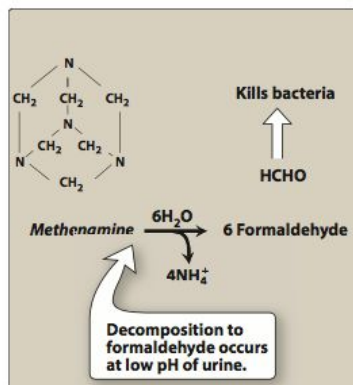
including *methenamine*, *nitrofurantoin*, and the quinolone *nalidixic acid* (not available in the United States). These drugs do not achieve antibacterial levels in the circulation, but because they are concentrated in the urine, microorganisms at that site can be effectively eradicated.

### A. Methenamine

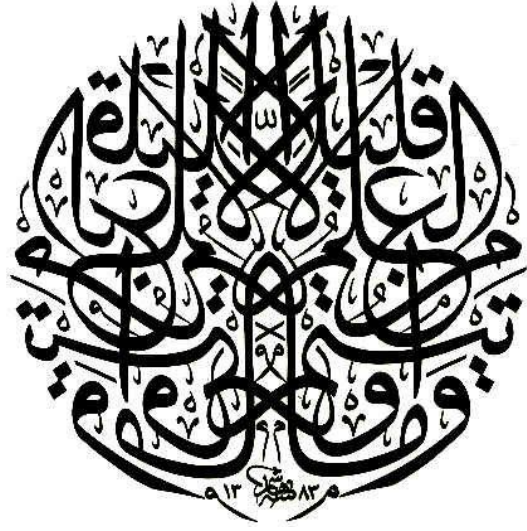
- Mechanism of action:** *Methenamine* [meth-EN-a-meen] decomposes at an acidic pH of 5.5 or less in the urine, thus producing formaldehyde, which acts locally and is toxic to most bacteria (Figure 40.15). Bacteria do not develop resistance to formaldehyde, which is an advantage of this drug. [Note: *Methenamine* is frequently formulated with a weak acid (for example, mandelic acid or hippuric acid) to keep the urine acidic. The urinary pH should be maintained below 6. Antacids, such as *sodium bicarbonate*, should be avoided.]
- Antibacterial spectrum:** *Methenamine* is primarily used for chronic suppressive therapy to reduce the frequency of UTIs. Routine use in patients with chronic urinary catheterization to reduce catheter-associated bacteriuria or catheter-associated UTI is not generally recommended. *Methenamine* should not be used to treat upper UTIs (for example, pyelonephritis). Urea-splitting bacteria that alkalinize the urine, such as *Proteus* species, are usually resistant to the action of *methenamine*.
- Pharmacokinetics:** *Methenamine* is administered orally. In addition to formaldehyde, ammonium ions are produced in the bladder. Because the liver rapidly metabolizes ammonia to form urea, *methenamine* is contraindicated in patients with hepatic insufficiency, as ammonia can accumulate. *Methenamine* is distributed throughout the body fluids, but no decomposition of the drug occurs at pH 7.4. Thus, systemic toxicity does not occur, and the drug is eliminated in the urine.
- Adverse effects:** The major side effect of *methenamine* is gastrointestinal distress, although at higher doses, albuminuria, hematuria, and rashes may develop. *Methenamine mandelate* is contraindicated in patients with renal insufficiency, because mandelic acid may precipitate. [Note: Sulfonamides, such as *cotrimoxazole*, react with formaldehyde and must not be used concomitantly with *methenamine*. The combination increases the risk of crystalluria and mutual antagonism.]

### B. Nitrofurantoin

*Nitrofurantoin* [nye-troe-FYOOR-an-toyn] sensitive bacteria reduce the drug to a highly active intermediate that inhibits various enzymes and damages bacterial DNA. It is useful against *E. coli*, but other common urinary tract gram-negative bacteria may be resistant. Gram-positive cocci (for example, *S. saprophyticus*) are typically susceptible. Hemolytic anemia may occur with *nitrofurantoin* use in patients with G6PD deficiency. Other adverse effects include gastrointestinal disturbances, acute pneumonitis, and neurologic problems. Interstitial pulmonary fibrosis has occurred in patients who take *nitrofurantoin* chronically. The drug should not be used in patients with significant renal impairment or women who are 38 weeks or more pregnant.



**Figure 40.15**  
Formation of formaldehyde from *methenamine* at acid pH.



« وَيَسْأَلُونَكَ عَنِ الرُّوحِ قُلِ الرُّوحُ مِنْ أَمْرِ رَبِّي وَمَا أُوتِيتُمْ مِنَ الْعِلْمِ إِلَّا قَلِيلًا »

سورة الإسراء الآية ٨٥

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### **Team Leaders**

Sara Alenezy & Ali Alzahrani

### **Heartful thanks to our phenomenal team members**

Fawzan Alotaibi  
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Munerah Alomari  
Nojood Alhaidari  
Elham Alzahrani  
Shahad Alenezy  
Maryam Saidan  
Johara Almalki  
Noura ALTawil  
Ola Alnuhayer  
Areeb Alogaiel  
Deema Alfaris  
Suha Alenazi