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Antibiotic UTIs susceptibility of bacterial in Tikrit city

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Abstract

Background: Urinary Tract Infection (UTI) is defined as a condition where pathogen infection occurs upon the urinary tract. The most common symptom is infection, however there are rare cases that it may become life-threatening. UTI is a critical infection since it could result in high mortality and morbidity for both males and females. For the past 10 years, it was a challenge to treat and it is worsened by antimicrobial resistance, resulting in a grave health issue.

Objectives: The purpose of this study is to explore bacterial resistance to a few antibiotics that are being used to treat UTIs within the city of Tikrit.

Methods: The study sample consists of 25 gram-positive that made up of 10 isolates, which consist of *Staphylococcus aureus* and 1 of *Staphylococcus epidermidis*. The remaining is gram-negative bacteria that consist of 5 isolates of *E. coli,* 7 of *Klebsiella pneumoniae,* and 2 of *Proteus mirabilis*. These bacteria are isolated from patients. Vitek2 system was used to diagnose the isolates. This study adopted the Disk diffusion method in order to test the isolates' sensitivity upon the eight antibiotics.

Results: The findings show Meropenem has 80% sensitivity while the sensitivity of Levofloxacin, Gentamicin, and Amikacin range from 60% to 68%. The highest resistant rate occurs with Trimethoprim-sulfamethoxazole (TM) at 36%. Meanwhile, Cefotaxime, Ceftriaxone, and Amoxicillin-clavulanic acid's resistant rate is at 28%.

Conclusion: The isolated bacteria demonstrate high sensitivity when being subjected to Meropenem. However, it is very resistant toward Trimethoprim-Sulfamethoxazole.

حساسية المضادات الحيوية لألتهابات المسالك البولية البكتيرية في مدينة تكريت

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الخلاصة

يُعرَّف التهاب المسالك البولية بأنه حالةٌ تصيب المسالك البولية بعامل مُمرض يُسبب التهابًا . العرض الأكثر شيوعًا هو الالتهاب، إلا أن هناك حالاتٍ نادرةً قد تُهدّد الحياة. يُعدُّ التهاب المسالك البولية حاله اللتهابية حرجةً، إذ قد يُؤدّي إلى ارتفاع معدلات الوفيات والاعتلال لدى كلٍّ من الرجال والنساء. على مدى السنوات العشر الماضية، كان علاجه صعبًا، وقد تفاقم بسبب مقاومة مضادات الميكروبات، مما يُؤدّي إلى مشكلةٍ صحيةٍ خطيرة. الهدف من هذه الدراسة هو استكشاف مقاومة البكتيريا لبعض المضادات الحيوية المستخدمة لعلاج التهابات المسالك البولية في مدينة تكريت. تتكون الدراسة من ٢٥ عينة سريرية من بكتيريا موجبة الجرام (عشر عزلات من المكورات العنقودية الذهبية وواحدة من المكورات العنقودية البشروية) وسالبة الجرام (خمس عزلات من الإشريكية القولونية، وسبع عزلات من الكلبسيلة الرئوية، وعزلتان من المتقلبة الرائعة) من مريض مصاب بعدوى المسالك البولية في نوفمبر ٢٠٢٤ من مستشفى تكريت العام بمدينة تكريت. شُخِّصت العزلات باستخدام نظام في هذه الدراسة، استُخدمت طريقة الانتشار القرصي لاختبار حساسية العزلات تجاه ثمانية مضادات حيوية. أظهرت النتائج أن الميروبينيم يتمتع بحساسية 80%، بينما تتراوح حساسية الليفوفلوكساسين والجنتاميسين والأميكاسين بين 60% و68%. وتُسجل أعلى نسبة مقاومة مع تريميثوبريم-سلفاميثوكسازول بنسبه 36%. في حين تبلغ نسبة مقاومة سيفوتاكسيم وسيفترياكسون وأموكسيسيلين-حمض الكلافولانيك 28%. أظهرت البكتيريا المعزولة شديدة الحساسية للميروبينيم، ومقاومة عالية لتريميثوبريم-سلفاميثوكسازول

Introduction

Urinary tract infections (UTIs) are very common amongst a multitude of health issues. Each year, millions of individuals are diagnosed with UTIs. The severity of UTIs ranges from mild discomfort but if left untreated, it could lead to serious complications. Generally, UTIs are categorized as lower (cystitis) or upper UTIs (pyelonephritis) with a unique clinical feature for each [(1)]. UTIs are a result of urinary system being exposed to pathogenic bacteria, which results in inflammation and infection. There are many factors that contribute towards the clinical severity of UTIs such as immune response, type of bacteria and infection site [(2)]. Bacterial pathogen is the main cause of UTIs. In particular, Escherichia coli or E. coli is the prominent causes of 90% of UTIs diagnosis. Examples of other bacteria that causes UTIs albeit at lower frequency are Proteus mirabilis, Staphylococcus saprophyticus, Enterococcus faecalis, and Klebsiella pneumoniae [(3)]. Ceftriaxone and Cefotaxime are third-generation cephalosporins, which are antibiotics that are used to treat UTIs. They prevent the bacterial cell wall from being synthesized, the bacteria are unable to form the cell wall. This results in bacterial cell lysis and thus the infection is eliminated [(4)]. Clavulanic acid is a beta-lactamase inhibitor. It prevents the degradation of amoxicillin through beta-lactamase enzymes that are synthesized by resistant organism. Therefore, it will increase the efficiency when being administered for beta-lactamase-producing bacteria. Amikacin and Gentamicin are aminoglycosides, which means their antibacterial property central on binding the 30S ribosomal subunit. Levofloxacin disable DNA from supercoiling, leading to defragmentation and ultimately death to the bacterial cell. Sulfamethoxazole and Trimethoprim prevents dihydropteroate synthase and dihydrofolate reductase respectively. The prevention of both stops the synthetization of tetrahydrofolic acid. This molecule enables the synthetization of DNA and protein of the bacteria [(6)]. The purpose of this study is to explore and explain the antimicrobial resistance and sensitivity

situation of common uropathogens focused upon the city of Tikrit.

Methods

Experimental procedures

This study uses 25 isolates of gram-positive and gram-negative bacteria. Isolates were obtained from the urine of midstream patients across all ages and both genders in November 2024 from the Tikrit General Hospital located in the city of Tikrit. Blood agars (MacConkey agar, Eosin Methylene agar, and Mannitol salt agar plates) was used to inoculate the clinical samples. All the plates were subjected to incubation for 18 to 24 hours at the temperature 37 °C. Vitek2 system was used to determine all the isolates. This study uses eight antibiotics that are frequently used. Mueller-Hinton agar (MHA) has a consistent outcome thus was adopted as the main tool to conduct tests for antimicrobial susceptibility. Kirby-Bauer disk was utilized to perform the tests for the susceptibility of the antibacterial while standardization was carried out for bacterial suspension for the purpose of matching 0.5 McFarland turbidity standard [(7)]. A sterile cotton swab was used to spread the standardized suspension on the agar surface in a consistent manner to achieve a uniform distribution. Next, antibiotic-impregnated disks were meticulously placed upon the inoculated plates. The plates were subjected to incubation between 18 to 24 hours at a temperature of 37°C. Measurements were taken for the diameters of inhibition zones in millimeters following the guidelines set by the Clinical and Laboratory Standards Institute [(8)].

Ethical approval

The “Guide for the care and use of laboratory animals” was followed for all experimental protocols, which were approved by the Scientific Research Ethics Committee at Tikrit University's Pharmacy College (Ref. no. SREC18/2024-04-15).

Results

The findings of the study are presented in Table 1. It presents the sensitivity isolation when subjected to antibiotics of gram-positive bacteria such as *Staphylococcus aureus* and *Staphylococcus epidermidi* as well as gram-negative, which includes *E. coli, Klebsiella pneumoniae,* and *Proteus mirabilis*. The highest sensitivity at 80% is Meropenem (MEM). The highest resistant at 36% is Trimethoprim-sulfamethoxazole (TM). Moderate sensitivity is revealed for certain antibiotics such as Gentamicin (CN), Levofloxacin (LEV), and Amikacin (AK). The following figures show the inhibition zone diameters (mm) of the antibiotic’s sensitivity test (Figures 1-6).

Table 1: The number and rate of susceptibility of bacterial isolates to the antibiotics

Bacteria	CN (10mcg)	LEV (5mcg)	AK (10mcg)	MEM (10mcg)	TM (5mcg)	CTX (10mcg)	CRO (10mcg)	AMC (30mcg)
K .p1	20	37	23	40	30	32	38	20
S .a1	27	37	20	40	27	10	20	16
S.a2	20	0	27	18	17	0	0	0
S.a3	0	23	10	20	23	0	0	15
S .a4	0	23	7	18	30	0	0	0
K.p2	25	30	30	38	0	33	30	18
K.p3	20	37	23	38	26	34	35	15
S .a5	15	16	26	33	0	10	10	22
K.p4	17	37	25	39	31	35	36	15
E.c1	15	35	25	40	0	30	40	15
S.a6	20	33	20	33	24	0	13	15
K.p5	16	39	23	36	30	34	37	18
S.e 1	30	39	20	40	27	10	19	15
P.m1	15	20	15	40	0	37	40	15
P.m2	20	20	15	35	0	10	14	15
K.p6	25	30	23	30	40	30	40	15
E.c3	12	25	18	30	15	29	14	10
S.a7	23	27	20	30	20	10	10	10
K.p7	20	27	20	33	7	6	6	13
E.c2	20	10	20	38	0	0	0	0
S.a8	20	30	20	30	28	29	30	14
S.a 9	6	23	8	20	0	12	0	13
S.a10	8	20	8	16	5	6	6	20
E.c4	24	25	20	25	20	16	28	8
E.c5	26	31	20	39	7	27	35	17

K.p : *Klebsiella pneumonia; Se: Staphylococcus epidermidis; Sa : Staphylococcus aureus;* E. coli: *Escherichia coli; P.m: Proteus mirabilis*.

Figure 1: Clear evidence of Kirby-Bauer disk diffusion is sensitive towards Meropenem, intermediate sensitivity towards Levofloxacin and Gentamicin, and resistance towards ceftriaxone.

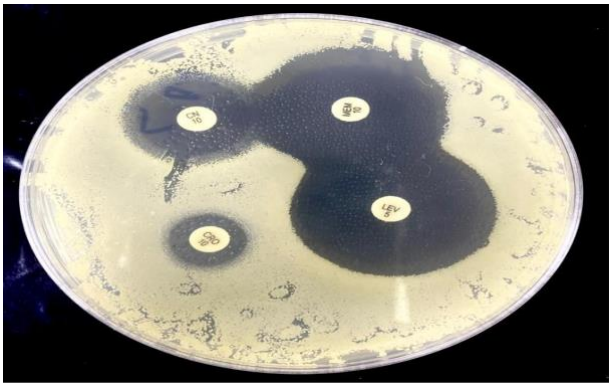

Figure (2) Kirby-Bauer disk diffusion is sensitive towards Meropenem and Levofloxacin, intermediate sensitivity towards Gentamicin while resistant towards Ceftriaxone.

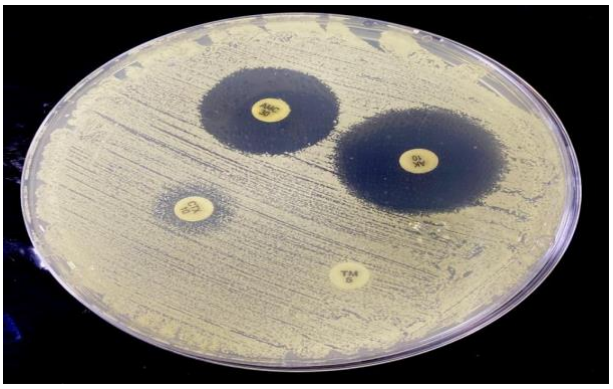

Figure 3: Clear evidence of Kirby-Bauer disk diffusion is sensitive towards Amikacin and Amoxicillin-clavulanic acid, while resistant towards trimethoprim-sulfamethoxazole and Cefotaxime.

Figure 4: Clear evidence of Kirby-Bauer disk diffusion is sensitive towards Trimethoprim-sulfamethoxazole, intermediate sensitivity towards Amikacin and Amoxicillin- clavulanic acid while resistant towards Cefotaxime.

Figure 5: Clear evidence of Kirby-Bauer disk diffusion is sensitive towards Meropenem and Levofloxacin and intermediate sensitivity towards Amikacin and Gentamicin.

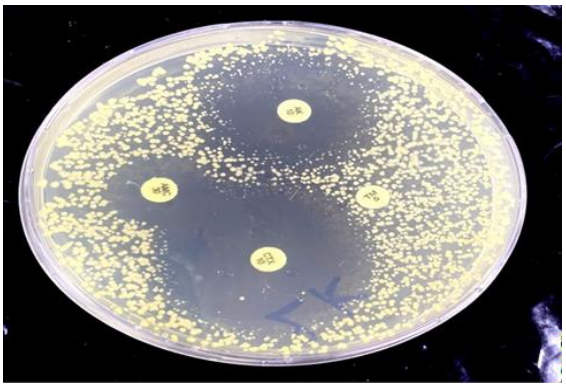

Figure 6: Clear evidence of Kirby-Bauer disk diffusion is sensitive towards Cefotaxime and Amikacin, intermediate sensitivity towards Amoxicillin-clavulanic acid while resistant towards Trimethoprim-sulfamethoxazole.

Figures 1-6: Inhibition zones diameters (mm) of the antibiotic's sensitivity test

Table 2 shows the sensitivity and resistance of all the samples when subjected to the following antibiotics: Gentamicin (CN, 10 mcg): 60% Sensitivity | 32% Intermediate Sensitivity | 8% Resistance. Levofloxacin (LEV, 5 mcg): 68% Sensitivity | 24% Intermediate Sensitivity | 8% Resistance. Amikacin (AK, 10 mcg): 64% Sensitivity | 28% Intermediate Sensitivity | 8% Resistance. Meropenem (MEM, 10 mcg): 80% Sensitivity | 16% Intermediate Sensitivity | 4% Resistance. Trimethoprim-sulfamethoxazole (TM, 5 mcg): 44% Sensitivity 20% Intermediate Sensitivity | 36% Resistance. Cefotaxime (CTX, 10 mcg): 52% Sensitivity | 20% Intermediate Sensitivity | 28% Resistance. Ceftriaxone (CRO, 10 mcg): 56% Sensitivity | 16% Intermediate Sensitivity | 28% Resistance. Amoxicillin-clavulanic acid (AMC, 30 mcg): 44% Sensitivity | 28% Intermediate Sensitivity | 28% Resistance.

Table (2) Results of antibiotics sensitivity test

Antibiotics	Sensitivity (S)	Intermediate (I)	Resistance (R)
MEM (10 mcg)	80% (20/25)	16% (4/25)	4% (1/25)
LEV (5 mcg)	68% (17/25)	24% (6/25)	8% (2/25)
CN (10 mcg)	60% (15/25)	32% (8/25)	8% (2/25)
AK (10 mcg)	64% (16/25)	28% (7/25)	8% (2/25)
CRO (10 mcg)	56% (14/25)	16% (4/25)	28% (7/25)
CTX (10 mcg)	52% (13/25)	20% (5/25)	28% (7/25)
TM (5 mcg)	44% (11/25)	20% (5/25)	36% (9/25)
AMC (30 mcg)	44% (11/25)	28% (7/25)	28% (7/25)

Discussions

Millions of individuals are infected with UTIs annually, and may result in serious health issues. UTIs can either be uncomplicated or complicated. UTIs is possible through complicated interaction between the pathogens with other organisms, potential host and the environment [(9)]. This study has demonstrated that antibiotics have a range of effectiveness when being administered to combat various strains of bacteria. Meropenem is the most activity at 80% sensitivity thus it is the ideal antibiotic to be used to administer against the tested strains. This result is in accordance to past research that focus on the wide ranges of Meropenem activities. For example, a study conducted by Paterson and Bonomo (2005) have revealed Meropenem is able to maintain its high effectiveness when being administered against spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae [(10)]. Antibiotics with intermediate sensitivity (60% to 68%) include Gentamicin, Levofloxacin, and Amikacin. Trimethoprim-sulfamethoxazole has the highest resistant rate (36%), and this means that there is an increased resistance for this antibiotic [(12)]. Cefotaxime and Ceftriaxone have shown resistance where beta-lactamase enzymes were present, which have the capability to break down these antibiotics [(13)]. This study recommends that trimethoprim-sulfamethoxazole and Cefotaxime should be used in a careful and controlled manner due to high resistance rate for the purpose of retaining their future efficacy [(14)]. Previous study that focused on Baghdad have revealed the following sensitivity of antibiotic with the highest being meropenem at 100%, and subsequently Amikacin at 91.8%, Levofloxacin at 76.4%, and Gentamicin at 72.7%. Meanwhile, the study has also shown that the antibiotics with highest resistance are Cefotaxime at 78.7% and subsequently Trimethoprim/Sulfamethoxazole at 69% and Ceftriaxone at 66% [(15)].

Conclusion

There is a high sensitivity exhibited by the isolated bacteria when subjected to Meropenem and medium sensitivity to Gentamicin, Levofloxacin, and Amikacin. They have high resistant rate toward Trimethoprim-Sulfamethoxazole.

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