The Effect of Some Factors on Virulence of *E. coli* Bacteria Isolated from UTI Infection. (Review study)

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**Abstract**

The study aims to demonstrate the effect of some traits on the virulence of *E. coli* bacteria, the important of which are the number and type of bacterial isolates, their sensitivity to some antibiotics and the production of the β-lactamase enzyme. We adopted in this research a multi-studies relative to some countries and different governorates inside Iraq to show the prevalence range of this gender and its great impact on urinary tract infection. It was found through various previous studies that *E. coli* is present in a large extent in the urinary tract compared to other isolates, as it is a suitable environment for causing infection after seizing the opportunity and reaching to the urinary tract after ascending from the digestive system, which are endemic organisms in which the normal flora. And it is found more often in women than in men for physiological reasons. It also contains multiple resistance to MDR antibiotics. This resistance may be depend on the presence of the plasmid that carries the genetic information to produce the enzyme β-lactamase, which works to break the β-lactamase cycle and create the bio resistance to the antibiotic. This resistance varies from gender to another and from one environment to another. Various studies around the world, especially penicillin's, the difference in the degree of sensitivity to this antibiotic or the degree of resistance according to the place in which the patient is located and according to the manufacture of the antibiotic and its chemical composition. This type of infection depends on its rapid identification and taking the appropriate antibiotic as soon as possible and for the required time, lest it lead to other complications, the most important of which is the kidney failure caused by this genus, and it is preferable to make a sensitivity test for antibiotics in order to be able to determine the appropriate antibiotic.

Key words : the Virulence , *E. coli* , UTI Infection

1. Introduction

Urinary tract infection (UTI) is an infection caused by the presence and growth of microorganisms anywhere in the urinary tract. It is usually due to bacteria from the digestive tract that reach the urethral opening and begin to replicate, causing an infection [1]. Women are more likely to have a UTI than men, mainly due to lack of prostate secretion, short urethra, pregnancy, and ease of urinary tract contamination with faecal flora [2]. Urinary tract infection is a common disease that affects millions every year and is more common in women than in men. It also affects children and adults. It is important to remember that normal urine contains body fluids and wastes and is completely free of bacteria, viruses and fungi, as the inner lining of the urinary tract is made by the creator(Allah) suitable for flow Urine is so difficult for microbes to stick on it [3]. The importance of urinary tract infection increased not only because of the dangerous pathological infections it causes, but also because it possesses special characteristics that enable it to cause infection, including its ability to adhere and invade and colonize the host's tissues and its ability to genetic conjugation and exchange of genetic genes that expressing of virulence factor or resistance to antibacterial [4].

*E. coli* bacteria is one of the pathogenic factors and the main cause of most bacterial infections, as this extra intestinal pathogenic *E. coli* (ExPEC) bacteria are responsible for 80% of urinary tract infections [5]. *E. coli* is a classic hospital-based opportunistic pathogen. The World Health Organization (WHO) claims that these bacteria are one of the primary pathogens of hospital acquired infections. Which contributes to a large percentage of infections in hospitals, as it’s the first in the rate of infection with Gram-negative pathogens. Because of the multiple drug resistance mechanism of *E. coli*, infections occurred more frequently and the drug resistance of bacteria gradually increased [6]. The genus *E. coli* belongs to the *Enterabacteriaceae* family. The type *E. coli* is the most common species of this genus and it is not pathogenic but can cause many opportunistic infections, as it can infect anywhere in the human body when the body’s natural defenses are weak, so it affects children often newborns and the elderly [7].
As this pathogenic bacteria present in a symbiotic form in the colon has the advantage of moving to other areas of the body and overcoming the host's defenses and causing multiple infections in it [8].

2. Search reviews

2.1. Number of isolates and percentage:

This germ characterizes by being broad transmissible, it can move easily between the digestive and the urinary system, [9] where founded there is a high increase in the proportion of this germ compared with other types that were isolated in urine samples taken from patients in Ramadi governorate hospital, where it was (106) isolate (59%), and this represents more than half of the bacterial isolates. The reason for this is that E.coli is a flora and moves easily between the digestive and urinary systems. This result also agree with [5], as he noticed a clear increase in the number of E.coli isolates out of the isolates number that taken from patients with urinary tract infection in a hospital in Baghdad, reaching (55) isolates compared to those taken from blood or wounds and burns, and by (78.57%) Where he relied on the site of infection, as he noticed the high rate of infection in the urinary tract, which indicates the quick and easy transition of these bacteria to the human urinary tract.

While it was found [10], that the number of isolates of this genus is the highest among other species in the sample, as it was by 46% and by (46) isolates from the total samples. It was also observed that there was a clear increase in E.coli genus isolates in women compared to men, as it reached (31) positive isolates in women and (15) isolates in men. To pregnancy in women and in this period the woman is an easy environment for microbial invasion. These results also agree with [11], that found of the isolates taken from non-pregnant women. The highest percentage of the genus E.coli (36.28%) was 36 isolates, the reason is due to its ability to adapt in the human urinary tract as a result of its endurance to environmental conditions in these places as well as its ability to adhere.

| No | Reference | Isolation No | Percentage | Cause |
|----|-----------|--------------|------------|-------|
| 1. | Hassan, H.Rashed; Laith, M.Najeeb. (2015) Nihad, K.; Eptissam, Y. (2019) | 106 | 59% | As E.coli is a flora, it moves easily between the digestive and urinary systems. |
| 2. | Mohammed, F.; Essam M. Abdullah.; Saad T. Mutlak. (2009) | 55 | 78.57% | Quick and easy access of these bacteria to the human urinary tract. |
| 3. | Saad T. Mutlak. | 46 | 46% | Shortness of the urethra in women and the presence of the prostate in men, which are impermeable to germs, in addition to pregnancy in women and during this period the woman is an easy environment for microbial invasion. |
| 4. | Raghad.H. (2016) | 36 | 36.28% | Its ability to adapt in the human urinary tract as a result of its endurance to environmental conditions in these places as well as its ability to adhere. |

2.2. Sensitivity test

Sensitivity testing is considered one of the most important tests that sheds light directly on the antibiotic. It acts and does not randomly use drugs that produce resistant strains in the wrong side[9]. Where he found the resistance of the genus E.coli isolated from urinary tract infection to the antibiotic Cefotaxime by 100%, and Gentamicin by 97.2% compared to the other antibiotics, while its sensitivity to the anti-Imipenem was 77.3. Amikacin was 75.5% and Nitrofurantion was 71.7%. This is agree with [12], he found that the reason for the high resistance is attributed to the randomly use of antibiotics, as well as to the containment of these bacterial species on plasmids, which are important carriers of the genes responsible for resistance to antibiotics.[5] also observed that E.coli isolated from different places of infection, especially from urine, had a rate of 55%, as it was found that this type has high resistance to Cefotaxime, Aztroneom and Ceftriaxone and the following rates are 95.71%, 94.29%, 90%, respectively. They are sensitive to the antibiotics Amikacin, Imipenem, and Nitrofurantoin, with sensitivity rates of 97.14%, 90%, and 87.14%, respectively, and he attributed that resistance to a number of genes that encode multiple resistance to antibiotics that are transmitted from one bacterium to another.

While [13], was found that all isolates taken from UTI infection were resistance to the antibiotic Ampicillin by 100%, there is also resistance to the antibiotic Amoxicillin by 75%. This is due to plasmids that transfer resistance genes from one bacterium to another, and this is agree with [14]. While [15], found during his study on the ability to inhibit E.coli taken from patients with urinary tract infection, which constituted 61% of the total important urinary isolates and 7.68% of the total Enterobacteriaeae of the antibiotic Amoxicillin of origin [9], different countries, also he noted the variation in proportions of Antibiotic inhibition in different degrees and the reason was attributed to the technology used in the country of origin in addition to the environmental conditions surrounding the microbe in that country.[16] noted that the bacteria isolated from urinary tract infection patients in Kirkuk governorate, the largest percentage (57.53%) was infant of the studied ages, as the sex E. coli constituted 44.44% of the total isolated germs, which showed a resistance rate of 100% Penicillin, Streptomycin,
Tetracycline, Erythromycin showed sensitivity to the antibiotics Gentamycin, Cefotaxime, Amoxicillin with a percentage of 100% for the first & second antibiotic and 94.4% for the third antibiotic. These results are agree with [17,18], where they attributed the reason to the incorrect and excessive use of different types of antibiotics that may contribute to the development of antibiotic-resistant strains that can be transmitted from one generation to another by conjugation.

Table 2. Resistant and Sensitive to β-lactam Antibiotics.

| No | Reference | Resistance antibiotic | Sensitive antibiotic | Cause |
|----|-----------|-----------------------|----------------------|-------|
| 1. | Hassan, H.Rashed; Laith, M.Najeeb; (2015) | Imipenem, Amikacin, Nitrofurantion | Cefotaxime, Gentamicin | The indiscriminate use of antibiotics, as well as because these bacterial species contain plasmids, which are important carriers of genes responsible for resistance to antibiotics. |
| 2. | Nihad, K.; Mohammed, F.; Eptissam, Y. Saafa T. Aka.; Sayran H. Haji.; Sameer A. Abid Ali.; Ghydaa H. Aljeboury. | Cefotaxime, Aztroneom, Ceftriaxone, Ampicilllin, Amoxicillin | Amikacin, Imipenem, Nitrofurantoin, Imipenem | He attributed that resistance to a number of genes that encode multiple resistance to antibiotics that are passed from one bacterium to another. |
| 3. | Ali.; Ghydaa H. Aljeboury. | Amoxicillin | Gentamicin | The reason was attributed to the technology used in the country of origin, in addition to the environmental conditions surrounding the microbe in that country. |
| 5. | Asal A. Tawfheed | Penicillin, Streptomycin, Tetracycline, Erythromycin | Gentamicin, Cefotaxime, Amoxicillin | He attributed the reason to the wrong and excessive use of different types of antibiotics. |

2.3. The β-lactamase enzyme production

β-lactamase enzymes (ESBLs) produced by Enterobacteriaceae are a growing and important global problem in hospital work, and are associated with the extensive use of broad-spectrum antibiotics [19]. The most predominant bacterial resistance mechanism among Gram-negative bacilli is the production of β-lactamases (by chromosomes or plasmids), which break down penicillin proteins bonds, outer membrane permeability, and group of multiple mechanisms [20]. The β-lactam antibiotic is among the safest and most popular antimicrobial drugs in the world [21]. The most important mechanism of bacterial resistance to β-Lactam is the production of β-Lactamase enzymes that can analysis nearly all lactam antibiotics except for Cephampcins and Carbapenems, and are generally inhibited by β-lactamase inhibitors such as Clavulanic acid, Sulbactam, or Tazobactam [22]. [23], founded that 58.82% of E.coli isolates extracted from the urinary tract were produced by β-lactamase, and amikacin showed the highest sensitivity (85%), followed by ciprofloxacin (67.6%). All isolates were resistant to penicillin, cefadine, cephatholin and carbenicillin. He was also founded that the isolates resistant to more than one type of anti-microbial were the most β-lactamase products. [24], founded in his study of Gram-negative isolates that taken from urinary tract infection and producing β-lactamase, founded that E.coli bacteria accounted for 12% compared with P.mirabilis, which gave a rate of 31.8%.

The diffusion of the species producing β-lactamase depends on several factors, including the method of using antibiotics, the rate of transmission of the strains produced between working and hospitalized people, and the type of sterilization used in hospital units, especially in intensive care units [25]. [26], obtained that 154 isolates of E.coli, the predominant pathogen associated with urinary tract infection, because they contain ESBL, as well as a percentage of 15.2% of the total studied samples, and females were in childbearing age were the most susceptible to infect, reaching 62.1% of the total E.coli, and the MDR was 64.9% and 40.3% produced β-lactamase. Nitrofurantoin, gentamycin and imipenem were also found to be the most effective antibiotics for E.coli isolates producing ESBL.

It was also founded that some of the isolates are sensitive to some antibiotics, including Nitrofurantoin (92.2%), gentamycin (76.6%), and some of them are multi-resistant to antibiotics, as 21% of the isolates were resistant to β-lactam for quinolones, sulfonamides and 12% for β-lactam aminoglycosides, sulfonamides and 9% β-lactam, quinolones, aminoglycosides. [27], showing that 12 of the 197 isolates taken from different places of the body were diagnosed with E. coli. They were patients with urinary tract infection, which formed the highest percentage of these bacterial isolates, and this results agree with [28][27], also indicated that E. coli, in general, was very sensitive to IMP, NIT, OFLX and was highly resistant to AMP, COT, and TET, and he attributed this resistance to the presence of a plasmid carrying genetic traits that enable the genus E. coli to synthesis of β-lactamase enzyme, as it was discovered that the number of isolates producing β-lactamase increased to 36 isolates in the species containing this plasmid, while it became only 5 isolates after delete this plasmid. [27], was founded that most people with positive ESBL suffer from urinary tract infection, sepsis, and other medical conditions, and this agree with [29] during his study of UTIs in India.
While [30], that isolates (61%) of the genus E. coli were obtained from samples taken from Baghdad hospitals for patients with urinary tract infections, where it was found that (35) isolates (70%) contain a plasmid called Temoneira (54%), this gave the bacteria the ability to produce the enzyme β-lactamase and this agree with [31], which obtained a percentage (58.6%). This refer to diffusion of the TEM gene in most E. coli isolates, which encodes for the production of β-lactamase enzymes that break down penicillin and cephalosporin in most Baghdad hospitals. This indicates resistance to most antibiotics in Baghdad hospitals.

### Table 3. Number of isolates producing β-lactam, resistant and sensitive antibiotics.

| No | Reference | Isolation No | Percentage | Resistance          | Sensitivity          |
|----|-----------|--------------|------------|---------------------|----------------------|
| 1. | Ansam M. Hamdoon, 2011. | -           | 58.82%     | penicillin Cefradine Cephalothin Cefradine | Amikacin Ciprofloxacin |
| 2. | Abbas F. Al-Dulaimi., Hadi R. Al-Taie. 2015. | 15          | 60%        | -                   | -                    |
| 3. | Roshan P., et al., 2020. | 154         | 40.3%      | Quinolones Sulphonamides | Nitrofurantoin Gentamycin Imipenem |
| 4. | Folasoge A. Adeyankinnu., et al., 2014. | 36          | -          | AMP COT TET | IMP, NIT, OFLX |
| 5. | Hussein Q. Nasir; and Ali H. Humadi. 2015 | 35          | 70%        | Penicillin Cefalosporin | - |
[20] Iroha I.R., Adikwu M.U., Esimone C.O, et al. 2009. ESBL in E. coli isolated from a tertiary hospital in Enugu state, Nigeria. Pak J Med Sci; 25 (2): 279-282.

[21] Aminzadeh Z., Sadat M., Shabani M. 2008. Bacteriuria by ESBL producing E. coli and Klebsiella pneumoniae. Iranian Journal of Kidney Diseases;2(4):197-200.

[22] David ML and Derek FJ. 2001. Detection of Blactamase mediated resistance. Journal of antimicrobial chemotherapy; 48 (S1): 59-64.

[23] Ansam M. Hamdoon , 2011. Detection of extended spectrum B-lactamase in E. coli from clinical samples. Vol. 37 No. 1 & 2: p.122-128.

[24] Abbas F. Al-Dulaimi., Hadi R. Al-Taie., Muhammad K. Al-Nuaimi. 2015. A bacteriological and molecular study of some Gram-negative bacterial genera, resistant to β-lactam, isolated from urinary tract infections. Diyalal journal for pure sciences Vol: 11 No: 3, July.

[25] Mohammed, M.A. (2020). Structural, Optical, Electrical and Gas Sensor Properties of ZrO2 Thin Films prepared by Sol-Gel Technique. Neuroquantology, 18(3), 22-27. doi: 10.14704/nq.2020.18.3.nq20146

[26] Roshan P., Balkrishna A., Sumesh S. Shrestha., Govardhan J., Basista P. Rijal., Narayan P. Parajuli., 2020. Extended-Spectrum β-Lactamase (ESBL) Genotypes among Multidrug-Resistant Uropathogenic E.coli Clinical Isolates from a Teaching Hospital of Nepal. Interdisciplinary Perspectives on Infectious Diseases. Volume, Article ID 6525826, 8 pages.

[27] Folasoge A. Adeyankinnu., Babatunde O. Motayo., Akinniyi A., John A., Joseph I. Ogiogwa., BukolaW. Aboderin., R. A. Agunlejika.2014. A Multicenter Study of β-Lactamase Resistant E.coli and Klebsiella pneumoniae Reveals High Level Chromosome Mediated Extended Spectrum β Lactamase Resistance in Ogun State, Nigeria. Interdisciplinary Perspectives on Infectious Diseases. Article ID 819896, 7 pages.

[28] Sanaa S. Abbas, Alaaj J. Subaih and Yahya A. Saleh. (2020). The Effects of Biological and Chemical Agents on the Management of Main Pests in Tomato Plant. Al-Qadisiyah Journal For Agriculture Sciences, 10(2), 325-334.

[29] B. Duttaroy., and S. Mehta, .2005.“Extended spectrum β-lactamases (ESBL) in clinical isolates of Klebsiella pneumoniae and E.coli,” Indian Journal of Pathology and Microbiology, vol. 48, no. 1, pp. 45–48.