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Isolation and antibiotic susceptibility of E. coli and S. aureus from urinary tract infections in Dohuk city, Iraq

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ABSTRACT

Introduction: Urinary tract infections (UTIs) are prevalent infections that frequently occur in the human population. They are characterized as infections, typically caused by bacteria that can develop in any part of the urinary system. The objectives of this study were to identify and isolate S. aureus and E. coli strains that colonize patients with urinary tract infections in Duhok city, Iraq.

Methods: A total of 300 urine samples were obtained from individuals displaying indications and symptoms of urinary tract infections. The bacteria present in the samples were isolated and identified using traditional biochemical analysis. The Kirby-Bauer method was employed to assess the antibiotic resistance patterns of E. coli and S. aureus against various antibiotics.

Result: Among 300 patients the prevalence of gram positive was 53.32 while gram negative 20.65 and prevalence of negative samples was 25.99 among them positive for S. aureus 34/300 (11.33%), 32/300 E. coli (10.66%). Staphylococcus aureus was totally 100% resistant to Vancomycin and Rifampin, and the lowest rate was found with Imipenem 11.77%. E. coli highest rate was seen also with 100% resistant to Vancomycin and Rifampin, and the lowest resistance was seen with meropenem and Imipenem 12.5% and 31.25% respectively.

Conclusion: In conclusion, the study found that gram-positive bacteria are more commonly responsible for urinary tract infections than gram-negative bacteria. There is a slight ratio between staphylococcus aureus and E. coli infections that affected the patients.

Keywords: *Urinary tract infection, Staphylococcus aureus, E. coli, Antibiotic resistance*

INTRODUCTION

Urinary tract infections (UTIs) are common bacterial infections that affect different components of the urinary tract, such as the kidneys, bladder, urethra, and prostate. (Selim et al., 2022). This condition has both direct and indirect impacts on individuals' lives and is a significant global concern. Additionally, these diseases are increasingly becoming a prominent contributor to morbidity. It is estimated that urinary tract infections (UTIs) will affect approximately 150 million individuals worldwide annually. (Flores-Mireles, Walker, Caparon, & Hultgren, 2015). Healthcare expenses in the

United States are estimated to amount to $6 billion. (Shrank, Rogstad, & Parekh, 2019). Urinary tract infections (UTIs) rank as the second most common cause of illness in humans. In the United States, urinary tract infections (UTIs) lead to approximately one million visits to the emergency room and 100,000 hospitalizations annually. Urinary tract infections (UTIs) can be categorized as either community-acquired (CA-UTI) or nosocomially acquired (N-UTI). Community-acquired UTIs occur within the community, typically within 48 hours of hospital admission, while nosocomially acquired UTIs manifest 48 hours after hospital admission or three days after discharge. (Despotovic et al., 2020). The prevalence of urinary tract infections (UTIs) is influenced by various factors including age, gender, catheterization, inpatient therapy, and prolonged antibiotic use. The majority of urinary tract infections (UTIs) are caused by Gram-negative bacteria (90%), while they account for only 10% of bacterial infections overall. (Seifu & Gebissa, 2018). Escherichia coli is the primary causative agent in the majority of urinary tract infections (UTIs), accounting for approximately 65-90% of infections. (Lee, Lee, & Choe, 2018). In addition to Escherichia coli, other uropathogens contribute to urinary tract infections (UTIs). These include Enterococcus species, Klebsiella pneumoniae, Citrobacter species, Pseudomonas aeruginosa, and coagulase-negative staphylococci (CoNS). Typically, urinary tract infections attributed to Staphylococcus aureus are uncommon. Nevertheless, in specific individuals, S. aureus can result in ascending colonization and infection in the urinary tract, frequently originating from staphylococcal bacteremia in other sites like endocarditis. The presence of indwelling catheters and other instruments in the urinary tract increases the risk of S. aureus transmission.

Staphylococcus aureus has flourished in the human population due to its adaptability and capacity to develop antibiotic resistance, establishing itself as a significant pathogen in various circumstances (Sakr, Brégeon, Mège, Rolain, & Blin, 2018). Methicillin-resistant Staphylococcus aureus (MRSA) accounts for over 50% of Staphylococcus aureus infections acquired in hospital settings. (MRSA). (Fukunaga et al., 2016). The emergence of antibiotic resistance in Staphylococcus aureus has been linked to the production of β-lactamases and other related mechanisms mediated by plasmids.

Drug resistance in microorganisms emerges through various mechanisms, such as the incorporation of foreign DNA into bacterial chromosomes, horizontal gene transfer, and genetic alterations. The patterns of resistance exhibited by microorganisms can vary across different regions, countries, states, hospitals of varying sizes, and even between hospitals and the community. In Dohuk city, Iraq, antibiotic resistance is worsening as a result of antibiotic overuse and misuse (Nauclér et al., 2021). A comprehensive national surveillance system for antibiotic resistance is lacking, and the available data is insufficient to accurately quantify the extent of the problem. (Gharbi et al., 2019). In clinical settings, it is crucial and advantageous to identify the bacteria responsible for urinary tract infections (UTIs) and determine their resistance to commonly prescribed antibiotics. This information greatly improves the effectiveness of empirical treatment. The objective of the current study was to emphasize the bacterial causes of UTIs and assess the resistance patterns of E. coli and S. aureus isolates.

METHODS

A cross-sectional study was conducted in Duhok city, Kurdistan region. During the period from October 2022 to December 2022, urine samples were collected from patients who visited the central laboratory of Duhok.

Sample collection and Isolation of Bacteria

A total of 300 samples of urine were gathered from patients visiting the central laboratory of Duhok. For suspected urinary tract infections (UTIs), direct staining of the urine was conducted. Subsequently, the samples were centrifuged, and the sediment was cultured on various types of agar, including blood agar, MacConkey agar, Eosin Methylene Blue (EMB) agar (a selective differential medium), Mannitol salt agar, and Nutrient agar (a general-purpose medium). The spread plate technique was utilized for the cultivation process. Bacterial colonies exhibiting distinct morphologies were meticulously chosen, purified, and identified by analyzing their biochemical profiles.

Multiple drug resistance

To assess the antibiotic susceptibility patterns of E. coli and S. aureus isolates, the Kirby-Bauer disc diffusion method was performed on Muller Hinton agar plates. The isolates were categorized as either sensitive or resistant based on the zone of inhibition, following the criteria set by the Clinical Laboratory Standards Institute. The central laboratory of Duhok in Duhok city, Iraq, conducted the isolation and antibiotic sensitivity testing of E. coli and S. aureus from urinary tract infections.

Statistical analysis

The data were collected using Microsoft Excel version 16 and statistically analyzed using the SPSS version 20 program. Correlation analysis was utilized, and the P-value was calculated based on the provided data to determine the minimum level of significance required to reject the null hypothesis. A P-value lower than 0.05 suggests stronger evidence supporting the alternative hypothesis.

RESULT

The study aimed to determine the bacterial causes of urinary tract infections (UTIs) in patients who were admitted to or visited the central laboratory of Duhok. Additionally, the resistance patterns of Escherichia coli and Staphylococcus aureus against multiple antibiotics were examined. A total of 300 consecutive urine samples were analyzed in this study, which aimed to identify and isolate S. aureus and E. coli strains from urinary tract patients in Duhok city. Furthermore, antibiotic sensitivity tests were performed to assess their susceptibility to antibiotics

Among the 300 bacterial isolates obtained from patients, rate of Staphylococcus aureus was (11.33%), and of E. coli was (10.66%), other gram positive bacteria was (53.32 %) and gram negative was (20.65 %). Staphylococcus aureus was totally 100% resistant to Vancomycin and Rifampin followed by Ciprofloxacin (CIP) and Amoxicillin / clavulanic acid (AMC) with rate 82.36%, Trimethoprim 70.59% and the lowest rate was found with Imipenem 11.77%. With respect to E. coli highest rate was seen also with 100% resistant to Vancomycin and Rifampin, followed by Amoxicillin / clavulanic acid (AMC), Ciprofloxacin and Trimethoprim with rate 87.5%, 56.25% and 75% respectively. The lowest resistance was seen with meropenem and Imipenem 12.5% and 31.25% respectively.

TABLE 1: Antibiotic sensitivity pattern for E. coli

NO.	Type of antibiotic	Resistance (%) E. coli	Correlation of Imipenem with other
1	Ciprofloxacin (CIP)	56.25	0.029
2	Meropenem (MEM)	12.5	0.424
3	Imipenem (IPM)	31.25	-
4	Trimethoprim (TMP)	75	0.485
5	Amoxicillin / clavulanic acid (AMC)	87.5	0.512
6	Vancomycin (VA)	100	0.545
7	Rifampin (RA)	100	0.545

*Correlation is significant at level (0.05 level).

TABLE 2: Antibiotic sensitivity pattern for S. aureus

NO.	Type of antibiotic	Resistance (%) S. aureus	Correlation of Imipenem with other
1	Ciprofloxacin (CIP)	82.36	0.021
2	Meropenem (MEM)	**58.83**	**0.455**
3	Imipenem (IPM)	11.77	-
4	Trimethoprim (TMP)	70.59	0.545
5	Amoxicillin / clavulanic acid (AMC)	82.36	0.657
6	Vancomycin (VA)	100	0.22
7	Rifampin (RA)	100	0.22

*Correlation is significant at level (0.05 level)

DISCUSSION

Urinary tract infections (UTIs) are prevalent infections in the human population and can be described as infections, typically caused by bacteria that occur in any part of the urinary system. (Motse et al., 2019). UTI is widely recognized as one of the most common health ailments across many countries worldwide. It ranks as the second most prevalent medical condition after respiratory tract infections, and its occurrence can lead to significant negative consequences. (Ibrahim, Mohammed, & Omar, 2018). Antibiotics, a remarkable accomplishment of the twentieth century, play a vital role in eradicating or inhibiting bacterial growth. However, the emergence of antibiotic resistance in E. coli and S. aureus isolates obtained from urinary tract infections (UTIs) has become a significant concern in public health. Consequently, it is crucial to evaluate the resistance patterns of E. coli and S. aureus isolates to ensure accurate and appropriate antibiotic prescriptions.

In our study the higher incidence of urinary tract infections was in females were higher than male, similar studies was found by (Shah, Cannon, Sullivan, Nemchausky, & Pachucki, 2005)the prevalence of female was higher than male. The higher incidence of urinary tract infections in females is due to anatomy because females have a shorter urethra than males, which means that bacteria have a shorter distance to travel to reach the bladder, increasing the likelihood of infection, hormonal changes during menstruation, pregnancy, and menopause can alter the vaginal pH, making it easier for bacteria to grow and causing an increased risk of UTIs, sexual activity can introduce bacteria into the urinary tract, increasing the risk of infection and poor personal hygiene practices, such as wiping from back to front after using the toilet, can increase the risk of UTIs (Czajkowski, Broś-Konopielko, & Teliga-Czajkowska, 2021). In the present study, the prevalence of urinary tract infections (UTIs) was more likely in female than male. And this is in agreement with recent studies which showed that the urinary tract infections are higher in females than in males (Mou et al., 2021). As we know our today's world is facing an antimicrobial resistance crisis, which should be monitored. However, one of the purposes of our study is to detect the resistance level of both E.coli and staphylococcus aureus to a group of antibiotics which include (Ciprofloxacin, Meropenem, Imipenem, Trimethoprim, Amoxicillin/ Clavulanic acid, Vancomycin and Rifampin) in Duhok prefecture, our results present that E.coli was resistant to the most of the most antibiotics except of meropenem(12.5%) and Imipenem (31.25%) which shows sensitivity, while staphylococcus aureus in the other hand present even a higher level of resistance for the antibiotics, the bacterium shows high resistance for all antibiotics except for Imipenem(11.77%) which the bacterium was sensitive for.

Surprisingly, our results shows that staphylococcus aureus was totally 100% resistant to vancomycin which is as same as the result of (Nelwan, Andayani, Clarissa, & Pramada, 2021), which shows us Vancomycin- resistant staphylococcus aureus is going to be a serious problem that we should be well aware of, however, the same study (Nelwan et al., 2021) shows that the complete resistant vancomycin S. aureus is mediated by a vanA gene cluster which had been transferred to S. aureus from vancomycin resistant enterococcus. Both bacteria appeared to be highly resistant to Amoxicillin/clavulanate in this study (87.5% for E. coli and 82.36% for S. aureus) that if we compare it to the result of (Anger et al., 2019) which they showed a high resistant to Amoxicillin/ clavulanate, in their study.

As for Rifampin, it is well known that the combination of Rifampin with another antibiotic is a successful way to treat infections of biofilm formation bacteria. However, both E.coli and S. aureus have showed a complete 100% resistant in our study that if we compare it to other study, it will completely make sense why our result showed this level of resistant for example; During the years 2005 and 2006, an antimicrobial susceptibility surveillance study conducted in South Africa by (Mkhize, Amoako, Shobo, Zishiri, & Bester, 2021) demonstrated that 52.8% of multidrug-resistant Staphylococcus aureus (MRSA) isolates obtained from public laboratories exhibited resistance to rifampicin. Also, another research by (Xiao et al., 2011) It can be concluded that the proportion of rifampicin-resistant (RIF-R) methicillin-resistant Staphylococcus aureus (MRSA) isolates in China exhibited a rapid increase, rising from 15.5% in 2004 to 50.2% in 2008. The rise in Rifampicin resistance levels is attributed to mutations occurring in a highly conserved section of the rpoB gene, referred to as the rifampicin resistance-determining region.

Overall, the results that we present in this study shows a serious level of resistance of both bacterium, which of course need further investigation and study for which if it continuous we will face a big crisis in treating a simple bacterial infection as simple as UTIs, that is why we need an urgent concern to solve the problem.

CONCLUSION

The antibiotic susceptibility patterns of some types of gram positive and gram negative bacteria, with a slight ratio between E. coli and S. aureus are considered most common pathogens causing urinary tract infections (UTIs), are crucial in guiding effective treatment strategies. The susceptibility of these bacteria to different antibiotics helps determine the most appropriate choice of medication, ensuring successful eradication of the infection and preventing the development of antibiotic resistance.

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Authors' contributions

The authors made equal contributions to this work.

Conflict of interest

There are no conflicts of interest have been reported.

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