

Prevalence of *Klebsiella pneumoniae* among Complicated and Uncomplicated Urinary Tract Infection in Najaf, Iraq

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ABSTRACT: This research carried to investigate the prevalence of cUTI among UTI Iraqi patients and *K. pneumoniae* as its causative bacterial agent. A cross section study involved 116 UTI patients where cUTI and uncomplicated UTI patient. All urine specimens cultured on blood agar base and MacConkey agar Vitek 2 compact system used for identification and detection of antibiotic resistance using GNID and AST card. According to urologist diagnosis, out of 116 UTI patients only 14 (12.06%) patients were reported as cUTI, out of them, 5(35.71%) patients were female and 9(64.28%) patients were male. Culturing results showed that only 45 urine specimens gave +ve culture on MacConkey agar where 13 isolates primary identified as *K. pneumoniae*. Out of them only 7(53.84%) isolates were confirmed as *K. pneumoniae*. All isolates (100%) were resistance to ampicillin whereas all these isolates (100%) showed sensitivity to each of piperacillin/tazobactam, cefoxitin, cefepime, ertapenem, meropenem, amikacin, gentamicin and trimethoprim/sulfamethoxazole.

KEYWORDS: *K. pneumoniae*, Complicated UTI, Uncomplicated UTI, Antibiotic resistance, Vitek 2 system.

I. INTRODUCTION

Complicated Urinary Tract Infections (cUTI) is an acute UTI with fever or other symptoms of systemic illness or flank pain, postvertebral angle tenderness, pelvic or perineal pain in men, or pyelonephritis^[1]. Uncomplicated UTIs occur in healthy women with normal urinary tracts while, cUTIs are associated with conditions include foreign bodies (eg, catheters or stones), abnormalities in the urinary tract, diabetic mellitus, infections with multidrug-resistant pathogens, and UTIs in male patients^[2].

Annually, cUTIs cost the US healthcare system at least 6 billion dollars, and growing rates of antibacterial drug resistance threaten infection management strategies^[3]. Several factors are associated in progression of cUTI include sex, pregnant status, indwelling urinary catheters, renal diseases, urinary tract obstruction, incomplete voiding due to detrusor muscle dysfunction, vesicoureteral reflux, diabetes, immunosuppression, and healthcare-associated UTIs^[4] which are lead to treatment failure, repeat infections, or significant morbidity and mortality with a poor outcome^[5]. Although uncomplicated infections in the community can usually be treated via brief antibiotic treatment, the cUTIs usually requires longer and more intensive antibiotic treatment^[6].

Patients with cUTI, infections are frequently caused by multidrug-resistant Gram negative bacilli^[7]. *Klebsiella pneumoniae*, an opportunistic pathogen which detected as a second most common etiological agent of community-acquired UTI (CAUTI) throughout the last 20 years, is an important Gram-negative, encapsulated, facultative anaerobic, rod-shaped, non-motile, oxidase negative and catalase positive pathogen^[8,9]. This research aim to investigate the prevalence of cUTI among UTI Iraqi patients and *K. pneumoniae* as its causative bacterial agent.

II. METHODOLOGY

1. Patients:

A cross section study involved 116 UTI patients whom admitted to AL-Najaf AL-Ashraf Teaching Hospital and out patients during the period between July 2023 to the November 2023 of both sexes with different age group. cUTI and uncomplicated UTI patient were confirmed by pathological reports according to urologist.

2. Specimen's collection and isolation of K. pneumonia:

Midstream urine specimen of all 116 patients were collected using sterile screw cap and cultured on blood agar base for primary isolation of Gram positive bacteria and MacConkey agar for primary isolation of K. pneumonia isolates. All suspected colonies have been further identified by vitek 2 compact system using Gram Negative Identification Card (GNID).

3. Determination the Antibiotic Resistance Pattern:

Vitek 2 compact system using antibiotic susceptibility test (AST) has been used to determine antibiotic resistance of K. pneumoniae isolates.

III. RESULTS AND DISCUSSION

1. Prevalence of cUTI:

The age groups of 116 UTI patients are mention in figure 1. The results showed that the highest level of UTI infection occurred in age group 30-39 years (31%) followed by the age group 20-29 years (27.58%) whereas the lower rate of infection were in age group 70-79 years (1.72%). According

to urologist, out of 116 UTI patients only 14 (12.06%) patients were reported as cUTI, out of them, 5(35.71%) patients were female and 9(64.28%) patients were male (Figure 2).

This result in contrast with^[10] that shows the highest level was in the age group 20-29 years (43%) followed by age group 30-39 years (30%), while the lower rate was in age group 1-9 years (2%

UTIs represented the most frequent bacterial infections in humans^[11], which describe as are a group of illnesses that can affect the kidneys, renal pelvis, or lower urinary tract alone (urethritis, cystitis, and urethrocystitis), which is resulted from the presence of microorganisms in the urine^[9]. UTIs begin when gut-resident uropathogens colonize the urethra and subsequently the bladder through the action of specific adhesions. If the host's inflammatory response fails to eliminate all bacteria, they begin to multiply, producing toxins and enzymes that promote their survival. Uropathogens own a number of strategies that they have developed to adhere to and invade host tissues^[12]. Complicating factors that are involved in the progression of UTI are biofilms, urinary stasis due to obstruction, and catheters.

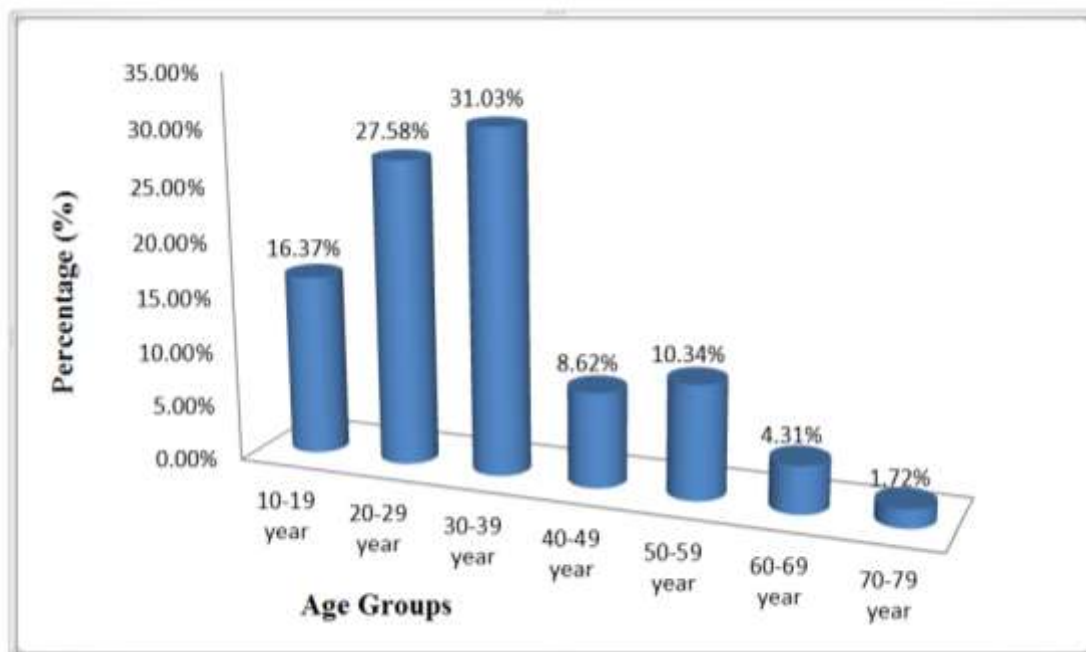


Figure 1: The percentage of distribution UTI among patients with different age groups.

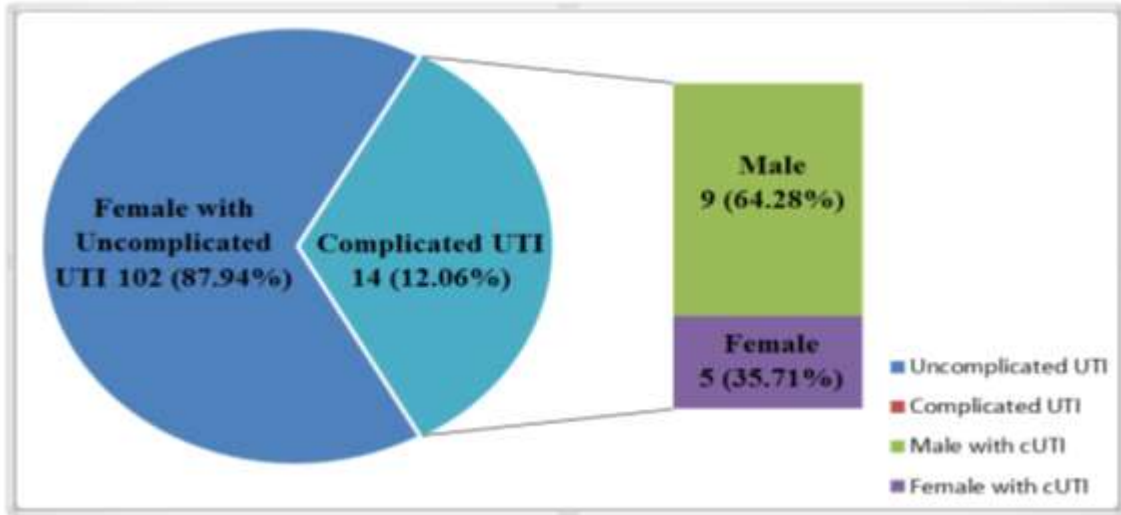


Figure 2: The prevalence of complicated and uncomplicated UTI according to sex

cUTI was defined by the criteria used in the ZEUS Phase 2/3 clinical trial^[13]. The results of present study showed wide distribution of uncomplicated UTI a case that associated with female only due to the anatomical characters of normal female urinary tract has a comparatively short urethra which make it easier to bacterial ascending from perinatal region to the bladder which increases the frequency of infections. Also, the risk of bacterial contamination in female was higher due to close related of the female urethra opening to both vagina and the anus. Simple cystitis, a one-off episode of ascending pyelonephritis, and occasionally even recurrent cystitis in the right context can be considered as simple UTI, provided there is a prompt response to first-line antibiotics without any long-term sequela. Any UTI that does not conform to the above description or clinical trajectory is considered a cUTI^[14]. On the other hand, the results showed that cUTI was wide distributed among male compared to female (Figure 2) this may due to physiological factors such as prostatic enlargement, obstruction, stones, or catheter.

2. Distribution of *K. pneumoniae*:

According to the cultural properties and microscopic examination the results showed that out of 116 urine specimens (Figure 3) only 45(38.79%) specimens gave positive results for culturing on MacConky agar with different morphological colonies while the other 71(61.21%) specimens gave positive results for culturing on blood agar base with different morphological characters of colonies and hemolysis pattern. Out of 45 positive culture samples only 13(28.9%) isolates were primarily characterized as *K. pneumoniae* which appeared mucoid, large and pink due to lactose fermentation, while the other 32(71.9%) isolates were belong to other Gram negative bacteria such as *E. coli*, and *Proteus* spp. The results of viteK 2 compact system revealed that out of 13 isolates only 7(53.84%) isolates were identified as *K. pneumoniae*. Also the results showed that 2(28.57%) isolates were isolated from cUTI patients where one of them from male and the other from female while the other 5(71.43%) isolates were isolated from uncomplicated UTI female patients as mentioned in figure 4. In addition to that, the results show the largest number of isolates were isolated from age group 20-29 (42.85%) followed by age group 30-39 (28.57%).

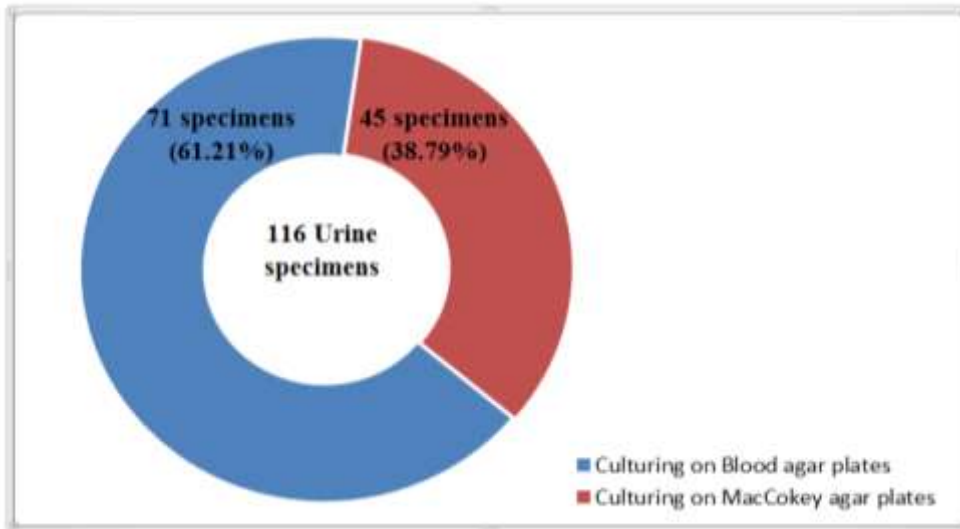


Figure 3: The percentage of positive culturing of urine specimens on Blood agar base and MacConkey agar

K. pneumoniae as a member of the Enterobacteriaceae family, it is a significant pathogen in hospital and community environments^[15]. *Escherichia coli* and *K. pneumoniae* are both important causes of cUTIs and

pyelonephritis^[14]. (Dunne et al., 2023). Many studies show different isolation rate in comparison with present study^[16,17,18], this different in the prevalence rates may be due to geographic location and population's hygiene behaviors^[19].

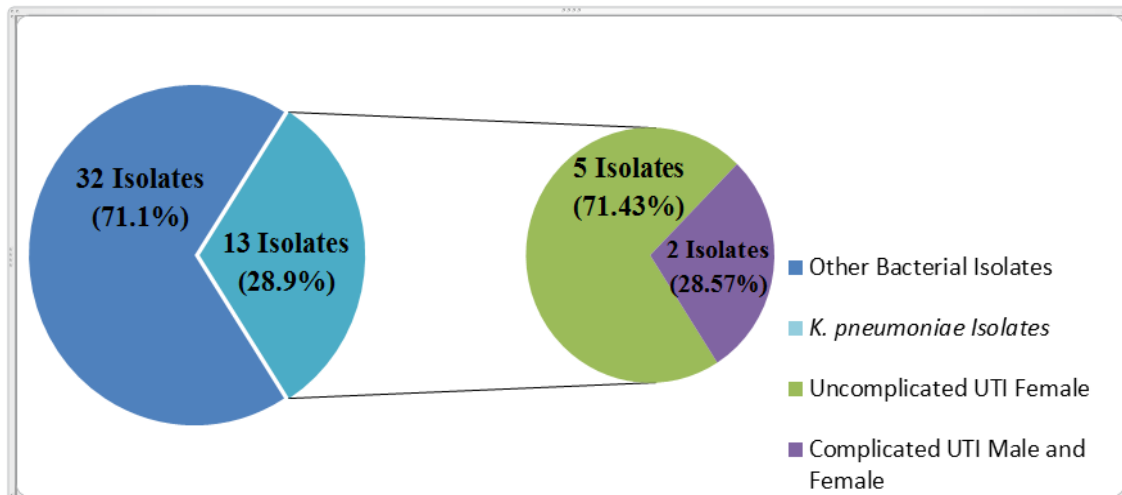


Figure 4: The percentage of *K. pneumoniae* isolated from complicated and uncomplicated UTI

3. Antibiotic Resistance Pattern:

The results of antibiotic resistance pattern of *K. pneumoniae* that detected by VITEC2 compact system showed that all isolates (100%) were resistance to ampicillin whereas all these isolates (100%) showed sensitivity to each of piperacillin/tazobactam, cefoxitin, cefepime, ertapenem, meropenem, amikacin, gentamicin and

trimethoprim/ sulfamethoxazole. Also, the results showed variable percentage of resistance to other antibiotics where 28.5% of isolates were resistance to cefuroxime and cefuroxime axetil and 14% were resistance to each of cefixime, ceftazidime, ceftriaxone, ciprofloxacin and nitrofurantoin (Figure 5).

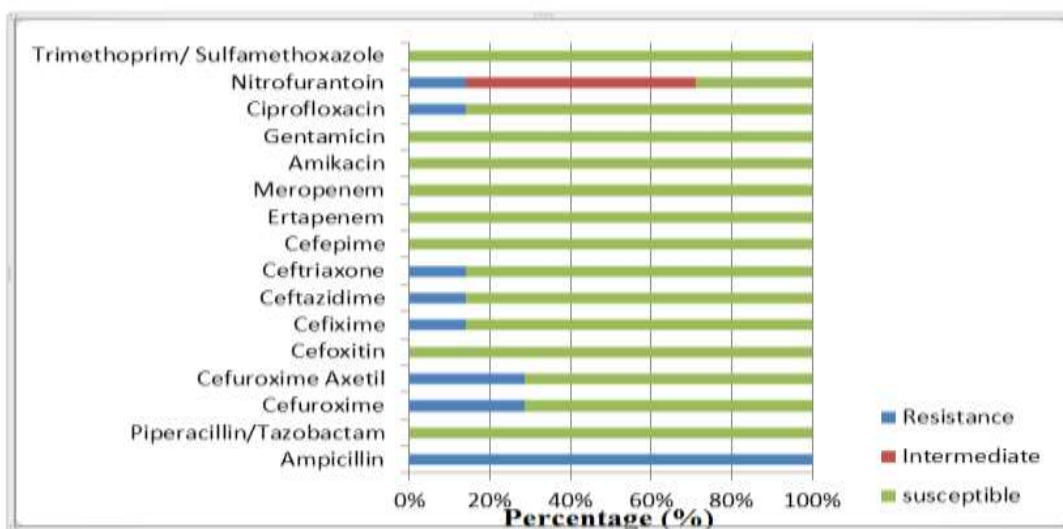


Figure 5: The percentage of antibiotic resistance of *Klebsiella pneumoniae*

On the other hand the results showed that *K. pneumoniae* isolate NO. 6 that isolated from cUTI patients showed high antibiotic resistance toward tested antibiotics, it showed resistant to 8 tested antibiotic followed by *K. pneumoniae* isolate NO. 7 that isolated from uncomplicated UTI

patients which recorded resistant to only 3 tested antibiotics in comparison with other 5 isolates that isolated from cUTI and non cUTI which showed resistant to only one tested antibiotic as mention in table 1

Table 1: The antibiotic resistance pattern of *Klebsiella pneumoniae*

| NO. of isolate | Type of UTI | Antibiotic resistance pattern |
|----------------|---------------|--|
| 1 | complicated | Ampicillin |
| 2 | uncomplicated | Ampicillin |
| 3 | uncomplicated | Ampicillin |
| 4 | uncomplicated | Ampicillin |
| 5 | uncomplicated | Ampicillin |
| 6 | complicated | Ampicillin, cefuroxime, cefuroxime axetil, cefixime, ceftazidime, ceftriaxone, ciprofloxacin, nitrofurantoin |
| 7 | uncomplicated | Ampicillin, cefuroxime, cefuroxime axetil |

Most studies show that *K. pneumoniae* owns a high resistance level to most of antibiotics in contrast to our study that show low level rate of resistance^[20,21,22].

K. pneumoniae have several mechanisms of resistance to antibiotics including quinolones antibiotics such as ciprofloxacin, norfloxacin, levofloxacin and ofloxacin, these mechanisms involved the modulation of the target site that bind with the antibiotics by triggering chromosomal genetic mutations in the genes encoding for DNA gyrase or Topoisomerase resulting in production of different enzyme that is resistant to these antibiotics^[23,24] (Jacoby, 2017; Al-Qaysi et al., 2024).

Also, *K. pneumoniae* have OqxAB and QepA efflux Pumps on the outer membrane of the bacteria that serve to expel the antibiotic to the outside and prevent the permeability of it^[25].

IV. CONCLUSION

Urinary tract infection represented a prevalence disease among Iraqi communication. Wide distribution on uncomplicated UTI among Iraqi female which reflect the risk of bacterial contamination in female. *K. pneumoniae* represented the second causes of UTI with high dominance among cUTI. Moderate level in antibiotic resistance of *K. pneumoniae*.

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Conflict of Interest: The authors claim that there is no conflict of Interest.

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