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Analysis of recurrent urinary tract infection (UTI) in University Hospital – approach of antibiotic resistance in clinical isolates

Análise da infecção recorrente do trato urinário (ITU) em Hospital Universitário – abordagem da resistência a antibióticos em isolados clínicos

Análisis de la infección del tracto urinario (ITU) recurrente en un Hospital Universitario – Aproximación a la resistencia antibiótica en aislados clínicos

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Abstract
The fifty-two bacteria were isolated from urinary tract infections in University Hospital in Sumaré, São Paulo State, Brazil. These isolates were analyzed about their antibiotic resistance and their bacterial characteristics. Around percentage from these isolates were identified as belonging to Escherichia coli strains, followed by Klebsiella pneumoniae and Pseudomonas aeruginosa. The multiresistance profile (resistance profile major than four 4 antibiotic classes) were viewed in thirteen (13) strains of Escherichia coli, sixteen (16) strains in Klebsiella pneumoniae (being two (2) carbapenem resistant suggesting an existence of KPC strain). The results had demonstrated an indiscriminate antibiotic use concentrated in the increase of quinolones resistance (principally in ciprofloxacin use), and also the rise of KPC super bacteria.
Keywords: Urinary tract infection; Antibiotic resistance; Multiresistant bacteria; UTI.

Resumo
As cinquenta e duas bactérias foram isoladas de infecções do trato urinário no Hospital Universitário de Sumaré, Estado de São Paulo, Brasil. Esses isolados foram analisados quanto a sua resistência a antibióticos e suas características bacterianas. Uma porcentagem desses isolados foram identificados como pertencentes a cepas de Escherichia coli, seguidas por Klebsiella pneumoniae e Pseudomonas aeruginosa. O perfil de multirresistência (perfil de resistência maior que quatro 4 classes de antibióticos) foi visualizado em treze (13) cepas de Escherichia coli, dezesseis (16) cepas em Klebsiella pneumoniae (sendo duas (2) resistentes a carbapenem sugerindo a existência de cepa KPC). Os resultados demonstraram um uso indiscriminado de antibióticos concentrado no aumento da resistência às quinolonas (principalmente no uso de ciprofloxacina), e também o surgimento de superbactérias KPC.
Palavras-chave: Infecção do trato urinário; Resistencia a antibiótico; Bactéria multiresistente; ITU.

Resumen
Las cincuenta y dos bacterias fueron aisladas de infecciones del tracto urinario en el Hospital Universitario de Sumaré, Estado de São Paulo, Brasil. Esos fueron analizados por su resistencia a los antibióticos y características bacterianas. Un porcentaje de aislamientos se identificaron como de Escherichia coli, Klebsiella pneumoniae y Pseudomonas

aeruginosa. El perfil de resistencia a múltiplos fármacos (perfil de resistencia superior a cuatro clases de antibióticos) se visualizó en trece (13) muestras de Escherichia coli, dieciséis (16) muestras de Klebsiella pneumoniae (dos (2) resistentes a carbapenem, lo que sugiere la existencia de una cepa KPC). Los resultados muestran uso indiscriminado de antibióticos enfocado a aumentar la resistencia a las quinolonas (principalmente en el uso de ciprofloxacino), y también la aparición de superbacterias KPC.
Palabras clave: Infección del tracto urinario; Resistencia antibiótica; Bacterias multirresistentes; ITU.

1. Introduction

In recent years, bacterial resistant infections have become a global health challenge and threaten the health of societies (Khameneh, et al., 2016; Riley, et al., 2012; Anes, et al., 2015; Nischal, 2014; Zhu, et al., 2022; Sakeena, et al., 2018). Due to emergence of resistant infections, existing antibacterial drugs have become less effective or even ineffective; this has led to development of new antibacterial drugs (Khameneh, et al., 2016). Also, quinolones are one of the most commonly prescribed classes of antibacterial in the world and are used to treat a variety of bacterial infections in humans (Aldred KJ, 2014). Ciprofloxacin was the first quinolone that displayed significant activity outside of the urinary tract (Aldred KJ, 2014; Emmerson & Jones, 2003; Mitscher, 2005; Andriole, 2005; Stein, 1988; Silva, et al., 2022; Li, et al., 2022).

The clinical success of ciprofloxacin spawned an array of newer-generation quinolones that displayed an even broader spectrum of activity, especially against Gram-positive species (Aldred KJ, 2014; Emmerson & Jones 2003; Mitscher, 2005; Andriole, 2005; Stein, 1988). Due to the development of antibiotic resistance and the outbreak of infectious diseases caused by resistant pathogenic bacteria, pharmaceutical companies and researchers are now searching for new unconventional antibacterial agents. The demand for individualized therapy and lower risks of adverse effects has always been a goal for health professionals. Besides, new pharmaceutical formulations seeking to increase efficiency and reduce drug toxicity are currently being researched (Nebert, et al., 2008; Audrey, 2014).

2. Methodology

The fifty-two (52) strains were isolated as described in the NCCSL protocols and growth in Brain Heart Infusion Agar (BHI Agar) in LABIOTEC (Alves, et al, 2016; Cavalieri, 2005; Santos, 2015; NCCLS, 2004; Baym, et al., 2016; Gajic, et al., 2022). The collection was identified as thirty-two (32) Escherichia coli strains, twenty-eight (28) Klebsiella pneumoniae strains and 1 Pseudomonas aeruginosa strain. The antibiotic resistance was tested in Mueller Hinton Agar, where it was purchased from Accumedia (Neogen Corporation, Lansing, MI, USA), using the antibiotics disks. For the test were used AMI: Amikacin, APS: Ampicillin/Sulbactam, AMP: Ampicillin, AZM: Aztreonam, CFL: Cephalothin, CPM: Cefepime, CXM: Cefotaxime, CXC: Cefotaxime/clavulanate, CFN: Cefotetan, CAZ: Ceftazidime CAC: Ceftazidime/ clavulanate, CFT: Ceftriaxone, CFR: Cefuroxime, CIP: Ciprofloxacin, ERT: Ertapenem, GEN: Gentamicin, IMP: Imipenem, LEV: Levofloxacin, MPM: Meropenem, NIT: Nitrofurantoin, PIT: Piperacillin/Tazobactam, PIP: Piperacillin, TET: Tetracycline, TGC: Tigecycline, TOB: Tobramycin, TRS: Trimethoprim/Sulfamethoxazole.

The protocol of inclusion of these strains in this study showed a recurrence of the UTI in one year. The strains were isolated of march 2013 to December of the same year.

3. Results and Discussion

The Table 1(a and b) showed the resistance profile to Escherichia coli strains isolated in this work. And in Table 2(a and b), the aspects of Klebsiella pneumoniae resistance showed an important data: the occurrence of sixteen multiresistant strains (69,6%) and among these strains the presence of carbapenem resistant K. pneumoniae (KPC).

Table 1a. Resistance of *Escherichia coli* strains in this work. Where S is susceptible, R resistant and I are intermediary. In the first column we have the antibiotics tested in *E. coli* isolated from those patients mentioned in the other columns.

E.c.	HES 1		HES 2		HES 3		HES 4		HES 5		HES 6		HES 7		HES 8		HES 9		HES 10		HES11		HES 12		HES 13		HES 14	
AMI	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S
APS	16/8	I	16/8	I	> 16/8	R	≤ 8/4	S	≤ 8/4	S	>16/8	R	≤ 8/4	S	16/8	I	16/8	I	16/8	I	16/8	I	≤ 8/4	S	16/8	I	≤ 8/4	S
AMP	> 16	R	> 16	R	> 16	R	≤ 8	S	≤ 8	S	> 16	R	≤ 8	S	> 16	R	> 16	R	> 16	R	> 16	R	≤ 8	S	> 16	R	≤ 8	S
CFL	16	I	> 16	R	16	I	≤ 8	S	≤ 8	S	> 16	R	16	I	≤ 8	S	16	I	16	I	≤ 8	S	≤ 8	S	≤ 8	S	≤ 8	S
CPM	≤ 8	S	≤ 8	S	≤ 8	S	≤ 8	S	≤ 8	S	> 16	R	≤ 8	S	≤ 8	S	≤ 8	S	≤ 8	S	≤ 8	S	≤ 8	S	≤ 8	S	≤ 8	S
CXC	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	4	R	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S
CFN	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S
CAZ	≤ 1	S	16	R	≤ 1	S	≤ 1	S	≤ 1	S	8	I	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S
CAC	≤ 0.25	S	2	R	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S
CFR	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S	> 16	R	≤ 4	S	≤ 4	S	8	S	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S
CIP	≤ 1	S	> 2	R	> 2	R	> 2	R	≤ 1	S	> 2	R	≤ 1	S	≤ 1	S	> 2	R	≤ 1	S	> 2	R	≤ 1	S	> 2	R	> 2	R
ERT	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S
GEN	≤ 4	S	> 8	R	≤ 4	S	≤ 4	S	≤ 4	S	> 8	R	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S
IMP	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S
LEV	≤ 2	S	> 4	R	> 4	R	4	R	≤ 2	S	> 4	R	≤ 2	S	≤ 2	S	4	R	≤ 2	S	> 4	R	≤ 2	S	> 4	R	> 4	R
MPM	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S
NIT	≤ 32	S	64	I	≤ 32	S	≤ 32	S	≤ 32	S	≤ 32	S	≤ 32	S	≤ 32	S	≤ 32	S	≤ 32	S	≤ 32	S	≤ 32	S	64	I	≤ 32	S
PIT	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	> 64	R	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S
PIP	> 64	R	> 64	R	> 64	R	≤ 16	S	≤ 16	S	> 64	R	≤ 16	S	> 64	R	> 64	R	> 64	R	> 64	R	≤ 16	S	32	I	≤ 16	S
TET	≤ 4	S	> 8	R	> 8	R	≤ 4	S	≤ 4	S	≤ 4	S	> 8	R	≤ 4	S	≤ 4	S	≤ 4	S	> 8	R	≤ 4	S	> 8	R	> 8	R
TGC	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S
TOB	≤ 4	S	> 8	R	≤ 4	S	≤ 4	S	≤ 4	S	> 8	R	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S
TRS	≤ 2/38	S	> 2/38	R	> 2/38	R	≤ 2/38	S	≤ 2/38	S	> 2/38	R	≤ 2/38	S	≤ 2/38	S	≤ 2/38	S	> 2/38	R	≤ 2/38	S	≤ 2/38	S	> 2/38	R	≤ 2/38	S

Source: Prepared by the authors. Font

Table 1b. Resistance of *Escherichia coli* strains in this work. Where S is Susceptible, R resistant and I are intermediary. In the first column we have the antibiotics tested in E. coli isolated from those patients mentioned in the other columns.

E.c	HES 15		HES 16		HES 17		HES 18		HES 19		HES 20		HES 21		HES 22		HES 23		HES 24		HES 25		HES 26		HES 27		HES28	
AMI	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S
APS	≤ 8/4	S	≤ 8/4	S	16/8	I	> 16/8	R	> 16/8	R	16/ago	I	> 16/8	R	≤ 8/4	S	16/8	I	16/8	I	> 16/8	R	16/8	I	16/8	I	16/8	I
AMP	≤ 8	S	≤ 8	S	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R	≤ 8	S	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R
CFL	≤ 8	S	≤ 8	S	> 16	R	> 16	R	16	I	> 16	R	> 16	R	16	I	16	I	≤ 8	S	> 16	R	> 16	R	≤ 8	S	≤ 8	S
CPM	≤ 8	S	≤ 8	S	≤ 8	S	≤ 8	S	≤ 8	S	> 16	R	> 16	R	≤ 8	S	≤ 8	S	≤ 8	S	≤ 8	S	16	R	≤ 8	S	≤ 8	S
CXC	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	4	R	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S
CFN	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S
CAZ	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	> 16	R	8	I	≤ 1	S	≤ 1	S	≤ 1	S	8	I	≤ 1	S	≤ 1	S	≤ 1	S
CAC	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	2	R	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S
CFR	≤ 4	S	≤ 4	S	> 16	R	≤ 4	S	8	S	> 16	R	> 16	R	≤ 4	S	8	S	≤ 4	S	> 16	R	> 16	R	≤ 4	S	≤ 4	S
CIP	≤ 1	S	≤ 1	S	> 2	R	> 2	R	> 2	R	> 2	R	> 2	R	> 2	R	≤ 1	S	> 2	R	> 2	R	≤ 1	S	> 2	R	> 2	R
ERT	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S
GEN	≤ 4	S	≤ 4	S	≤ 4	S	> 8	R	≤ 4	S	> 8	R	≤ 4	S	≤ 4	S	≤ 4	S	> 8	R	≤ 4	S	≤ 4	S	> 8	R	≤ 4	S
IMP	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S
LEV	≤ 2	S	≤ 2	S	> 4	R	> 4	R	> 4	R	> 4	R	> 4	R	> 4	R	≤ 2	S	> 4	R	> 4	R	≤ 2	S	> 4	R	> 4	R
MPM	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S
NIT	≤ 32	S	≤ 32	S	> 64	R	≤ 32	S	≤ 32	S	≤ 32	S	≤ 32	S	≤ 32	S	≤ 32	S	≤ 32	S	> 64	R	≤ 32	S	≤ 32	S	≤ 32	S
PIT	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S
PIP	≤ 16	S	≤ 16	S	> 64	R	> 64	R	> 64	R	> 64	R	> 64	R	≤ 16	S	64	I	> 64	R	> 64	R	> 64	R	> 64	R	> 64	R
TET	> 8	R	≤ 4	S	> 8	R	> 8	R	> 8	R	> 8	R	> 8	R	> 8	R	> 8	R	> 8	R	> 8	R	≤ 4	S	> 8	R	> 8	R
TGC	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S
TOB	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S	> 8	R	≤ 4	S	≤ 4	S	≤ 4	S	> 8	R	≤ 4	S	≤ 4	S	> 8	R	≤ 4	S
TRS	≤ 2/38	S	≤ 2/38	S	> 2/38	R	> 2/38	R	> 2/38	R	> 2/38	R	> 2/38	R	> 2/38	R	≤ 2/38	S	> 2/38	R	> 2/38	R	≤ 2/38	S	> 2/38	R	> 2/38	R

Source: Prepared by the authors.

In these two tables above, we have the 28 patients in which we obtained the bacteria from the urinary tract, in addition to the antibiotics tested on each bacterium. from the results, it was possible to see a large number of resistant strains, in this case resistant to ciprofloxacin and levofloxacin (46.4%), which are the most used antibiotics for the treatment of UTI

Table 2a. Resistance of *Klebsiella pneumoniae* strains in this work. Where S is Susceptible, R resistant. In the first column we have the antibiotics tested in *K. pneumoniae* isolated from those patients mentioned in the other columns.

K.p.	HES 1		HES 2		HES 3		HES 4		HES 5		HES 6		HES 7		HES 8		HES 9		HES 10		HES 11		HES 12		HES 13		HES 14	
AMI	≤ 16	S	> 32	R	≤ 16	S	≤ 16	S	> 32	R	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	> 32	R
APS	> 16/8	R	> 16/8	R	≤ 8/4	S	> 16/8	R	16/8	I	> 16/8	R	> 16/8	R	> 16/8	R	≤ 8/4	S	16/8	I	> 16/8	R	> 16/8	R	≤ 8/4	S	> 16/8	R
AMP	> 16	R	> 16	R	16	R	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R
CFL	> 16	R	> 16	R	≤ 8	S	> 16	R	≤ 8	S	> 16	R	> 16	R	> 16	R	≤ 8	S	≤ 8	S	> 16	R	> 16	R	≤ 8	S	> 16	R
CPM	> 16	R	> 16	R	≤ 8	S	≤ 8	S	≤ 8	S	> 16	R	> 16	R	> 16	R	≤ 8	S	≤ 8	S	≤ 8	S	> 16	R	≤ 8	S	> 16	R
CXC	4	R	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	> 4	R	≤ 0.5	S	4	R	≤ 0.5	S	≤ 0.5	S
CFN	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S
CAZ	> 16	R	> 16	R	≤ 1	S	≤ 1	S	≤ 1	S	> 16	R	> 16	R	> 16	R	≤ 1	S	≤ 1	S	≤ 1	S	> 16	R	≤ 1	S	> 16	R
CAC	2	R	2	R	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	2	R	2	R	2	R	≤ 0.25	S	≤ 0.25	S	≤ 0.25	S	2	R	≤ 0.25	S	2	R
CFR	> 16	R	> 16	R	≤ 4	S	8	S	8	S	> 16	R	> 16	R	> 16	R	≤ 4	S	≤ 4	S	> 16	R	> 16	R	≤ 4	S	> 16	R
CIP	> 2	R	> 2	R	≤ 1	S	> 2	R	> 2	R	> 2	R	> 2	R	> 2	R	> 2	R	≤ 1	S	> 2	R	> 2	R	≤ 1	S	> 2	R
ERT	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	> 4	R	≤ 1	S	≤ 1	S
GEN	≤ 4	S	> 8	R	≤ 4	S	> 8	R	> 8	R	> 8	R	> 8	R	> 8	R	≤ 4	S	≤ 4	S	> 8	R	> 8	R	≤ 4	S	> 8	R
IMP	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S
LEV	> 4	R	> 4	R	≤ 2	S	> 4	R	> 4	R	> 4	R	> 4	R	> 4	R	> 4	R	≤ 2	S	> 4	R	> 4	R	≤ 2	S	> 4	R
MPM	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S
NIT	> 64	R	> 64	R	≤ 32	S	> 64	R	> 64	R	> 64	R	> 64	R	> 64	R	> 64	R	> 64	R	> 64	R	> 64	R	64	I	> 64	R
PIT	> 64	R	> 64	R	≤ 16	S	> 64	R	≤ 16	S	> 64	R	> 64	R	> 64	R	≤ 16	S	≤ 16	S	> 64	R	> 64	R	≤ 16	S	> 64	R
PIP	> 64	R	> 64	R	≤ 16	S	> 64	R	> 64	R	> 64	R	> 64	R	> 64	R	> 64	R	32	I	> 64	R	> 64	R	> 64	R	> 64	R
TET	≤ 4	S	> 8	R	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S	> 8	R	≤ 4	S	8	I	≤ 4	S	≤ 4	S	≤ 4	S	≤ 4	S	> 8	R
TGC	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S
TOB	> 8	R	> 8	R	≤ 4	S	> 8	R	> 8	R	> 8	R	≤ 4	S	> 8	R	≤ 4	S	≤ 4	S	> 8	R	> 8	R	≤ 4	S	> 8	R
TRS	> 2/38	R	> 2/38	R	> 2/38	R	> 2/38	R	> 2/38	R	> 2/38	R	> 2/38	R	> 2/38	R	> 2/38	R	≤ 2/38	S	> 2/38	R	> 2/38	R	≤ 2/38	S	> 2/38	R

Source: Prepared by the authors.

Table 2b. Resistance of *Klebsiella pneumoniae* strains in this work. Where S is Susceptible, R resistant. In the first column we have the antibiotics tested in *K. pneumoniae* isolated from those patients mentioned in the other columns.

K.p.	HES 15		HES 16		HES 17		HES 18		HES 19		HES 20		HES 21		HES 22		HES 23	
AMI	≤ 16	S	≤ 16	S	≤ 16	S	32	S	≤ 16	S	≤ 16	S	≤ 16	S	> 32	R	≤ 16	S
APS	≤ 8/4	S	> 16/8	R	> 16/8	R	> 16/8	R	> 16/8	R	≤ 8/4	S	> 16/8	R	> 16/8	R	16/ago	I
AMP	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R
CFL	≤ 8	S	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R	> 16	R	≤ 8	S
CPM	≤ 8	S	> 16	R	> 16	R	> 16	R	> 16	R	≤ 8	S	> 16	R	> 16	R	≤ 8	S
CXC	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	> 4	R	≤ 0.5	S	≤ 0.5	S	≤ 0.5	S	> 4	R
CFN	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S	> 32	R	≤ 16	S	≤ 16	S	≤ 16	S	≤ 16	S
CAZ	≤ 1	S	> 16	R	16	R	> 16	R	> 16	R	≤ 1	S	> 16	R	> 16	R	≤ 1	S
CAC	≤ 0.25	S	2	R	2	R	2	R	> 2	R	≤ 0.25	S	2	R	2	R	≤ 0.25	S
CFR	≤ 4	S	> 16	R	> 16	R	> 16	R	> 16	R	≤ 4	S	> 16	R	> 16	R	≤ 4	S
CIP	≤ 1	S	> 2	R	> 2	R	> 2	R	> 2	R	≤ 1	S	> 2	R	> 2	R	≤ 1	S
ERT	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	> 4	R	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S
GEN	≤ 4	S	> 8	R	> 8	R	≤ 4	S	≤ 4	S	≤ 4	S	> 8	R	> 8	R	≤ 4	S
IMP	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	> 8	R	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S
LEV	≤ 2	S	> 4	R	> 4	R	> 4	R	> 4	R	≤ 2	S	> 4	R	> 4	R	≤ 2	S
MPM	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S	> 8	S	≤ 1	S	≤ 1	S	≤ 1	S	≤ 1	S
NIT	≤ 32	S	> 64	R	> 64	R	> 64	R	> 64	R	≤ 32	S	> 64	R	> 64	R	> 64	R
PIT	≤ 16	S	> 64	R	> 64	R	> 64	R	> 64	R	≤ 16	S	> 64	R	> 64	R	≤ 16	S
PIP	≤ 16	S	> 64	R	> 64	R	> 64	R	> 64	R	≤ 16	S	> 64	R	> 64	R	32	I
TET	> 8	R	≤ 4	S	≤ 4	S	≤ 4	S	> 8	R	≤ 4	S	> 8	R	> 8	R	≤ 4	S
TGC	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S	≤ 2	S
TOB	≤ 4	S	> 8	R	> 8	R	> 8	R	> 8	R	≤ 4	S	≤ 4	S	> 8	R	≤ 4	S
TRS	> 2/38	R	> 2/38	R	> 2/38	R	> 2/38	R	> 2/38	R	≤ 2/38	S	> 2/38	R	≤ 2/38	S	> 2/38	R

Source: Prepared by the authors.

In these two tables above, we have the 23 patients in which we obtained the urinary tract bacteria, in addition to the antibiotics tested on each bacterium. from the results, it was possible to observe a large number of resistant strains, totaling 69.6% of resistance to antibiotics in general. We also highlight the case of two patients, HES12 and HES19, in which they have *K. pneumoniae* with multi-resistance to many antibiotics.

Further this analysis, the occurrence of these bacterial resistance could be an indicative of the non-employed of good pharmaceutical practices for antibiotic use and consequent antibiotic resistance acquisition for bacteria. Also, the use of quinolones, principally ciprofloxacin, showed the involvement of the wrong medical protocols, performed before an easy microbiological resistance analysis of the bacteria causing UTI.

4. Conclusion

In conclusion, the incorrect use of the antibiotic therapy in the UTI treatment is a principal cause of the bacterial

resistance in recurrent infection presented in this clinical etiology. The knowledge around the multiresistant bacteria, their genes and genomic structure is an aim of our group to elucidate the new resistance mechanisms for bacteria causing UTI. Based on the knowledge obtained in this article, the group intends to continue monitoring antibiotic resistance linked to the UTI.

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