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Evaluation of agents grown from urine culture and antibiotic susceptibility in patients followed up with the diagnosis of urinary system infection

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ABSTRACT

Aim: In this study, it was aimed to determine the reproducing agents and the antibiotic susceptibility of the agents in a total of 89 urine samples cultured in Ankara Training and Research Hospital, Infectious Diseases and Clinical Microbiology laboratory during the 6-month period between 2021-2022.

Material and Method: While growth was detected in urine culture in 68 (76%) of 89 urine samples taken in the study, no growth was found in 21 (24%) of them. Antibiotic susceptibility was studied on Mueller-Hinton agar by the disc diffusion method in isolates with growth in urine culture.

Results: Reproducing factors are in order of frequency; 25 *E. coli*, 17 extended-spectrum beta-lactamase (ESBL) positive *E. coli*, 10 *Klebsiella pneumoniae*, 3 *Pseudomonas aeruginosa*, 3 *Proteus mirabilis*, 3 *Enterococcus faecalis*, 1 *Enterobacter cloacae*, 1 *Candida krusei*, 1 *Staphylococcus aureus*, 1 patient *E. coli* and *Proteus* species were determined. Resistance rates in *E. coli* strains isolated from urine culture; 20% (4/20) for ciprofloxacin, 5% (1/19) for nitrofurantoin, 9.5% (2/21) for trimethoprim/sulfamethoxazole (TMP/SMZ). No resistance was found to fosfomycin 0% (0/19) and to carbapenems (imipenem, meropenem, and ertapenem) (0/21). The resistance rates in ESBL positive *E. coli* strains are; 100% (13/13) for ciprofloxacin, 7% (1/14) for nitrofurantoin, 12.5% (1/8) for fosfomycin, 26.6% (4/15) for TMP-SMZ. No resistance was found to carbapenems (imipenem, meropenem and ertapenem).

Conclusion: In our study, it was determined that the most common infectious agent causing urinary tract infection was *E. coli*. In our study, it was determined that the resistance rates for ciprofloxacin and TMP-SMZ, which are used in empirical treatment, are high, and the resistance rates for fosfomycin and nitrofurantoin are low in *E. coli* strains that cause urinary system infection. Due to the low rates of resistance in the empirical treatment of urinary system infections, it would be a suitable approach to prefer oral treatment options such as fosfomycin and nitrofurantoin in outpatients.

Keywords: Urinary tract infections, pathogens, antibiotic resistance

INTRODUCTION

Urinary tract infections may be shown among the most prevalent infections in communities and hospitals (1). The distribution of the factors leading to urinary tract infections may differ depending on whether the infection is complicated (e.g., obstructive uropathy, congenital anomaly, neurological bladder) or if it is hospital-acquired or community-acquired. *E. coli* is the most common cause of community- and hospital-acquired urinary tract infection. In addition, *Proteus*, *Pseudomonas*, *Klebsiella*, *Enterobacter*, drug-resistant *E. coli* (e.g., ESBL producing *E. coli*), enterococci, and staphylococci may be encountered as agents in patients with recurrent and complicated urinary tract infections. The frequency of urinary tract infections due to antibiotic-resistant bacteria may differ by patient population and geographical region (1-3). Besides, the incidence and annual incidence of urinary tract infections are higher among females than in males (3,4). The present research aimed to determine the reproducing agents and the antibiotic susceptibility of these agents on a total of 89 urine samples cultured in the Infectious Diseases and Clinical Microbiology Laboratory of Ankara Training and Research Hospital within a 6-month period between 2021-2022.

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MATERIAL AND METHOD

No human or animal biological material was used in the study, and since it is a laboratory study on bacterial strains, it does not require an ethics committee decision. All procedures were carried out in accordance with the ethical rules and the principles.

In this study, the reproducing agents and their antibiotic susceptibility in a total of 89 urine cultures were retrospectively screened in the specified Infectious Diseases and Clinical Microbiology Laboratory. Urine samples were cultivated on 5% sheep blood agar and Eosin-Methylene Blue agar media using a real-time quantitative method. Then, the media were incubated at 37°C for 18-24 hours under aerobic conditions. Microorganisms were detected using conventional methods (Gram staining, oxidase, triple sugar iron (TSI), Indol production, methyl red, vogas-proskauer and citrate utilization (IMVIC)) in samples >105 colony-forming units/mL (CFU/mL). Antibiotic susceptibility of isolated bacteria to ciprofloxacin, nitrofurantoin, fosfomycin, trimethoprim/sulfamethoxazole (TMP/SMZ), and carbapenems (imipenem, meropenem, and ertapenem) was explored using the Kirby-Bauer disk diffusion method. For this purpose, commercial antibiogram discs of ciprofloxacin, nitrofurantoin, fosfomycin, TMP/SMZ, imipenem, meropenem, and ertapenem (Becton Dickinson, USA) were used. Antibiotic susceptibility tests were interpreted in accordance with the recommendations of the European Committee for Antimicrobial Susceptibility Testing (EUCAST) (5).

RESULTS

The study included 89 urine samples obtained from patients hospitalized in the infectious diseases clinic. There was growth in 68 urine samples (76%) samples, but it was not the case in 21 (24%). The findings revealed the frequencies of reproducing agents to be as follows: *E. coli* (25), extended-spectrum beta-lactamase (ESBL) positive *E. coli* (17), *Klebsiella pneumoniae* (10), *Pseudomonas aeruginosa* (3), *Proteus mirabilis* (3), *Enterococcus faecalis* (3), *Enterobacter cloacae* (1), *Candida krusei* (1), *Staphylococcus aureus* (1), and *E. coli* and *Proteus* (1). Only one microorganism was isolated in the urine cultures, except for one sample, and both *E. coli* and *Proteus* were isolated as agents in this exception sample. Due to the low numbers of reproducing agents other than *E. coli*, which was the most frequently isolated bacteria in the urine cultures, the findings of antibiotic resistance of these agents were not presented.

Table 1 shows the findings of antibiotic resistance of *E. coli* and ESBL-positive *E. coli* strains to ciprofloxacin, nitrofurantoin, fosfomycin, TMP/SMZ, and carbapenems (imipenem, meropenem, and ertapenem).

It was also found that antibiotic-resistant *E. coli* strains (ESBL (+) *E. coli*) showed stronger resistance to these four antibiotics when compared to ESBL-negative *E. coli* strains. For example, while the resistance rate was 20% in ESBL (-) *E. coli* strains, it was found to be 100% in ESBL (+) *E. coli* strains for ciprofloxacin. On the other hand, any of the ESBL-producing *E. coli* strains (n=17) strains) and non-ESBL-producing *E. coli* strains (n=17) showed resistance to carbapenems (imipenem, meropenem, and ertapenem).

Table 1. The findings of antibiotic resistance of *E. coli* and ESBL-positive *E. coli* strains to ciprofloxacin, nitrofurantoin, fosfomycin, TMP/SMZ, and carbapenems

Antibiotics	*E. coli* (n:25)		ESBL (+) *E. coli* (n:17)	
	n	(%)	n	(%)
Ciprofloxacin	4/20	20	13/13	100
Nitrofurantoin	1/19	5	1 /14	7
Fosfomycin	0/19	0	1/8	12.5
TMP/SMZ	2/21	9.5	4/15	26.6
Imipenem	0/21	0	0/17	0
Meropenem	0/21	0	0/17	0
Ertapenem	0/21	0	0/17	0

TMZ/SMX: trimethoprim/ sulfamethoxazole,

DISCUSSION

Urinary system infections rank first among the most prevalent infections in communities and hospitals (1,2). *E. coli* is the most common cause of community- and hospital-acquired (nosocomial, healthcare-associated) urinary tract infections (1-6). Keskin et al. (6) reported the antibiotic resistance rates of *E. coli* strains in community-acquired infection (CAI) and hospital-acquired infection (HAI) - respectively - as 2% and 4% to nitrofurantoin, 23% and 43% to ciprofloxacin, 1% and 3% to fosfomycin, 34% and 53% to TMP/SMZ, 1% and 18% to imipenem, 2% and 21% to meropenem, and 5% and 27% to ertapenem. While the resistance to ciprofloxacin in this study was higher than the rate reported by Keskin et al. (6), it was vice versa for TMP-SMZ. However, *E. coli* strains did not show resistance to any of the carbapenems. Avcıoğlu et al. (7) reported that *E. coli*s strains causing uncomplicated urinary tract infections showed a 4% resistance to fosfomycin, 4% to nitrofurantoin, 41% to ciprofloxacin, 40% to TMP/SMZ, and 2% to imipenem. In that study, the resistance rates reported for fosfomycin and nitrofurantoin were similar to the rates found in the present study, while the authors reported lower resistance rates for ciprofloxacin and higher rates for TMP/SMZ. Multiple-center studies in the national literature reported the resistance rates for TMP/SMZ to be between 20-60% (7-9).

In this study, carbapenem resistance was not detected in any ESBL (-) and ESBL (+) *E. coli* strains. A Turkey-

based study concluded 0.3% resistance to imipenem in ESBL-positive *Enterobacter*iaceae isolates (6, 10).

Various Turkey-based studies reported ciprofloxacin resistance in *E. coli* strains to be between 36.5% and 43% (6, 11). In our study, ciprofloxacin resistance in ESBL (-) *E. coli* strains was determined to be 20%, while this rate was determined to be 100% in ESBL (+) *E. coli* strains.

Only a single bacterial agent leads to 95% of uncomplicated urinary tract infections. Yet, more than one agent can be isolated in urine culture in complicated urinary tract infections (1). In this study, more than one agent (*E. coli* and *Proteus*) grew in only 1 (1.47%) of 68 samples.

The previous research recommended not to utilize quinolones and TMP/SMZ in the empirical treatment of infections due to the high rate of resistance (20% or more) to these antibiotics which are often adopted in the treatment of community-acquired acute bacterial cystitis. In the same study, the use of fosfomycin and nitrofurantoin was found to be more convenient due to the low rates of resistance to these antibiotics (12).

This study is not free of a few limitations. Since the present research aimed was to determine the resistance rates for specific antibiotics in *E. coli* strains causing urinary tract infections, antibiotic resistance rates of bacteria other than *E. coli* were not considered.

CONCLUSION

Overall, it was concluded that the most common infectious agent causing urinary tract infection was *E. coli*. It was also detected that while *E. coli* strains showed high resistance to ciprofloxacin and TMP-SMZ, used in empirical treatment, they produced poor resistance to fosfomycin and nitrofurantoin. Thus, it would be more appropriate to prefer oral treatment options, such as fosfomycin and nitrofurantoin, in the empirical treatment of outpatients with urinary tract infections due to poor resistance from the infectious agents.

ETHICAL DECLARATIONS

Ethics Committee Approval: No human or animal biological material was used in the study, and since it is a laboratory study on bacterial strains, it does not require an ethics committee decision.

Informed Consent: Informed consent is not required for this study as it is a retrospective laboratory study designed retrospectively on bacterial strains.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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