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ORIGINAL ARTICLE UROLOGY

Effects of the february 6 earthquake on the agents growing in urine cultures and antibiotic resistance rates

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ABSTRACT

OBJECTIVE: The aim of this study was to investigate the effects of the February 6 earthquake on the bacteria grown in urine cultures and antibiotic resistance of patients admitted to the urology outpatient clinic.

METHODS: In this study, 11,397 urine samples requested by the urology outpatient clinic between January 2022 and December 2023 were examined. We evaluated the urine cultures and antibiotic resistance profiles of the pathogens in patients' clinic in the years 2022 and 2023 separately and post-earthquake year 2023 as two separate periods, as the first 6-month period immediately after the earthquake. The pathogens grown in urine cultures and antibiotic resistance profiles were examined retrospectively. Only one of the same strains isolated in consecutive repeated growths in the urine cultures of the patients was included.

RESULTS: Of the 11,397 urine cultures, 6,914 were requested in 2022 and 4,483 were requested in 2023. There was no statistical difference in the growth rate between the years (13.1–14.1%). When the demographic data of the first and last 6 months of 2023 were compared, statistical differences were found between the first and last six months of 2023 in terms of the number of patients for whom culture was requested, the number of culture positives, the reproduction rate, and the number of male and female patients. The total number of patients for whom urine culture was requested was 4483 (1471 in the first six months - 3012 in the last six months) ($p=0.008$) and the number of culture-positive patients was 630 (184–446) ($p=0.007$). The reproduction rates were found to be 12.5% and 14.8%, respectively ($p=0.047$). It was found that the resistance rates of *Escherichia coli* (*E. coli*) to gentamicin (GN), cefuroxime (CXM), cefixime (CFM) and ceftazidime (CAZ) groups of antibiotics were higher in the first six-month period of 2023 ($p<0.05$). Similarly, the resistance rate of *Klebsiella* spp. to CXM and CAZ groups of antibiotics was found to be higher in the first six-month period of 2023 ($p<0.05$).

CONCLUSION: The results of our study show that the conditions in communal living areas after the February 6 earthquake had an increasing impact on antibiotic resistance rates and antibiotic resistance rates of certain groups of antibiotics, especially the *Enterobacterales* group were higher in the first half of 2023.

Keywords: Antibiotic resistance; earthquake; urinary tract infection.

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On February 6, 2023, according to the data of the Disaster and Emergency Management Presidency (AFAD, www.afad.gov.tr), a major earthquake with a moment magnitude (Mw) of 7.7 and an epicenter of Pazarcık-Kahramanmaras (N37.288°, E37.043°) occurred, followed by a second earthquake with a moment magnitude (Mw) of 7.6 9 hours later, at 13:24 local time (10:24 GMT) [1]. Both earthquakes affected 11 provinces, including Malatya, and a total population of over 15 million. As of 18.02.2023, it was announced that the total number of deaths exceeded 40,000 and 110,000 people were injured. In particular, more than 8,000 buildings in Malatya were reported to be at the 'Heavily/Destroyed Urgently Collapsed' level [2].

It has been reported that 195,962 people had to leave their homes and 155,379 tents were set up since the first moment of the earthquake. In addition, people had also sheltered in gyms, dormitories, educational buildings and other government buildings [2–4].

Urinary tract infections are a very common problem in both hospitals and the general population and an important problem affecting public health. The appropriate antibiotic treatment for these infections can be started after identifying the causative organism and determining the antibiotic resistance profile.

Exposure to pathogens may occur due to lack of sanitation and disinfection of areas inside the toilets and inadequate hand hygiene [5]. Several studies have shown that infectious disease outbreaks originating from toilets are largely due to improper sanitation and disinfection of toilet facilities [6]. It has been reported that up to 3.8 million infections occur each year in long-term care settings, including community living facilities [7].

The aim of this study was to investigate the effects of the devastating February 6 earthquake, which caused a large population to live in communal areas and to use shared bathrooms and toilets, on urinary tract infections (UTIs) and the antibiotic resistance rates of the responsible microorganisms determined by urine culture tests.

MATERIALS AND METHODS

In our study, bacterial agents isolated from 11,397 urine samples collected from patients over the age of three, which is the estimated age to acquire toilet habits, who were admitted to the Urology Outpatient Clinic of Malatya Turgut Ozal University Hospital between January 2022 and December 2023, were examined retrospectively.

Highlight key points

- There is a significant difference in both the diversity of bacteria produced and antibiotic resistance before and after the earthquake.
- In addition to natural disasters, such as earthquakes, living in communal areas such as schools, nursing homes and military bases during normal times can also increase the risk of urinary tract infections and facilitate the spread of antibiotic-resistant pathogens.
- The effects of natural disasters on antibiotic resistance of bacteria were evaluated and it will be useful in protecting public health.

The urinary cultures of the patients were evaluated separately in 2022 and 2023, and the year 2023 was evaluated separately as the first and the second six months. Only one of the same strains isolated in consecutive repeated reproductions of the urine cultures was included in the study.

Statistical Analysis

The data were evaluated by using the SPSS 28.0 statistical package program (Statistical Package for the Social Sciences 28.0, Armonk, NY: IBM Corp.). Since the research data were categorical, numbers and percentages were used for descriptive values. Cross-tables were created in comparisons and chi-square analysis was applied. In the analyses, a value of $p<0.05$ was accepted as statistically significant.

RESULTS

When the years 2022 and 2023 were compared in terms of demographic data, it was found that 6,914 urine culture tests were performed in 2022 and 4,483 in 2023, and the difference was statistically significant ($p<0.05$). In addition, the number of culture-positive patients (903 in 2022 and 630 in 2023) and the number of female patients (578 in 2022, 397 in 2023) were statistically higher in 2022 ($p<0.05$). When the demographic data of the first and last six months of 2023 were compared, there were statistically significant differences in terms of number of patients for whom culture was requested, the number of positive culture tests, the reproduction rates, and the number of male and female patients ($p<0.05$ for all) (Table 1). When the antibiotic resistance rates of the most common species from the *Enterobacterales* family were compared for the

Table 1. Demographic data for the first and last 6 months of 2023

	Total	First 6 months	Last 6 months	p
Total number of patients for whom culture was requested	4483	1471	3012	0.008*
Number of culture positive patients	630	184	446	0.007*
Reproduction rate %	**14.1**	**12.5**	**14.8**	0.047*
Age				
Sex				
Male	233	74	159	0.037*
		40.2	**35.7**	
Female	397	110	287	0.031*
		59.80	**64.3**	

*: P<0.05; there is a statistical difference between months.

years 2022 and 2023, there were no statistically significant differences in antibiotic resistances of *P. mirabilis* and *E. coli* bacteria (p>0.05).

Statistical differences were found between years in terms of the numbers of coagulase-negative-staphylococcus (CNS), *Morganella morganii*, *Citrobacter* spp., *Proteus vulgaris*, *Pseudomonas putida*, *Sphingomonas paucimobilis*, *Stenotrophomonas maltophilia*, *Burkholderia cepacia*, *Streptococcus* Group B bacteria (p<0.05) (Table 2).

Statistical differences were found between the first and last six months of 2023 in terms of the numbers of *Proteus mirabilis* (*P. mirabilis*), *Acinetobacter boumanii*, *Serratia marcescens*, *Streptococcus agalactia*, *Streptococcus pyogenes*, and total bacteria (p<0.05) (Table 3).

When the antibiotic resistance rates of the most common species from the *Enterobacterales* family were evaluated for the years 2022 and 2023, there were no statistically significant differences between the antibiotic resistance rates of *P. mirabilis* and *E. coli* (p>0.05). It was found that antibiotic resistance rates of *Klebsiella* spp. to amikacin (AC) and ertapenem (ERT) were statistically significantly higher in 2022 compared to 2023 (AC: 2022n/N, 1/121, 0.8%, 2023n/N, 6/82, 7,3%; ERT: 2022n/N, 7/118, 5.9%, 2023n/N, 16/83, 19.3%) (p<0.05). In addition, it was found that the resistance rate of *Enterobacter* spp for gentamicin (GN) was statistically higher in 2022 (2022n/N, 10/13, 76.9%; 2023n/N, 0/8, 0%) (p<0.05). When the first and second six-month periods of 2023 were compared, no statistical differences were found between the antibiotic resistance rates of *P. mirabilis* and *Enterobacter* spp. (p>0.05). The resistance rates of *E. coli* for GN, CXM, CFM, and CAZ antibiotics were statistically significantly higher in the first period of 2023 (p<0.05). For *Klebsiella* spp., the resistance rates for CXM and CAZ antibiotics were also statistically significantly higher in the first six months of 2023 (p<0.05) (Table 4).

DISCUSSION

One of the main problems observed in public areas is the failure to maintain sustainable hygiene standards. *E. coli*, one of the most common agents of UTI, is usually spread by the fecal-oral route or by transmission from contaminated surfaces. Studies conducted in our country and abroad have reported that these bacteria are present on surfaces such as door handles, flush valves, taps and toilet seats in public toilets [8, 9]. In addition, it has been reported that inadequate sanitation or disinfection of toilets increases the risk of infection [10].

Individuals with a weak immune system (pregnant women, elderly and diabetic patients, etc.) are at greater risk of infection in public areas. It is known that the course of UTI complications is more severe in these patients. In addition, it has been determined that the incidence of infection is higher in groups with insufficient hygiene training [11, 12].

Kawade et al. [13]. in their study, reported that the risk of UTI was shown to be higher in women who do not have access to toilets and those who use unhygienic and inadequately maintained public toilets. Similar studies have reported a significant relationship between the

Table 2. Bacteria isolated from urine culture sent from the urology outpatient clinic in 2022–2023

Factors	2022		2023		p
	n	%	n	%	
Escherichia coli	639	70.8	445	70.6	0.987
Klebsiella spp.	121	13.4	84	13.3	0.957
Enterococcus spp.	45	5.0	28	4.4	0.984
Pseudomonas aeruginosa	30	3.4	23	3.6	0.986
Proteus mirabilis	22	2.5	28	4.4	0.974
Enterobacter spp.	14	1.6	9	1.4	0.972
Staphylococcus aureus	11	1.2	8	1.3	0.998
CNS	4	0,4	0	0.0	0.001*
Acinetobacter boumanii	4	0.4	1	0.2	0.998
Morganella morganii	2	0.2	0	0.0	0.001*
Citrobacter spp.	2	0.2	0	0.0	0.001*
Proteus vulgaris	1	0.1	0	0.0	0.001*
Serratia marcescens	1	0.1	1	0.2	0.997
Pseudomonas putida	1	0.1	0	0.0	0.001*
Sphingomonas paucimobilis	1	0.1	0	0.0	0.001*
Stenotrophomonas maltophilia	1	0.1	0	0.0	0.001*
Burkholderia cepacia	1	0.1	0	0.0	0.001*
Streptococcus agalactia	1	0.1	2	0.3	0.998
Streptococcus Grup B	1	0.1	0	0.0	0.001*
Streptococcus pyogenes	1	0.1	1	0.2	0.997
Total	903	100.0	630	100.0	0.578

CNS: Coagulase negative *staphylococcus*; *: P<0.05; there is a statistical difference.

use of shared toilets and UTIs, especially among women [14]. Similarly, in our study, it was observed that the number of female patients who were admitted with the symptoms of UTI was higher in the second six months of 2023 compared to the first six months.

In a study conducted by Das et al. [15], it was reported that access to individual toilets has a protective effect against UTIs. Considering that access to individual toilets is difficult in natural disasters such as earthquakes where people have to live closer in common areas, it is inevitable that there will be an increase in infections, especially UTIs. In addition, since it is not easy to access an available toilet and their unhygienic nature, the use of shared toilets may also cause people to restrict fluid intake in order to reduce the need for a toilet. In the literature, it has been reported that this situation is another reason that increases the risk of UTI [16, 17].

In our study, when the years 2022 and 2023 were compared in terms of demographic data, it was found that the number of patients who had urine cultures done, the number of positive culture results and the number of female patients were found to be statistically low in 2023, as expected ($p<0.05$).

When the demographic data of the first and last six months of 2023 were compared, the number of patients who had urine cultures done, the number of positive culture results, the reproduction rate, and the number of both male and female patients were found to be statistically higher in the second six months due to the low number of admissions in the first months immediately after the earthquake ($p<0.05$) (Table 1). In addition, when the distribution of isolated bacteria was examined, no statistical differences were found between 2022 and 2023 and the first and second half of

Table 3. Bacterial distribution in the first and last 6 months in 2023 years

Factors	First 6 months		Last 6 months		p
	n	%	n	%	
Escherichia coli	134	72.8	311	69.7	0.785
Klebsiella spp.	21	11.4	63	14.1	0.845
Enterococcus spp.	7	3.8	21	4.7	0.746
Pseudomonas aeruginosa	6	3.3	17	3.8	0.994
Proteus mirabilis	11	6.0	17	3.8	0.049*
Enterobacter spp.	2	1.1	7	1.6	0.841
Staphylococcus aureus	2	1.1	6	1.4	0.952
CNS	0	0.0	0	0.0	
Acinetobacter boumanii	0	0.0	1	0.2	0.001*
Morganella morganii	0	0.0	0	0.0	
Citrobacter spp.	0	0.0	0	0.0	
Proteus vulgaris	0	0.0	0	0.0	
Serratia marcescens	1	0.5	0	0.0	0.001*
Pseudomonas putida	0	0.0	0	0.0	
Sphingomonas paucimobilis	0	0.0	0	0.0	
Stenotrophomonas maltophilia	0	0.0	0	0.0	
Burkholderia cepacia	0	0.0	0	0.0	
Streptococcus agalactia	0	0.0	2	0.5	0.001*
Streptococcus Grup B	0	0.0	0	0.0	
Streptococcus pyogenes	0	0.0	1	0.2	0.001*
Total	184	100.0	446	100.0	0.010*

CNS: Coagulase negative *staphylococcus*; *: P<0.05; there is a statistical difference.

2023 in terms of the frequency of the most frequently isolated species *E. coli* and *Klebsiella* spp.

The resistance status of the microorganism is its ability to resist the effects of antimicrobial drugs [18]. The resistance problem caused by microorganisms that have developed since the 1970s has become an important problem today. Microorganisms' resistance to antimicrobial drugs is increasing day by day due to various reasons such as the increase in the number of patients in intensive care units with impaired immune systems, the increase in the irregular use of antimicrobial drugs and the use of antimicrobial drugs in animal husbandry. Especially antimicrobial drugs which are frequently used in hospitals contribute significantly to the development of resistance [19, 20]. In our study, the resistance rate of *E. coli* for the antibiotics including GN, CXM, CFM and CAZ was statistically significantly higher in the last six months of 2023 ($p<0.05$); whereas the resistance rate of *Klebsiella* spp. for CXM and CAZ was also statistically significantly higher in the last six months of 2023 ($p<0.05$) (Table 4). We found that bacteria that developed resistance to antibiotics, especially those which were commonly used in communal living areas.

In the first six months, they were detected at a high rate in the second six months and the prevalence of antibiotic-resistant bacteria was higher in infected individuals in communal living areas. The findings of the study are similar to previous studies showing that communal living environments are important for the prevalence of UTIs and antibiotic resistance. Studies on conditions in dormitories, refugee camps and correctional facilities have shown that unhygienic conditions increase the development of resistance due to frequent exposure to inadequate antibiotic treatments. Bacteria

Table 4. Resistance rates of *Enterobacterales* group bacteria in the first and last 6 months of 2023

Antibiotic	*E. coli*			*Klebsiella* spp.			*Proteus mirabilis*			*Enterobacter* spp.		
	First 6 months n/N (%)	Last 6 months n/N (%)	p	First 6 months n/N (%)	Last 6 months n/N (%)	p	First 6 months n/N (%)	Last 6 months n/N (%)	p	First 6 months n/N (%)	Last 6 months n/N (%)	p
AMP	92/134 68.7	187/311 60.1	0.110	21/21 100.0	62/63 98.4	0.998	3/11 27.3	10/17 58.8	0.212	2/2 100.0	7/7 100.0	
AMC	38/120 31.7	92/298 30.9	0.967	11/20 55.0	17/60 28.3	0.058	0/11 0.0	2/17 11.8	0.668	2/2 100.0	2/4 50.0	0.759
GN	19/118 16.1	26/305 8.5	**0.037***	3/15 20.0	3/58 5.2	0.181	1/10 10.0	1/17 5.9	0.998	0/2 0.0	0/7 0.0	
AK	4/134 3.0	5/311 1.6	0.562	3/21 14.3	3/61 4.9	0.349	1/11 9.1	2/17 11.8	0.998	0/2 0.0	0/7 0.0	
NOR	37/115 32.1	92/296 31.1	0.924	5/16 31.3	11/57 19.3	0.497	2/10 20.0	3/17 17.7	0.998	0/2 0.0	0/7 0.0	

N: Total number of bacteria; n: Number of resistant strains; AMP: Ampicillin; AMC: Amoxicillin-clavulanic acid; GN: Gentamicin; AK: Amikacin; NOR: Norfloxacin; %: Resistance rate. p<0.05: There is a statistical difference between years.

that are resistant to broad-spectrum antibiotics in particular were isolated more frequently in these environments. This situation shows that antibiotic-resistant bacteria, which act as a 'reservoir' in communal areas, can be easily transmitted between individuals [21].

Limited access to healthcare services due to earthquakes may lead people to take medications without proper guidance. In addition, access to antibiotic treatment or the correct use of these medications is often inadequate in areas of disaster. Early termination of treatment or use of the wrong dose increases the development of antibiotic resistance. In addition, unconscious use of antibiotics during infection outbreaks in common areas also causes resistant strains to spread to a wider population. Therefore, in cases where living in groups is mandatory due to earthquakes or in places such as dormitories, it is critical to limit antibiotic use to prescription only and to provide better access to healthcare services. Regular monitoring of antibiotic resistance patterns and integration of surveillance data into public health strategies can help control efforts.

Studies conducted after disasters are generally studies on the emergence and spread of infectious diseases (respiratory viral infections, gastroenteritis, parasitic diseases, etc.) [22, 23]. These studies show that UTI, which is more frequently seen in common living areas after disasters, has not received enough attention. After the February 6 earthquake, thousands of people had to leave their homes and live in common living areas where they had to share bathrooms and toilets for a long time. In disasters, many infectious diseases, especially UTIs, are seen to increase as a result of inadequate sanitation, malnutrition, and weakening of the immune system due to stress. In addition, similar to natural disasters such as earthquakes, common areas such as schools, nursing homes and military bases where people live together during normal times can increase the risk of urinary tract infections and facilitate the spread of antibiotic-resistant pathogens. In such cases, it is important to implement effective sanitation practices as much as possible, improve education and strengthen antibiotic management to reduce these risks and protect public health. We believe that this study will guide the detection and treatment of UTI infections, which increase in disasters such as earthquakes.

Conclusion

The results of our study show that antibiotic resistance of bacteria causing UTI increased due to the changes in lifestyles as a result of the February 6 earthquake and the number of patients admitted to the hospital due to UTI decreased due to the decrease in population.

Ethics Committee Approval: The Malatya Turgut Ozal University Non-Interventional Ethics Committee granted approval for this study (date: 13.02.2024, number: 2024/39).

Informed Consent: Written informed consents were obtained from patients who participated in this study.

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