Antimicrobial Resistance of Uropathogenic *Escherichia coli* in Outpatient Cases at Baeza Basic Hospital, Ecuador

Karina Inés Paredes Páliz[1], Vladimir Medardo Pazmiño Velasteguí[2], Anabell del Rocio Urbina Salazar[2], Alberto Renato Inca Torres[2]

[1]*Universidad Nacional de Chimborazo. Faculty of Health Science. Research Group in Public Health. Riobamba, Ecuador.*
[2]*Universidad de las Fuerzas Armadas ESPE. Department of Life and Agricultural Sciences. Quito, Ecuador*

KEYWORDS
Antibiotic resistance, Uropathogenic *Escherichia coli,* Outpatient patients, Urine antimicrobial resistance

ABSTRACT
Introduction: Bacterial resistance to antibiotics is one of the current major public health issues, as these compounds constitute a primary tool for controlling and treating bacterial infections. Objective: To determine the bacterial resistance of uropathogenic Escherichia coli in outpatient individuals attending the Microbiology Laboratory of Baeza Basic Hospital (BBH) during the period January-December 2023. Methodology: An observational, descriptive, and cross-sectional study was conducted to describe the characteristics of uropathogenic Escherichia coli during the period January-December 2023. Results: We analyzed 169 positive urine culture results from outpatient individuals of both sexes, varying ages, with a diagnosis of urinary tract infection. The most frequently isolated microorganisms were Escherichia coli (80.1%), followed by Enterococcus faecalis (3.8%) and Proteus mirabilis (3.3%). Regarding antimicrobial resistance profiles expressed as a percentage for E. coli, they were as follows: ampicillin (70.8%), nalidixic acid (53.7%), amoxicillin + clavulanic acid (48.8%), trimethoprim + sulfamethoxazole (44.0%), and ciprofloxacin (34.3%). 12.4% of E. coli were extended-spectrum beta-lactamase (ESBL) producers. The sensitivity of E. coli to nitrofurantoin was 92.1%, ampicillin-sulbactam 90.4%, and fosfomycin 87.1%. Conclusions: The recommended empirical first-line treatment is nitrofurantoin, fosfomycin, and as second-line options, cephalexin and cefuroxime for uncomplicated urinary tract infections. Based on this information, it is proposed to develop a Clinical Guide for the treatment of uncomplicated urinary tract infections in the study area.

1. Introduction

Antibiotics are used in humans, animals, or crops, which can cause side effects and contribute to the development of antibiotic resistance. Antibiotic-resistant germs can also share their ability to become resistant with other germs that have not been exposed to antibiotics (1). In this context, during the 68th World Health Organization (WHO) Assembly held in 2015, it was established to adopt the Global Action Plan against Antimicrobial Resistance (AMR) by WHO Member States. They committed to developing and implementing the Action Plan for AMR. Currently, seven countries in Latin America have officially endorsed this document. This is how Ecuador has the National Plan for the Prevention and Control of AMR for the years 2019-2023, which is soon to be officially endorsed through Ministerial Agreement (2). Consequently, a large number of countries in Latin America have implemented surveillance networks for bacterial resistance (3), and alerts have been declared on all continents. Antimicrobial resistance has varied over the years, necessitating continuous updates to the empirical treatment of urinary tract infections (UTIs) based on the antibiotic sensitivity of the predominant pathogens.

Therefore, the administration of antibiotics, or the improvement of prescription and their usage, is crucial to optimize the treatment of patients with infections, safeguard patients from harm, and combat antibiotic resistance (4). In the case of the country in question, Ecuador, it has been emphasized that the post-discovery use of penicillin marked a significant milestone in the history of medicine. Almost nine decades later, we once again confront an uncertain future as bacteria have developed mechanisms to adapt to the effects of antibiotics (5), a public health issue that disproportionately affects developing countries such as this Latin American nation.

In this context, with a focus on urinary tract infections, which emerge as one of the major challenges to public health, with over 150 million cases reported worldwide each year (6), resulting in significant economic burden for individuals undergoing treatment, the most prominent bacteria

causing UTIs belong to the Enterobacteriaceae family. Within this group, 70 to 95% of cases are attributed to *Escherichia coli.* This bacterium is commonly found in the human intestinal tract. Enterobacteria producing extended-spectrum beta-lactamases (ESBLs) have been spreading globally since the 1980s. Many countries have initiated national plans to control this threat to public health (7). Meanwhile, in Latin America, it is considered that since 1990, resistance of enterobacteria to antibiotic treatment has been on the rise due to the emergence and dissemination of new resistance mechanisms, with extended-spectrum beta-lactamases being among the most notable (8).

This is how the ability of *Escherichia coli* to acquire resistance genes renders its sensitivity unpredictable, necessitating its determination through antibiogram. This enables the prescription of medications to patients, ensuring they receive timely antibiotic treatment when necessary for addressing infections and preventing sepsis (1).

Due to the significance of precision in determining the conditions under which sanitary measures are necessary for the proper administration of antimicrobials, considering the health risks associated with the absence of a specific and timely guideline to address cases involving pathological diagnoses in the urinary tract, the current research has been initiated. The objective of this investigation is to determine the bacterial resistance of uropathogenic *Escherichia coli* in outpatient individuals attending the Microbiology Laboratory of Baeza Basic Hospital during the period January-December 2023.

2. Methodology

The present research was conducted at Baeza Basic Hospital, located in the city of Baeza, the cantonal seat of Quijos Canton, belonging to the Napo Province. It corresponds to the second level of health care within the 15D0-2 El Chaco-Quijos Health District of the Ministry of Public Health of Ecuador. It borders to the north with “El Chaco Canton”, to the east with Loreto Canton in the Orellana Province, to the south with Archidona Canton, and to the west with the MetropolitanDistrict of Quito. Its altitude ranges between 5758 meters above sea level at the summits of the Antisana volcano and 1200 meters above sea level in the Sumaco sector (9).

This involved utilizing reports from positive antibiograms for *Escherichia coli* isolated from the urine of patients who visited the Microbiology Laboratory of Baeza Basic Hospital during January-December 2023.

The research employed the Kirby Bauer technique (disc diffusion) on Muller Hinton agar. The interpretation of inhibition zones was carried out in accordance with the Clinical and Laboratory Standard Institute (CLSI) guidelines (10).

Regarding the research type, it was observational and descriptive. It was observational as we described the antimicrobial resistance characteristics of uropathogenic *Escherichia coli* without employing value judgments, aiming for high levels of objectivity, and retrospective since we examined different age groups, both female and male outpatient patients, during the period January- December 2023 (11). Furthermore, it had a quantitative research focus as we attempt to generalize patterns of resistance and sensitivity in uncomplicated urinary tract infections caused byuropathogenic *Escherichia coli.*

Population and Sample

A population of 601 outpatient patients who sought consultation due to urinary symptoms was recorded. Among them, 211 presented a colony count greater than 100,000 CFU/mL. This resulted in 169 positive isolates for *E. coli,* with a colony count > 100,000 CFU/mL, encompassing all age groups and both female and male outpatient patients with uncomplicated urinary tract infections, during the period January-December 2023. The sampling method employed was probabilistic, considering a total of 169 positive urine cultures for *E. coli.*

Regarding the Inclusion Criteria, the following were considered:

• Urine samples.

• Isolated strain from a sample collected from outpatient patients.

• Patients not hospitalized in the last 72 hours.

• Uncomplicated urinary tract infection.

• Colony count > 100,000 CFU/mL. • Positive for *E. coli.*

The Exclusion Criteria were:

• Hospitalized patients.

• Other types of samples.

• Repeated samples.

• Patients with catheters.

Regarding the hypotheses proposed in the development of this research:

H1: Is there high antimicrobial resistance in uropathogenic *Escherichia coli* among outpatient patients who visit the Microbiology Laboratory of Baeza Basic Hospital?

H0: Is there no high antimicrobial resistance in uropathogenic *Escherichia coli* among outpatient patients who visit the Microbiology Laboratory of Baeza Basic Hospital?

3. Results

Following the processing of the laboratory samples considered for the investigations conducted in the presented work, the findings were determined. At this stage, the analysis of *Escherichia coli* isolates was carried out by considering urine samples from outpatient patients, applying a filter of one isolate per patient and the initial antimicrobial sensitivity test. This approach ensured the elimination of repetitive occurrences of the same organism and patient. Additionally, a filter corresponding to the sample collection date was included, allowing for the analysis of the study period. Therefore, the data were entered into the statistical system SPSS (Statistical Package for the Social Sciences) version 25.0 for Windows in Spanish, adhering to the variables and their coding, and ensuring data quality. For continuous quantitative variables, measures of central tendency and distribution were employed, while frequencies and percentages were utilized for qualitative variables (Table 1).

The references for the considered values were based on the National Institute of Public Health Research and the National Antimicrobial Reference Center, requiring a minimum of 30 isolates for statistical analysis of resistances through a frequency table. In the construction of the AASA table, the following labeling was considered as a background in each cell with susceptibility:

Resistance less than 30%.

Resistance between 30 – 70%.

Resistance more than 70%.

Antibiotic not recommended in children without specialist review (12).

Table 1. Age ranges		
Age	**Frequency**	**Percentage**
0 – 6	20	11,8
7 – 12	11	6,5
13 – 20	18	10,7
21 – 40	**65**	**38,5**
41 – 64	40	23,7
65 – 89	15	8,9
Total	169	100,0
Source: Data obtained in the current research.		
Own work (2024).		

In this study, it was determined that urinary tract infections predominantly affect the female gender, accounting for 94.7%, while the male gender represents only 5.3%, as detailed in Table 2.

Table 2. Gender of the patients.		
Gender	**Frequency**	**Percentage**
Female	**160**	**94,7**
Male	9	5,3
Total	169	100
Source: Data obtained in the current research.		
Own work (2024).		

Regarding the profiles of antimicrobial resistance expressed as percentages for *E. coli*: (70.8%) ampicillin, (53.7%) nalidixic acid, and (48.8%) amoxicillin + clavulanic acid, (44.0%) trimethoprim + sulfamethoxazole, and (34.3%) ciprofloxacin. The sensitivity of *E. coli* to nitrofurantoin (92.1%), ampicillin-sulbactam (90.4%), and fosfomycin (87.1%) (Table 3)

Table 3. Percentages of Resistance and Sensitivity of *E. coli* in urine samples from outpatient patients, Microbiology Laboratory BBH. January-December 2023.

Antibiotic	**%R**	**%I**	**%S**
Ampicillin	70,8	0	29,2
Amoxicillin/Clavulanic acid	48,8	0	51,2
Ampicillin/Sulbactam	9,6	0	90,4
Piperacillin/Tazobactam	0	1,8	98,2
Cephazolin	13,4	0	86,6
Ceftazidime	12,7	0	87,3
Ceftriaxone	12,1	0,6	87,3
Cefotaxime	12,7	0	87,3
Cefepime	11,6	0	88,4
Cefoxitin	1,2	0	98,8
Cefuroxime axetil	13,8	1,3	84,9
Cephalexin	15,3	0	84,7
Aztreonam	12,8	0	87,2
Ertapenem	0	3,3	96,7
Imipenem	0	0	100

Meropenem		0	0	100	
Amikacin		0	0	100	
Gentamicin		10,9	6,1	83	
Nalidixic acid		53,7	1,3	45	
Ciprofloxacin		34,3	4,8	60,8	
Levofloxacin		29,1	4,6	66,2	
Trimethoprim/Sulfamethoxazol		44	2,4	53,6	
Fosfomycin		8	4,9	87,1	
Nitrofurantoin		3,7	4,3	92,1	
Doxycycline		15	5	80	
%R = percentage of resistant isolates, %I = percentage of isolates with intermediate sensitivity, %S = percentage of susceptible isolates. Source: Data obtained in the current research. **Own work (2024)**					

Regarding the empirically employed antibiotic treatment for uncomplicated urinary tract infections by surveyed physicians: ciprofloxacin 56.3%, amoxicillin + clavulanic acid 18.8%, and aminopenicillins and cephalexin 12.5%. It is noteworthy that none of the respondents prescribe nitrofurantoin or fosfomycin empirically, as recommended by most guidelines (Table 4).

Table 4. Percentage of empirically prescribed antibiotics for the treatment of uncomplicated urinary tract infections in outpatient patients.

Antibiotics	**Frequency**	**Percentage**
Aminopenicillins	2	12,5
Amoxicillin + Clavulanic acid	3	18,8
Cephalexin	2	12,5
Fosfomycin	0	0
Ciprofloxacin	9	56,3
Nitrofurantoin	0	0
Trimethoprim-Sulfamethoxazole	0	0
Total	16	100,0

Source: Survey administered to medical personnel prescribing antimicrobials
Own Work (2024)

Of the 169 isolated strains of *Escherichia coli*, 21 were producers of Extended-Spectrum Beta-Lactamases, accounting for 12.4%, while the remaining 148 strains did not exhibit this resistance mechanism, corresponding to 87.6%. It is noteworthy that this mechanism confers resistance to first, second, third, and fourth generation cephalosporins, including aztreonam (Table 5).

Table 5. Extended-spectrum beta-lactamase (ESBL) producing strains of *E. Coli* in urine of outpatient patients, Microbiology Laboratory BBH. January-December

2023.		
ESBL	**Frequency**	**Percentage**
Negativo	148	87,6
Positivo	21	12,4
Total	**169**	**100,0**

Source: Survey administered to medical personnel prescribing antimicrobials.

Own work (2024)

After processing the results through the aforementioned tools, it was evident that there were 169 positive isolates for *E. coli*, with a colony count > 100,000 CFU/mL, spanning all ages and both female and male outpatient patients with urinary tract infections during the period from January to December 2023. In line with previous studies in this field, it was determined that the highest number of cases presenting UTI due to *Escherichia coli* was 65 (38.5%) in the age group of 21–40 years, predominantly affecting 94.7% of the female gender. Factors such as the onset of sexual activity, the frequency of sexual activity generating changes in urine pH, new sexual partners in the last year, the use of spermicides, and anatomical conditions of women emerge as the main predisposing causes for UTI. These factors lead to the colonization of pathogenic microorganisms in the urethra (13). In this manner, these data align with studies published by Jimenez-Guerra in 2016 in Spain-Granada, where it is asserted that the primary group of individuals presenting UTIs is between 20 and 44 years, with the female population in this age group exhibiting the highest incidence of community-acquired UTIs(14). In this regard, findings from the study by Cáceres confirm that the primary pathogen isolated in UTIs is *E. coli* (80.1%) in outpatient patients. These data exhibit similarity with the study conducted by Cáceres in 2020 in Honduras, in the cities of San Pedro Sula and El Progreso, which revealed that the most frequently isolated uropathogenic microorganism is *E. coli,* present in 70.4% of patients attended in outpatient consultations (15).

In the same context, a study conducted at the Central Hospital of the Social Security Institute (IPS) in Paraguay revealed that the bacterium *E. coli* is the primary microorganism causing urinary infections, constituting 70.1% of the total positive urine cultures in their research. However, this percentage is lower than the one found in this study (16). Furthermore, in the research conducted by Morales in 2020, the resistance observed in this study to ciprofloxacin (34.3%) poses a health problem. This antibiotic, in addition to exhibiting good activity against Gram-negative bacilli, is specifically usedfor urinary tract infections due to its high concentration in urine. These values are below those reported by Morales-Espinosa et al. (2020) in a study conducted at the Family Medicine Clinic in Mexico City, where the prevalence of ciprofloxacin resistance in *E. coli* strains isolated from urine samples reached 60.4%, aligning with data from another study by Escalona in the Municipality of Banes, Holguín-Cuba, which reported a 49.3% resistance to quinolones (17).

Thus, just as in the present study, the isolation and identification of the causative agents of *E. coli* infection were carried out, the authors Laguna-Rangel also addressed the administration of drugs to which *Escherichia coli* strains showed higher resistance. In this case, the study revealed that the medications with the highest resistance were Ampicillin (78.3%), followed by Amoxicillin + Clavulanic acid (48.8%) and Trimethoprim-sulfamethoxazole (44%). The high resistance is likely due to the empirical use of these antimicrobials; therefore, they may not be suitable for the treatment of this pathology. These results align with the findings of Lagunas in 2018 in Mexico, who determined that Ampicillin (74.1%), Amoxicillin + Clavulanic acid (45.4%), and Trimethoprim- sulfamethoxazole (43.6%) would not be advisable for empirical treatment of urinary tract infection inthe community setting (18). Of the *Escherichia coli* isolates, 12.4% were producers of extended- spectrum beta-lactamases (ESBLs), representing a considerably high number in the studied outpatientpopulation. This result indicates a high tendency towards an increase in ESBL-producing *E. coli*

strains from urinary tract infections. In a study conducted by León in 2018 in Cuenca, Ecuador, where they analyzed a group of urine cultures, the result showed that 6.8% of the isolated *E. coli* strains were ESBL producers in outpatient patients, posing a health problem (19).

In the case of the presented research, a high percentage of sensitivity to nitrofurantoin (92.1%), fosfomycin (87.1%), cephalexin (84.7%), and cefuroxime (84.9%) was determined. These could be used as first-line treatment in outpatient patients diagnosed with urinary tract infections (UTIs), aligning with the study conducted by Expósito and colleagues in 2019 in Guantanamo, Cuba. In their analysis of 351 positive urine cultures with isolated *E. coli*, the sensitivity percentages to nitrofurantoin (92.9%) and cephalexin (82.4%) were similar for these antimicrobials (20).

4. Conclusions

The objective of this research was to determine the bacterial resistance of uropathogenic *Escherichia coli* in outpatient patients attending the Microbiology Laboratory of Baeza Basic Hospital from January to December 2023. In line with this, it was determined that there is high resistance for the bacterium *E. coli* to the following antibiotics: (70.8%) ampicillin, (53.7%) nalidixic acid, and (48.8%) amoxicillin + clavulanic acid, (44.0%) trimethoprim + sulfamethoxazole, and (34.3%) ciprofloxacin; therefore, they cannot be used as empirical treatment for urinary tract infections. An accumulated analysis of antimicrobial susceptibility of uropathogenic *E. coli* was conducted, allowing us to recommend the following drugs for empirical treatment: nitrofurantoin (92.1%),ampicillin-sulbactam (90.4%), and fosfomycin (87.1%).

Based on the results obtained from antimicrobial susceptibility, a draft of a guide for empirical treatment of urinary tract infections in outpatient patients was developed. Due to time constraints, it could not be finalized, hoping that the initiative will be taken to improve the diagnosis and empirical antibiotic prescription, thereby reducing antimicrobial resistance rates. This will contribute to the elimination and reduction of resistance among infectious agents to future incidences of such contaminations in the urinary tract.

Furthermore, it was noted that there is a high percentage of unawareness among patients and healthcare personnel regarding the microbiology field, specifically regarding the antimicrobial resistance program and internal quality control of antimicrobials.

Reference

[1] US Department of Health and Human Services, & CDC. Antibiotic Resistance Threats in the United States. Centers for Disease Control and Prevention, 2019 1–113. https://www.cdc.gov/drugresistance/biggest_threats.html

[2] MSP. Reporte de datos de resistencia a los antimicrobianos en ecuador 2014-2018. Ministerio de Salud Pública, 2018. 10. https://www.salud.gob.ec/wp-content/uploads/2019/08/gaceta_ram2018.pdf

[3] Tomczyk, S.; Taylor, A.; Brown, A.; de Kraker, M.E.A.; El-Saed, A.; Alshamrani, M.; Hendriksen, R.S.; Jacob, M.; Löfmark, S.; Perovic, O.; et al. Impact of the COVID-19 pandemic on the surveillance, prevention and control of antimicrobial resistance: A global survey. J. Antimicrob. Chemother. 2021, 76, 3045–3058.

[4] Centers for Disease Control and Prevention. Antibiotic use in the United States, 2018 Update: Progress and opportunities. U.S. Department of Health and Human Services. 2019 https://www.cdc.gov/antibiotic-use/stewardship-report/pdf/stewardship-report-2018-508.pdf

[5] Kot B, Grużewska A, Szweda P, Wicha J, Parulska U. Antibiotic resistance of uropathogens isolated from patients hospitalized in district hospital in central Poland in 2020. Antibiotics (Basel) [Internet]. 2021 [citado el 16 de febrero de 2024];10(4):447. Disponible en: https://www.mdpi.com/2079-6382/10/4/447

[6] Delgado-Serrano, J., Albarracin Ruiz, M. J., Rangel-Vera, J. A., Galeano-Salazar, E., Niño-vargas, D., Wilches-Cuadros, M. A., Dominguez-Garcia, L., & Torres-Dueñas, D. Perfil de resistencia antimicrobiana de aislamientos bacterianos en pacientes con infección urinaria de un centro de referencia en Bucaramanga. MedUNAB, 2020, 405–422. https://doi.org/10.29375/01237047.3950

[7] Chervet, D., Lortholary, O., Zahar, J. R., Dufougeray, A., Pilmis, B., & Partouche, H. Antimicrobial resistance in community-acquired urinary tract infections in Paris in 2015. Medecine et Maladies Infectieuses, 48(3), 2018. 188–192. https://doi.org/10.1016/j.medmal.2017.09.013

[8] Rada, A. M., Hernández-Gómez, C., Restrepo, E., & Villegas, M. V. Distribución y caracterización molecular de betalactamasas en bacterias Gram negativas en Colombia, 2001-2016. Biomédica, 39, 2019 199–220. https://doi.org/10.7705/biomedica.v39i3.4351

[9] Gobierno Autónomo Descentralizado Municipal de Quijos. PLAN DE DESARROLLO Y ORDENAMIENTO TERRITORIAL DEL CANTÓN QUIJOS. 2013. Disponible en: https://odsterritorioecuador.ec/wp-content/uploads/2019/04/PDOT-CANTON-QUIJOS-2014-2022.pdf

[10] Gajic I, Kabic J, Kekic D, Jovicevic M, Milenkovic M, Mitic Culafic D, et al. Antimicrobial susceptibility testing: A comprehensive review of currently used methods. Antibiotics (Basel) [Internet]. 2022 [citado el 16 de febrero de 2024];11(4):427. Disponible en: https://www.mdpi.com/2079-6382/11/4/427

[11] Hernández, R., Fernández, C., & Batista, P. (2014). Metodología de la Investigación (S. A. D. C. V. McGRAW-HILL / INTERAMERICANA EDITORES (ed.); 2014.

[12] Instituto Nacional de Investigación en Salud Publica & Centro Nacional de Referencia Antimicrobiana. Instructivo de elaboración del "análisis acumulado de susceptibilidad antimicrobiana" (AASA). 2016. Disponible en: https://www.ecdc.europa.eu/sites/default/files/documents/surveillance-antimicrobial-resistance-Europe-2018.pdf

[13] Martinez, E., Osorio, J., Delgado, J., Esparza, G. E., Motoa, G., Blanco, V. M., Hernandez, C. A., Agudelo, A., Aluma, L. J., Betancurt, C. A., Ospina, W., Camargo, J. C., Canaval, H., Castañeda, C., Correa, A., De La Cadena, E., Gomez, A., Gomez, J., Rico, C. L., … Villegas, M. V. Infecciones del tracto urinario bajo en adultos y embarazadas: consenso para el manejo empírico. Infectio, 2013; 17(3), 122–135. https://doi.org/10.1016/s0123-9392(13)70719-7

[14] Jiménez-Guerra, G., Hoyos-Mallecot, Y., Rodríguez-Granger, J., Navarro-Marí, J. M., & Gutiérrez-Fernández, J. Método rápido para la detección de la sensibilidad a cefotaxima en enterobacterias. Revista Argentina de Microbiologia, 2016: 48(4), 320–324. https://doi.org/10.1016/j.ram.2016.08.002

[15] Cáceres, S. B., Cervantes, H. V., Coto, S. G., Mejía, A. C., López, C. C., Mendoza, T. D., Rivera, S. H., & López, J. M. Perfil de sensibilidad a los antibióticos de las bacterias en infecciones del tracto urinario. Acta Médica Costarricense, 2020; 58(4), 146–154. https://doi.org/10.51481/amc.v58i4.938

[16] Leguizamón, M., Samudio, M., & Aguilar, G. Sensibilidad antimicrobiana de enterobacterias aisladas en infecciones urinarias de pacientes ambulatorios y hospitalizados del Hospital Central del IPS. Mem. Inst. Invest. Cienc. Salud(Impr.), 2017; 15(3), 41–49. http://scielo.iics.una.py/scielo.php?script=sci_arttext&pid=S1812-95282017000300041&lng=es&nrm=iso&tlng=es

[17] Morales-Espinosa, R., Contreras Hernández, I. F., Duran Ángeles, A. B., Olivares Luna, A. M., Valencia Gómez, C., García de la Cruz, Y., & González-Pedraza Aviles, A. Patrones de susceptibilidad antimicrobiana "in vitro" de bacterias Gram negatives asilades de infección de vías urinarias en pacientes ambulatorios de una clínica del sur de la Ciudad de México. Revista Clínica de Medicina de Familia, 2020; 13(2), 131–138.

[18] Lagunas-Rangel, F. A. Antimicrobial susceptibility profiles of bacteria causing urinary tract infections in Mexico: Single-centre experience with 10 years of results. Journal of Global Antimicrobial Resistance, 2018; 14(2010), 90–94. https://doi.org/10.1016/j.jgar.2018.03.004

[19] León Cajamarca, P. A. Prevalencia de Escherichia coli, Productora de BLEE en Pacientes Ambulatorios de la Ciudad de Cuenca. Revista Científica Digital INSPILIP, 2019; 2(2), 9. https://www.inspilip.gob.ec/wp-content/uploads/2019/01/Prevalencia-de-Escherichia_coli_productora_de_BLEE_en_pacientes_ambulatorios_de_la_ciudad_de_Cuenca-1.pdf

[20] Expósito B, L. M., Bermellón S, S., Lescaille G, L., Delgado R, N., & Aliaga C, I. Resistencia antimicrobiana de la Escherichia coli en pacientes con infección del tracto urinario. Resvista Informática Científica, 2019; 98(6).