Antimicrobial Resistance Patterns of Uropathogenic *Escherichia coli*: Comparison of Infection Setting and Community Classification

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BACKGROUND

Urinary tract infections (UTIs) are among the most common infections in clinical practice worldwide, particularly among outpatients. The dominant pathogen isolated in both uncomplicated and complicated UTIs is *Escherichia coli* (*E. coli*).[1,2] UTIs are often treated empirically prior to identifying a specific infectious agent and obtaining antibiotic susceptibilities. Thus, antibiotic resistance rates can influence therapeutic recommendations. However, little is known about differences in antibiotic resistance rates for *E. coli* based on whether the patient is from an urban or rural community.

STUDY OBJECTIVE

To compare antibiotic resistance rates for uropathogenic *E. coli* based on setting of infection acquisition (hospital vs. community) and community classification (urban vs. rural).

METHODS

Urine Cultures with isolated *E. coli*

Antibiotic susceptibility report obtained using Vitek 2® System BioMerieux

Antibiogram Susceptibility Report sent to electronic medical record system

Data extrapolated using Business Objects® software

De-identified data analysis using SAS® version 9.3

- 12,600 urine samples processed at a large hospital system in North Carolina from 2016-2018 were analyzed to determine the overall 3-year and annual resistance rates of uropathogenic *E. coli* to routinely tested first-line antibiotics via SAS (version 9.3) at alpha = 0.05.
- Antibiotic resistance rates per 1,000 patients were compared based on setting of infection acquisition and community classification.
- T-test and chi-square tests were used to compare prevalence of extended spectrum β-lactamase (ESBL)-producing *E. coli* isolates by demographic factors and infection setting.

RESULTS

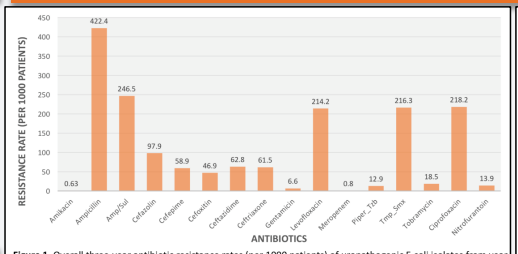

Figure 1. Overall three-year antibiotic resistance rates (per 1000 patients) of uropathogenic E.coli isolates from year 2016 to 2018.

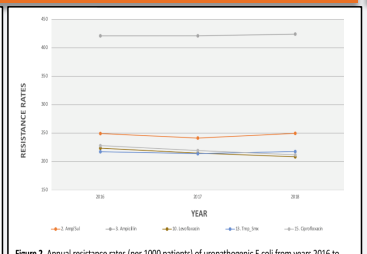

Figure 2. Annual resistance rates (per 1000 patients) of uropathogenic E.coli from years 2016 to 2018 in the following antibiotics; Ampicillin, Ampicillin and Sulbactam, Trimethoprim and Sulfamethoxazole, Levofloxacin, and Ciprofloxacin.

Table 1. Hospital- and Community-Acquired Antibiotic Resistance Rates of Uropathogenic *E. coli*

Antibiotics	Hospital Acquired		Community Acquired		P-value
	R/N*	Rate/1000 Patients	R/N*	Rate/1000 Patients	
Amikacin	5/8475	0.6	3/4124	0.7	0.774
Ampicillin	2190/8474	258.4	916/4126	222.0	<.001
Amp/Sul	3708/8476	437.5	1615/4126	391.4	<.001
Cefazolin	917/8475	108.2	317/4124	76.9	<.001
Cefepime	573/8478	67.6	170/4126	41.2	<.001
Cefoxitin	428/8475	50.5	164/4124	39.7	0.008
Ceftazidime	605/8476	71.4	186/4126	45.1	<.001
Ceftriaxone	599/8477	70.7	176/4125	42.7	<.001
Gentamicin	618/8477	72.9	265/4126	64.2	0.073
Levofloxacin	1909/8474	225.3	790/4124	191.6	<.001
Meropenem	7/8471	0.8	3/4124	0.7	0.853
Piper_Tzb	129/8446	15.3	33/4102	8.0	0.001
Tmp_Smx	1956/8468	231.0	767/4120	186.1	<.001
Tobramycin	164/8475	19.4	59/4124	14.3	0.044
Ciprofloxacin	1941/8478	228.9	810/4124	196.4	<.001
Nitrofurantoin	105/8477	12.4	71/4123	17.2	0.030

*Resistance Rate Per Number of Patients

Table 2. Antibiotic Resistance Rates of Uropathogenic *E. coli* in Urban and Rural Community Settings

Antibiotics	Urban		Rural		p-value
	R/N*	Rate/1000 Patients	R/N*	Rate/1000 Patients	
Amikacin	5/9636	0.50	3/2963	1.00	0.351
Ampicillin	2361/9638	245.0	745/2962	251.5	0.469
Amp/Sul	4090/9638	424.4	1233/2964	416.0	0.420
Cefazolin	944/9637	98.0	290/2962	97.9	0.994
Cefepime	563/9641	58.4	180/2963	60.7	0.634
Cefoxitin	456/9637	47.3	136/2962	45.9	0.752
Ceftazidime	605/9639	62.8	186/2963	62.8	0.999
Ceftriaxone	590/9639	61.2	185/2963	62.4	0.808
Gentamicin	671/9639	69.6	212/2964	71.5	0.721
Levofloxacin	2007/9636	208.3	692/2962	233.6	0.003
Meropenem	10/9634	1.00	0/2961	0	0.080
Piper_Tzb	121/9603	12.6	41/2945	13.9	0.578
Tmp_Smx	2059/9631	213.8	664/2957	224.6	0.214
Tobramycin	162/9637	16.8	61/2962	20.6	0.172
Ciprofloxacin	2042/9639	211.8	709/2963	239.3	0.002
Nitrofurantoin	118/9637	12.2	58/2963	19.6	0.003

*Resistance Rate Per Number of Patients

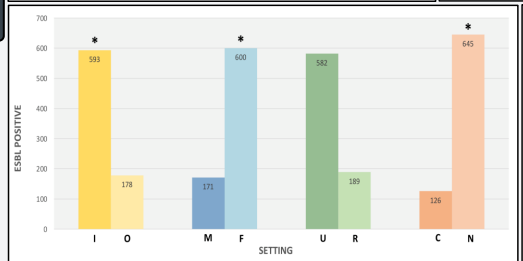

Figure 3. Prevalence of Extended Spectrum β-Lactamase (ESBL) positive uropathogenic *E. coli* isolates compared between two categories: inpatient (I) vs. outpatient (O), male (M) vs. female (F), urban (U) vs. rural (R), and catheterized (C) vs non-catheterized (N). *Statistically significant (P<0.05)

Table 3. Extended Spectrum β-Lactamase (ESBL) Production

VARIABLE	ESBL POSITIVE	ESBL NEGATIVE	P-Value
MEAN AGE (SD)	69.5 (19.9)	60.1 (24.1)	<0.001
GENDER			<0.01
Male	171 (12.5)	1194 (87.5)	
Female	600 (5.4)	10600 (94.6)	
COMMUNITY CLASSIFICATION			0.504
Urban	582 (6.1)	9027 (93.9)	
Rural	189 (6.4)	2767 (93.6)	
PATIENT DESCRIPTION			<0.001
Inpatient	593 (7.0)	7856 (93.0)	
Outpatient	178 (4.3)	3938 (95.7)	
SOURCE OF ISOLATE			<0.001
Catheterized	126 (14.0)	772 (86.0)	
Non-catheterized	645 (5.5)	11022 (94.5)	

NOTE. Values for gender, community classification, patient description, and source of isolate are n (%).

CONCLUSIONS

- Resistance to first-line fluoroquinolones (ciprofloxacin and levofloxacin) and nitrofurantoin was more prevalent in patients from rural compared to urban areas in eastern North Carolina.
- Resistance rates and ESBL prevalence were significantly higher for hospital-acquired UTIs.
- Our findings have important implications for the empirical treatment of UTIs based on geographical area and setting.
- The development of *E. coli* resistance to fluoroquinolones is increasing worldwide, with recent studies finding high resistance rates in Asia and an observable upward trend occurring in North America.[3] A vital approach to improve UTI treatment involves incorporating antimicrobial stewardship pharmacists in the antibiotic selection process based on demographic resistance patterns in underserved areas.

REFERENCES

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