BACTERIAL PATTERNS AND URINE CULTURE SENSITIVITY DESCRIPTION OF UROLOGY PATIENTS IN THE PAEDIATRIC POPULATION AT TERTIARY HOSPITAL

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ABSTRACT

Objective: *The aim of this research is to determine trends in urine culture and antibiotic resistance in pediatric urology patients in Soetomo General Hospital, January 2021-December 2023.* ***Material& Methods:*** *Medical record data and the microbiology laboratory database were studied retrospectively using a descriptive method. Identification of the pattern of antibiotic sensitivity for bacterial infection is the objective of the present study.* ***Results:*** *The most frequent bacteria cultured from 1,234 urine samples were: Escherichia coli 45%, Klebsiella pneumoniae 25%, and Pseudomonas aeruginosa 15%. E. coli exhibited high sensitivity to Meropenem (95%), Imipenem (93%), and Amikacin (90%), but strong resistance to Ampicillin (75%), Trimethopral-Sulfamethoxazole (70%), and Ciprofloxacin (65%). K. pneumoniae also displayed comparable resistance patterns. pneumoniae and P. aeruginosa, whose resistance to several drugs over the research period was clearly increasing.* ***Conclusion:*** *In summary, for juvenile uropathogens carbapenems and amikacin are still quite powerful therapeutic choices. These results highlight the critical requirement of responsible antibiotic use and continuous antimicrobial resistance surveillance in order to counteract increasing resistance trends and protect efficient treatment possibilities for children.*

Keywords: *Urinary Tract Infections, Pediatric urology, Antibiotic resistance, Uropathogens, Escherichia coli*

ABSTRAK

Tujuan: *Penelitian ini bertujuan untuk mengevaluasi hasil kultur urin dan pola sensitivitas antibiotik pada pasien urologi pediatrik di RSUD Dr. Soetomo selama periode Januari 2021 hingga Desember 2023. Temuan ini diharapkan memberikan wawasan untuk pengelolaan terapi antibiotik yang lebih baik.****Bahan & Cara:****Penelitian ini menggunakan pendekatan deskriptif retrospektif. Data diperoleh dari rekam medis dan database laboratorium mikrobiologi rumah sakit. Informasi yang dianalisis meliputi hasil kultur urin serta profil sensitivitas dan resistensi antibiotik dari pasien pediatrik yang menjalani perawatan di unit urologi.* ***Hasil:*** *Sebanyak 1.234 sampel urin dianalisis, dengan hasil menunjukkan bahwa Escherichia coli (45%), Klebsiella pneumoniae (25%), dan Pseudomonas aeruginosa (15%) adalah bakteri yang paling sering diisolasi. E. coli menunjukkan sensitivitas tinggi terhadap Meropenem (95%), Imipenem (93%), dan Amikacin (90%), namun resistensi yang cukup signifikan terhadap Ampisilin (75%), Trimethoprim-Sulfamethoxazole (70%), dan Ciprofloxacin (65%).Pola resistensi serupa juga terlihat pada K. pneumoniae dan P. aeruginosa, dengan peningkatan resistensi terhadap beberapa antibiotik tertentu selama periode penelitian.* ***Simpulan:*** *Carbapenem dan Amikacin tetap menjadi pilihan utama yang sangat efektif melawan uropatogen pada pasien pediatrik. Namun, temuan ini menegaskan perlunya pengawasan antimikroba yang ketat dan penggunaan antibiotik yang lebih bijak. Langkah ini penting untuk mencegah peningkatan resistensi antibiotik yang dapat mengancam efektivitas pengobatan di masa depan.*

Keywords: *Infeksi Saluran Kemih, Urologi Pediatrik, Resistensi Antibiotik, Uropatogen, Escherichia coli*

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INTRODUCTION

Urinary tract infections (UTIs) are a predominant cause of morbidity and mortality in children, ranking second to upper respiratory tract infections in prevalence.[1-2] The World Health Organization designates Enterobacteriaceae as the primary bacterial etiology of juvenile urinary tract infections, with Escherichia coli accounting for the bulk of instances (80-90%).[3-4] Additional bacteria, including Enterobacter aerogenes, Klebsiella pneumoniae, Proteus mirabilis, and Pseudomonas aeruginosa, further exacerbate the disease load in this demographic.[5]

Treating UTIs in children is essential, not just for prompt symptom alleviation but also because a solitary occurrence may indicate an underlying problem.UTIs are the first presentation of their disease in approximately 30% of children who have CAKUT.[6-7] The fact that UTIs are relatively common and increasing in drug resistance requires prevention strategies aimed at limiting their frequency through the observance of proper hygiene and the support of judicious antibiotic consumption. Prophylactic antibiotics are notably successful in preventing postoperative infections; however, their selection should be informed by local microbial patterns to guarantee optimal results.[8-9]

This study is to examine urine culture outcomes from pediatric urology patients at Dr. Soetomo General Hospital. It emphasizes the identification of prevalent infections, their antibiotic susceptibility profiles, and resistance patterns. The research aims to identify bacteria frequently linked to urosepsis by analyzing data from inpatient and outpatient settings, and to propose the most effective medications to mitigate morbidity and fatality rates.

The main novelty of this investigation will be its concentration on local microbiological trends and antibiotic resistance in Indonesian pediatric urology patients. The results would play a role in addressing local data gaps that would further enhance the available options for treatment, clinical outcomes, and fighting antibiotic resistance in such a vulnerable group of patients.

OBJECTIVE

The aim of this research is to determine trends in urine culture and antibiotic resistance in pediatric urology patients in Soetomo General Hospital, January 2021-December 2023.

MATERIAL&METHODS

A retrospective descriptive method was used to look at the results of urine cultures and patterns of antibiotic resistance in pediatric urology patients at Dr. Soetomo General Hospital. The study ran three years, from January 2021 until December 2023.

Undergoing urine culture testing, the study comprised pediatric patients (≤ 18 years old) from both inpatient and outpatient urology departments. Data came from hospital medical records as well as the microbiology laboratory database. The documentation included key information such as patient demographics, urine culture findings, bacterial isolates, and antibiotic sensitivity profiles.

Urine sample collecting followed standardized techniques to ensure little contamination. If a urine culture showed any bacterial growth in samples taken by suprapubic aspiration, $\geq 10^5$ colony-forming units (CFU/mL) for midstream samples, $\geq 10^4$ CFU/mL for catheterized samples, or both, it was considered positive. The Clinical and Laboratory Standards Institute (CLSI) guidelines guided the use of acceptable microbiological methods and antibiotic sensitivity testing for bacterial identification.

Analysis of the frequency and proportion of bacterial isolates used descriptive statistics. We thoroughly investigated antibacterial sensitivity trends for the three most frequently found infections. We calculated the sensitivity and resistance rates as percentages to illustrate the results. To spot developing trends, also examined were variations in bacterial frequency and resistance patterns across the three-year period.

This study followed very high ethical criteria. Approval for the study plan came from the Faculty of Medicine at Airlangga University and the Ethics Committee of Dr. Soetomo General Hospital. Patient confidentiality was protected all through data collecting and analysis in order to preserve anonymity.

We applied SPSS version 25.0 for data processing. To give a clear and quick summary of the results for categorical variables, frequencies and percentages were compiled.

RESULTS

Of the 1.702 samples collected between 2021 and 2023, Escherichia coli was the most common pathogen detected in the hospital.Table 2 graphically shows, in figures 1 and 2, the wide range of drugs Escherichia coli is susceptible to. The results clearly show that the major antibiotics - namely, Amikacin, Fosfomycin, Imipenem, Meropenem, Cefoperazone-Sulbactam - are all acting very effectively (>70%). However, Piperacillin-Tazobactam, with 10.7% resistance in the year 2022, has a huge 63.5% in 2023. What is more alarming is that by 2023, Ciprofloxacin has attained absolute or 100% resistance. This means that more judicious prescription policies must be in effect to prevent development of resistance. Together with Table 3, figures 3 and 4 assist one to understand the sensitivity and resistance patterns of Klebsiella pneumoniae. Both bacteria showed a diminishing tendency over the course of the investigation; at first demonstrating a relatively high sensitivity (>70%), to meropenem and amikacin. Likewise, from 2021 to 2023 sensitivity to more antibiotics including imipenem and Ceftazidime has gradually dropped. These numbers show how difficult it is right now to control Klebsiella pneumoniae infections brought on by growing resistance.

Table 4 lists all patterns of drug resistance for Pseudomonas aeruginosa. About seventy percent of the time the bacteria were still sensitive to amikacin, imipenem, meropenem, piperacillin-tazobactam, and cefoperazone-sulbactam. Still, over the three years sensitivity to gentamicin and fosfomycin fell drastically. This decrease especially in severe cases raises questions about the few treatment options available for infections caused by Pseudomonas aeruginosa.

Table 1. Frequency and Percentage of Bacterial Isolates from Urine Samples (2021–2023).

Bacteria	2021		2022		2023	
	n	%	n	%	n	%
Escherichia coli	107	18.1%	113	22.2%	119	19.7%
Klebsiella pneumoniae	46	7.8%	35	6.9%	50	8.3%
Pseudomonas aeruginosa	59	10.0%	55	10.8%	52	8.6%
Total	212	35.9%	203	39.9%	221	36.6%
Total Sample	590		509		603	

Table 2. Antibiotic Sensitivity and Resistance Patterns of *Escherichia coli* (2021–2023).

Antibiotic	2021	2022	2023
Amikacin	100.00%	95.60%	98.30%
Fosfomycin	87.00%	100.00%	87.50%
Meropenem	86.00%	96.30%	86.80%
Imipenem	86.20%	93.90%	85.00%
Cefoperazone-Sulbactam	93.30%	81.10%	81.10%
Cefoxitin	0.00%	77.50%	76.00%
Ertapenem	N/A	100.00%	75.00%
Trimethoprime	N/A	N/A	75.00%
Tigecycline	94.70%	75.70%	68.90%
Nitrofurantoin	88.00%	77.30%	67.60%
Gentamycin	67.00%	59.80%	57.80%
Chloramphenicol	69.60%	58.90%	54.50%
Ceftazidime	38.10%	44.60%	48.70%
Astreonam	35.80%	44.10%	41.10%
Ceftriaxone	39.60%	41.50%	39.10%
Cefepime	35.00%	43.80%	38.20%
Cefotaxime	36.80%	44.20%	37.40%
Piperacillin-Tazobactam	85.40%	89.30%	36.50%
Amoxicillin-Clavulanic Acid	67.10%	69.60%	25.70%
Temocillin	N/A	N/A	25.00%
Moxifloxacin	46.80%	54.30%	24.10%
Cotrimoxazole	32.70%	26.50%	22.00%
Ampicillin-Sulbactam	25.30%	25.90%	13.30%
Piperacillin	6.70%	4.70%	12.90%
Tetracyclin	25.20%	21.60%	12.80%
Levofloxacin	0.00%	3.90%	6.40%
Ampicillin	8.40%	2.70%	4.20%
Ciprofloxacin	3.10%	5.70%	0.00%
Cephazolin	0.00%	1.40%	0.00%
Colistin	0.00%	0.00%	N/A
Linezolid	100.00%	N/A	N/A
Mupirocin High Level	100.00%	N/A	N/A
Rifampycin	100.00%	N/A	N/A
Cefotaxime-Sulbactam	0.00%	N/A	N/A
Teicoplanin .	0 00%	N/A	N/A

*N/A : Not Applicable * 0,0% : Antibiotics have a sensitivity of 0%

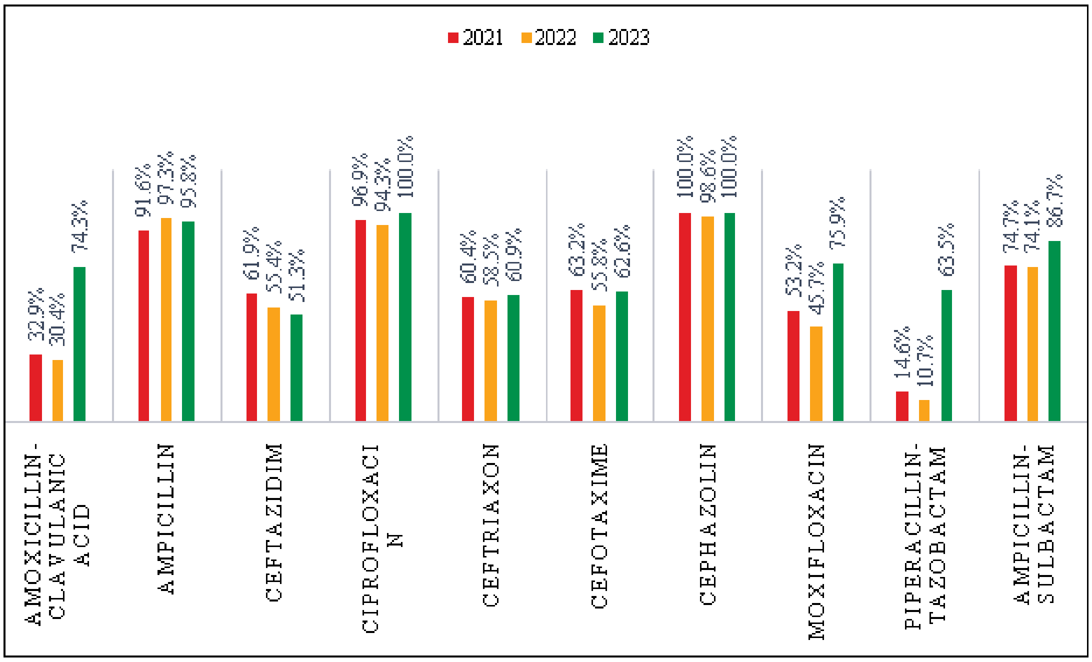

Figure 1. Antibiotic Resistance to *Eschericia coli.*

Table 3. Antibiotic Sensitivity and Resistance Patterns of *Klebsiella pneumoniae* (2021–2023).

Antibiotic	2021	2022	2023
Amikacin	97.80%	91.40%	76.00%
Meropenem	90.70%	90.30%	75.00%
Imipenem	89.20%	87.50%	63.00%
Moxifloxacin	59.50%	65.60%	60.50%
Cefoxitin	N/A	16.70%	57.10%
Chloramphenicol	70.70%	57.90%	51.10%
Temocillin	N/A	N/A	50.00%
Trimethoprime	N/A	N/A	50.00%
Cefoperazone-Sulbactam	76.70%	69.00%	47.40%
Fosfomycin	76.90%	90.90%	44.40%
Tetracyclin	46.50%	48.60%	42.90%
Gentamycin	45.70%	54.30%	34.00%
Levofloxacin	0.00%	7.70%	25.00%
Cotrimoxazole	41.30%	34.30%	24.50%
Ceftazidime	31.10%	40.00%	22.00%
Ceftriaxone	32.60%	41.20%	20.40%
Cefotaxime	28.30%	38.20%	20.00%
Cefepime	36.60%	40.60%	20.00%
Piperacillin-Tazobactam	69.00%	59.40%	20.00%
Tigecycline	70.60%	44.40%	19.50%
Amoxicillin-Clavulanic Acid	52.90%	63.60%	18.40%
Astreonam	32.60%	40.00%	18.40%
Piperacillin	22.70%	27.30%	14.30%
Ampicillin-Sulbactam	27.30%	32.30%	14.30%
Nitrofurantoin	38.50%	27.30%	11.10%
Ciprofloxacin	0.00%	0.00%	3.00%
Ampicillin	0.00%	0.00%	0.00%
Cephazolin	0.00%	0.00%	0.00%

*N/A : Not Applicable   * 0,0% : Antibiotics have a sensitivity of 0%

Figure 2. Antibiotic Resistance against *Klebsiella pneumoniae*

Table 4. Antibiotic Sensitivity and Resistance Patterns of *Pseudomonas aeruginosa* (2021–2023)

Antibiotik	2021	2022	2023
Amikacin	94.50%	77.40%	95.70%
Meropenem	96.60%	86.00%	82.60%
Imipenem	81.00%	78.60%	78.60%
Piperacillin-Tazobactam	98.00%	87.50%	78.60%
Cefoperazone-Sulbactam	88.00%	84.40%	73.20%
Moxifloxacin	50.00%	0.00%	66.70%
Gentamycin	75.00%	54.20%	59.20%
Ceftazidime	69.80%	61.70%	59.10%
Astreonam	56.00%	40.00%	52.60%
Ciprofloxacin	53.60%	42.00%	51.10%
Levofloxacin	51.80%	34.00%	46.80%
Piperacillin	66.10%	55.80%	41.70%
Cefepime	60.00%	48.00%	41.20%
Fosfomycin	56.80%	47.40%	33.30%
Nitrofurantoin	5.50%	0.00%	2.10%
Amoxicillin-Clavulanic Acid	0.00%	0.00%	0.00%
Ampicillin	0.00%	0.00%	0.00%
Amoxicillin	N/A	N/A	0.00%
Chloramphenicol	5.10%	1.90%	0.00%
Ceftriaxone	10.70%	2.10%	0.00%
Cefotaxime	0.00%	0.00%	0.00%
Cefoxitin	0.00%	0.00%	0.00%
Cephazolin	0.00%	0.00%	0.00%
Penicillin	N/A	N/A	0.00%
Ampicillin-Sulbactam	0.00%	0.00%	0.00%
Cotrimoxazole	1.90%	0.00%	0.00%
Tetracyclin	0.00%	0.00%	0.00%
Tigecycline	4,70%	0.00%	0.00%

*N/A : Not Applicable * 0,0% : Antibiotics have a sensitivity of 0%

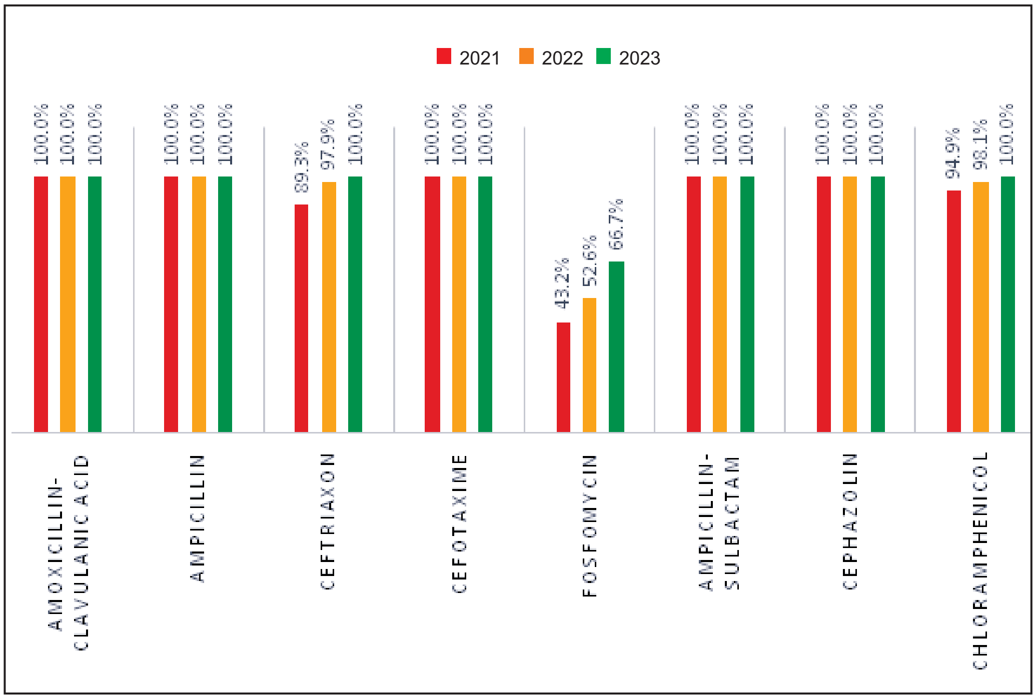

Figure 3. Antibiotic Resistance to *Pseudomonas aeruginosa*

DISCUSSION

The results of our analysis indicated significant microbiological trends over the course of the three-year period. Clinically, as evident, Escherichia coli was the most prevalent pathogen. Specifically interesting, though, was the peak of prevalence that it attained in 2022, which was a whopping 22.2%.[10] The main pathogen is E. coli behind an overwhelming 80-90% of pediatric UTI cases. It just makes a lot of sense, considering E. coli's remarkable ability to latch onto those uroepithelial receptors, especially in kids with compromised urinary flow.[12]

Our second most common culprit was always Klebsiella pneumoniae, ranging between 6.9% and 8.3%. Though these figures agree with the ones by Megawati and Gebretensiae, we found it interesting to note that in Sharma's study conducted in 2020 in Madhya Pradesh, K. pneumoniae was the most predominant.[13-14] This regional variation really brings out how local factors might influence bacterial prevalence patterns.[15]

What was out of our expectations, though, was Pseudomonas aeruginosa 10.8%, considering this notorious pathogen due to its nosocomial infection association.[10] Definitely an increasing nuisance, especially in view of clinical practice, because of this enviable armamentarium of antibiotic-resistant mechanisms that have so far been developed.

The resistance patterns of E. coli that we have seen over these three years tell a story. The good news? We continue to see strong sensitivity (>70%) to several heavy hitters: Amikacin, Fosfomycin, Imipenem, Meropenem, and Cefoperazone-Sulbactam.[17-18] The concerning part, though not unexpected given the trends that Tamma's group documented in their U.S. study, is the Ceftriaxone resistance hovering around 58.5-60.9%.[20]

It is actually the 100% Ciprofloxacin resistance observed from 2021 to 2023 that keeps us awake. As clinicians, we have been observing this rise in resistance to fluoroquinolones over these years, but to see complete resistance is a bit different. The molecular biology here is fascinating-these bacteria have practically perfected their defense mechanisms through mutations in their DNA gyrase and topoisomerase IV genes, aside from developing some impressive pump systems that allow them to pump the drug out.[22]

No less disturbing is the story of Piperacillin-Tazobactam: a jump from 10.7% resistance in 2022 to 63.5% in 2023 signifies a fundamental shift in our treatment landscape. Evidence exists that bacteria are evading our β-lactamase inhibitors by multiple mechanisms, not just the simple production of additional β-lactamases but also the evolution of very sophisticated efflux systems.[23]

The trend in sensitivity decline regarding K. pneumoniae to Meropenem and Amikacin between the years 2021 and 2023 reflects what Hu's team observed in their longitudinal study.[24]Intriguingly, the mechanism underlying such resistance is very fascinating-these Ambler class B zinc-dependent β-lactamases are actually elegantly contrived at a molecular level, though clinically a real problem.[25]

What really stands out is the complete resistance to Ampicillin throughout our study period. Though not wholly unexpected-TR 78.3% were resistance in Ayatollahi's group back in 2020-it does bring into perspective the dynamic challenge we face in the treatment of these infections.[26-28]

The findings concerning P. aeruginosa are two-pronged in nature with an optimistic as well as cautionary outlook. The optimistic one is brought forth by the across-the-board sensitivity exhibited by a few extremely valuable antibiotics like Amikacin, Imipenem, Meropenem, Piperacillin-Tazobactam, and Cefoperazone-Sulbactam. Notably, the rate of sensitivity for Amikacin reached up to 94.6% in the year 2023. But the diminishing Piperacillin-Tazobactam sensitivity trend from 100% to 78.8% shows we cannot relax.[29]

With total resistance to several β-lactams as far as 2023, this emphasizes the amazing adaptation of this organism.[30]P. aeruginosa impresses with its great capacity for building resistance whether through changes in PBP3, decreased absorption, or improved efflux mechanisms.[31]

CONCLUSION

The findings of this research showed that Escherichia coli was always the most dominant bacterium annually and across all typical case types, followed by Klebsiella pneumoniae and Pseudomonas aeruginosa. Remarkably, an alarming proportion of major antibiotics had high levels of resistance, with some exhibiting a declining trend of sensitivity over time. This is in agreement with the world's alarm regarding the rapid expansion pace of antibiotic resistance brought on, in the main, by misuse and overuse of the very same drugs. The continued escalation in the trend of antibiotic resistance calls for a clarion call: health systems should institute more robust policies of antibiotic stewardship in tandem with stringent infection control practices.

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