



Antibiotic Use for Genitourinary Infections in an Indonesian Hospital During COVID-19: A Retrospective Study

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ABSTRACT: Managing genitourinary infections presents a growing challenge due to antimicrobial resistance, shifting regional patterns, and evolving etiologies. This study aimed to elucidate antibiotic utilization trends and patterns for genitourinary system diseases at an Indonesian teaching hospital during the COVID-19 pandemic. This retrospective, cross-sectional study analyzed antibiotic use in an Indonesian teaching hospital's inpatient department in 2021. Data on systemic antibiotics (ATC: J01) for genitourinary infections (ICD-10: N00-N99) were extracted from electronic records. Prescription patterns were evaluated by patient characteristics, disease profiles, administration routes, and WHO AWaRe classification. Among the 47,696 hospitalized patients who received antibiotics, 1,752 were treated with J01 antibiotics for genitourinary disorders, mostly in elderly men with prostatic hyperplasia and obstructive uropathy. Cephalosporins, especially ceftriaxone (724 prescriptions) and cefazolin (294 prescriptions), were the most commonly prescribed, while amoxicillin/beta-lactamase inhibitors were the least prescribed. Parenteral administration was more common than oral, and "Watch" category antibiotics were prescribed twice as often as "Access" antibiotics in adults and the elderly. Genitourinary disorders like prostatic hyperplasia and obstructive uropathy significantly impact elderly men. This study reveals a trend of high broad-spectrum antibiotic use, such as ceftriaxone and cefazolin injections, in hospitalized patients with these conditions.

Keywords: genitourinary infections; antibiotic utilization; COVID-19; antimicrobial stewardship; retrospective.

Introduction

Managing genitourinary infections (GUIs) presents a growing challenge in clinical practice due to escalating rates of antimicrobial resistance, evolving regional resistance patterns, and shifting disease etiologies [1]. The genitourinary system, including the urinary tract and vaginal microbiomes, plays a vital role in maintaining health and managing microbial exposures [1-3]. Accurate diagnosis is essential to differentiate between infection and asymptomatic bacterial colonization, guiding appropriate antibiotic therapy and avoiding unnecessary treatments [4].

Recent studies in Ethiopia have highlighted the prevalence of genitourinary infections as the leading indication for antibiotic prescriptions, with notable proportions of inappropriate prescriptions attributed to errors in dosage and selection [3]. Urinary tract infections (UTIs) and male genital infections represent pervasive clinical entities, necessitating a judicious approach to antibiotic prescribing to mitigate societal burdens [1,5].

Precise clinical classification, including uncomplicated cystitis, uncomplicated pyelonephritis, complicated UTI, and genital infections, is a cornerstone for selecting optimal antibiotic regimens tailored to the microbial spectrum, resistance profiles, and site-specific antimicrobial activity [6].

Recent shifts in the etiology of nosocomial UTIs show a decrease in gram-negative rods and an increase in fungal and gram-positive organisms [2,7]. Currently, *Escherichia coli* (*E. coli*) accounts for only 17.5% of nosocomial UTIs, while *Candida albicans* 16%, *Enterococcus species* 14%, *Pseudomonas aeruginosa* 11%, and *Enterobacter species* 5% also play significant roles [2]. Gram-positive organisms, including coagulase-negative *staphylococci* and *Staphylococcus aureus*, are implicated as primary pathogens in 30% of infections [8].

The changing landscape of UTI etiology, with gram-positive organisms increasingly

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implicated alongside *Escherichia coli*, is possibly driven by the widespread use of antibiotics with limited efficacy against gram-positive pathogens [9]. Consequently, reevaluating first-line antibiotic agents for UTIs is imperative to forestall treatment failures and mitigate future antimicrobial resistance trends [10]. The emergence of the COVID-19 pandemic has further complicated the management of genitourinary infections by impacting antimicrobial prescribing practices, healthcare delivery, and patient outcomes. Hospital-acquired UTIs, have been exacerbated by the strain on healthcare resources and infection control measures during the pandemic.

Understanding the interplay between COVID-19 and genitourinary infections is essential for optimizing antibiotic stewardship practices and mitigating the dual burden of infectious diseases [11]. This study aims to illustrate antibiotic utilization trends and patterns for genitourinary system diseases within an Indonesian teaching hospital during the COVID-19 pandemic, contributing to the global discourse on antimicrobial stewardship and infectious disease management.

Methods

Study Design and Setting

This study, retrospective, observational, and cross-sectional, examine antibiotic utilization trends and patterns within the inpatient department of an Indonesian Teaching Hospital in Cilacap Regency in Indonesia during 2021. This study was conducted at the Indonesian Teaching Hospital in Cilacap Regency. The designed study includes the common, which caters to approximately 60,000 patients annually, with nearly 50,000 admissions to the inpatient department involving antibiotic therapy during the study period. Located in one of Central Java's densely populated districts, the Indonesian Teaching Hospital in Cilacap Regency provides healthcare services to both the urban and rural areas of Cilacap, catering to a combined population of nearly 2 million individuals. Notably, the hospital's urology clinics facilitated approximately 2,061 patient visits in 2021.

Data Sources

Deidentified data on systemic antibiotics prescribed by anatomical Therapeutic Chemical (ATC: J01) Indonesian Teaching Hospital in Cilacap Regency from January to December 2021. Utilizing the hospital's electronic medical records system, pertinent data encompassing patient information including age, sex, entry date, and department entry, as well as diagnostic information classified by ICD-

10 (International Classification of Disease) codes, antibiotic details such as name, dose, formulation and route of administration were sourced from the hospital pharmacy installation. The study encompassed all patients admitted to the inpatient department from January to December 2021, diagnosed with genitourinary infections based on ICD-10 Chapter XIV codes N00-N99, and prescribed J01 antibiotics. Exclusions comprised cases lacking identifiable ICD codes or incomplete electronic medical records (e-RM).

Study Variables

The study population comprises the entirety of prescriptions issued at the Indonesian Teaching Hospital in Cilacap Regency throughout 2021. Inclusion criteria centered on antibiotic usage. The research investigated antibiotic prescription patterns, focusing on patient demographics such as age, gender, ICD-10 Chapter XIV codes N00-N99, month of admission, and WHO AWaRe classification. Antibiotic prescriptions encompassed various administration routes, including oral, liquid oral, solid oral medications, and parenteral routes. Age categories were stratified into children (0-14 years), adults (15-64 years), and elderly individuals (65 years and above). Additionally, gender-specific analyses were conducted, and detailed data on genitourinary infections were obtained using ICD-10 Chapter XIV codes N00-N99. The AWaRe classification is intended as a tool for monitoring antibiotic consumption, defining targets, and monitoring the effects of stewardship policies that aim Right drug, Right dose, and Right route to optimize antibiotic use and curb antimicrobial resistance [12,13].

Sample

The study utilized a purposive sampling approach to systematically refine the sample from the total patient population at RSUD Cilacap in 2021. Initially, all 60,601 patients were reviewed, and only those admitted to the hospitalization department were included. From this subset, patients diagnosed with genitourinary system diseases (ICD-10 Chapter XIV, N00-N99) were identified. Further refinement included selecting patients prescribed systemic antibiotics (ATC code J01). Exclusion criteria were applied to remove records with incomplete data, such as missing demographic information, diagnosis, or treatment details. This rigorous process ensured that the final sample accurately represented the study population for the analysis of systemic antibiotic use in genitourinary infections.

Statistical Analysis

Data were analyzed using Microsoft Excel 2021. Descriptive statistics were used to summarize findings, and visualization was done by the Microsoft Excel.

Ethical Considerations

The ethical approval was granted by the Health Research Ethics Committee of Universitas Harapan Bangsa No. B.LPPM-UHB/576/06/2024. The respondents provided written informed consent for participation in the survey. This research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki.

Result and Discussion

This study revealed 47,696 antibiotic-utilizing patients admitted to the inpatient department during COVID-19 in 2021. Subsequently, the final study population was narrowed down to 1,752 individuals receiving systemic antibiotics classified under ATC code J01, with a specific focus on addressing indications related to genitourinary system disorders according to ICD-10 codes (N00-N99) [Figure 1](#). [Table 1](#) represents the most patients with genitourinary disorders were active adults (65.75%, n=1,152), followed by elderly patients (30.2%, n=530), and children (4%, n=70). Male patients constituted a larger proportion across all age groups, with 61.4% of children, 63.6% of active adults, and 80% of elderly patients being male. The predominant antibiotics used were from subclass J01D (55.7% in children, 71.9% in active adults, and 73.2% in the elderly), indicating a high reliance on broad-spectrum cephalosporins or treating genitourinary infections across all age groups. The use of other subclasses was significantly lower, with J01M (quinolones) and J01X (other antibiotics) being more common in active adults and the elderly compared to children.

The findings underscore the predominance of genitourinary disorders among the male population, particularly in the elderly age group, and highlight the significance of optimizing antibiotic prescribing practices to address this clinical burden effectively. The prevalence of genitourinary problems in men is a significant health concern, with a range of conditions such as urinary tract infections, prostatitis, benign prostatic hyperplasia, urogenital cancers, premature ejaculation, erectile dysfunction, urinary incontinence, and sexually transmitted infections [\[14\]](#). Previous study in USA also showed genitourinary problems were found to be most common in men [\[15\]](#), with elderly males being nearly four

times more likely to experience these conditions compared to their younger counterparts. This observation aligns with the well-established association between advancing age and the development of genitourinary disorders, such as benign prostatic hyperplasia (BPH) and obstructive uropathy [\[16\]](#). The prevalence of genitourinary problems in elderly men is a significant concern, with a higher likelihood of these issues compared to younger men [\[17\]](#). The impact of these genitourinary problems on the quality of life of elderly men is substantial, highlighting the need for effective evaluation and management strategies [\[18\]](#).

The higher incidence of genitourinary infections in men compared to women can be attributed to multiple factors, such as the prevalence of genitourinary symptoms and risk factors like low income, unprotected commercial sex, and living in impoverished areas [\[19\]](#). In particular, the incidence of genitourinary cancer among men is notably high in countries like Iran, where prostate cancer rates are significantly higher compared to other Asian countries [\[20\]](#). In Indonesia, the prevalence of genitourinary conditions in men is markedly higher than in women, with a rate of 13.0% [\[21\]](#). This disparity is influenced by factors such as the higher prevalence of urogenital mycoplasmas in men, which can lead to severe complications and infertility [\[22\]](#). Additionally, *Mycoplasma genitalium*, which can cause urethritis, is more commonly found in men than women [\[23\]](#). These factors collectively contribute to the high incidence of genitourinary infections in Indonesian men.

Moreover, the "Watch" category of antibiotics, which includes drugs with higher resistance potential, was the most frequently used, accounting for 40% of prescriptions in children, 70.1% in active adults, and 72.3% in the elderly. Parenteral administration was predominant, especially in the elderly (88.3%) and active adults (84%). The monthly distribution of antibiotic use showed variation throughout the year, with the highest usage in December (15.7% in children, 15.5% in active adults) and significant peaks in April and November.

The similarity observed in the AWaRe classification of genitourinary infections between children and adults, contrasted with the two-fold difference seen in the elderly, can be explained by the distinct characteristics associated with these age groups. For instance, adrenocortical carcinoma (ACC) in children and adults exhibits different clinicopathologic profiles, with a higher prevalence of functioning tumors in the pediatric population [\[24\]](#). This discrepancy is further highlighted by the distinct molecular mechanisms underlying adrenocortical tumorigenesis in these age groups [\[25\]](#). Moreover, the prevalence of social and behavioral issues in children with agenesis of

the corpus callosum (ACC) may also contribute to the observed similarity in the AWaRe classification between children and adults [26].

Parenteral administration, which includes injectable and intravenous routes, is often preferred over oral administration for several reasons. These include cases where a drug cannot be taken orally due to absorption

limitations, the patient's inability to swallow, or the need for immediate action [27]. Additionally, parenteral administration can be more effective for drugs with poor bioavailability and a narrow therapeutic index, as it offers a rapid onset of action and avoids first-pass metabolism [28].

Table 1. Sociodemographic characteristics of patients based on the reviewed medical files.

Classification	N	Children	Active Adults	Elderly
		0-14	15-64	65+
Sex	Female	70 (3,9%)	1152 (65,75%)	530 (30,25%)
	Male	27 (38.6%)	419 (36.4%)	106 (20%)
Antibiotic Subclass (ATC)	J01A	43 (61.4%)	733 (63.6%)	424 (80%)
	J01B	(0%)	2 (0.2%)	(0%)
	J01C	(0%)	3 (0.3%)	(0%)
	J01D	29 (41.4%)	23 (2%)	11 (2.1%)
	J01E	39 (55.7%)	828 (71.9%)	388 (73.2%)
	J01F	(0%)	10 (0.9%)	(0%)
	J01M	2 (2.9%)	15 (1.3%)	11 (2.1%)
	J01X	(0%)	189 (16.4%)	104 (19.6%)
	J01X	(0%)	82 (7.1%)	16 (3%)
Antibiotic AWaRe	Access	27 (38.6%)	331 (28.7%)	132 (24.9%)
	Watch	28 (40%)	807 (70.1%)	383 (72.3%)
	Reserved	0 (0%)	0 (0%)	0 (0%)
	Not Listed	30 (42.9%)	135 (11.7%)	190 (35.8%)
Administration	Parenteral	43 (61.4%)	968 (84%)	468 (88.3%)
	Oral	27 (38.6%)	184 (16%)	62 (11.7%)
	• Liquid Oral	18 (25.7%)	2 (0.2%)	(0%)
	• Solid Oral	9 (12.9%)	182 (15.8%)	62 (11.7%)
Month	January	0 (0%)	38 (3.3%)	41 (7.7%)
	February	9 (12.9%)	91 (7.9%)	39 (7.4%)
	March	3 (4.3%)	73 (6.3%)	66 (12.5%)
	April	10 (14.3%)	122 (10.6%)	46 (8.7%)
	May	4 (5.7%)	104 (9%)	37 (7%)
	June	0 (0%)	86 (7.5%)	86 (16.2%)
	July	0 (0%)	67 (5.8%)	32 (6%)
	August	5 (7.1%)	76 (6.6%)	26 (4.9%)
	September	10 (14.3%)	100 (8.7%)	26 (4.9%)
	October	9 (12.9%)	80 (6.9%)	42 (7.9%)
	November	9 (12.9%)	136 (11.8%)	58 (10.9%)
	December	11 (15.7%)	179 (15.5%)	31 (5.8%)

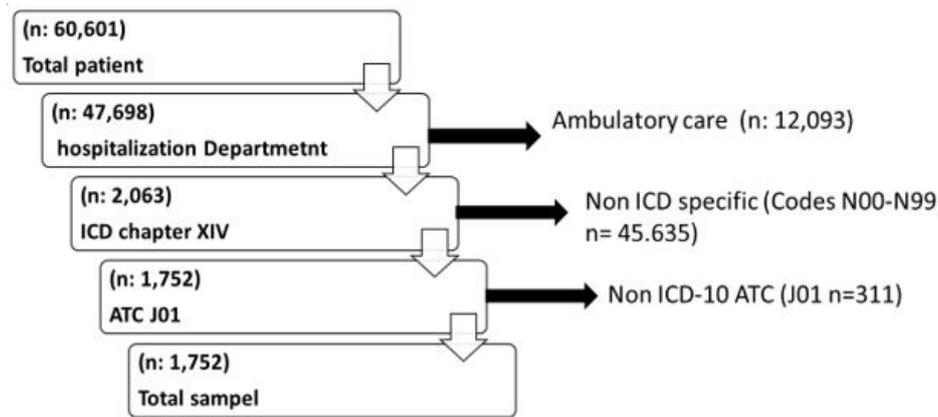


Figure 1. Flowchart of total participants.

The study identified the top ten genitourinary infections based on ICD-10 codes Chapter XIV, encompassing codes N00-N99 among 1,752 patients treated with systemic antibiotics in 2021 showed in Table 2. Hyperplasia of the prostate emerges as the most prevalent genitourinary system ailment, affecting 566 patients, followed closely by Obstructive and reflux uropathy (451 patients) and other urinary system disorders (304 cases). Additionally, conditions such as calculus of the lower urinary tract, chronic kidney disease, acute renal failure, calculus of the kidney and ureter, urethral stricture, inflammatory disorders of the breast, and inflammatory disorders of male genital organs were also prevalent, with cases ranging from 42 to 106.

Benign prostatic hyperplasia (BPH) is a common condition in men, characterized by the non-nodular enlargement of the prostate transition zone [2] Antibiotic treatment for Benign Prostatic Hyperplasia (BPH) frequently involves the use of ceftriaxone as a prophylactic

and empirical antibiotic [29]. Our findings indicate that ceftriaxone is administered more often to hospitalized patients compared to cefazolin and levofloxacin, which rank second and third, respectively, in usage Figure 2. Our findings reveal that antibiotics are frequently prescribed to patients with obstructive and reflux uropathies and other urinary system disorders to prevent urinary tract infections (UTIs) and decrease their frequency [30]. Antibiotics are essential in managing obstructive uropathy, reflux disease, and other urinary system disorders. They help reduce the frequency of urinary tract infections (UTIs) in children with malformative uropathy and recurrent UTIs [31]. However, overprescribing antibiotics can lead to significant risks, including the development of antibiotic resistance, disruption of the gut microbiome, allergic reactions, and increased healthcare costs [32].

The analysis of the top 10 antibiotics used for treating genitourinary infections in Chapter XIV revealed that cephalosporin antibiotics were the most prescribed,

Table 2. Top 10 genitourinary infections in ICD 10.

ICD Specific Disease (N00-N99)	n
Hyperplasia of prostate (N40)	566
Obstructive and reflux uropathy (N13)	451
Other disorders of urinary system (N39)	304
Calculus of lower urinary tract (N21)	106
Chronic kidney disease (N18)	92
Acute renal failure (N17)	72
Calculus of kidney and ureter (N20)	58
Urethral stricture (N35)	52
Inflammatory disorders of breast (N61)	43
Inflammatory disorders of male genital organs, not elsewhere classified (N9)	42

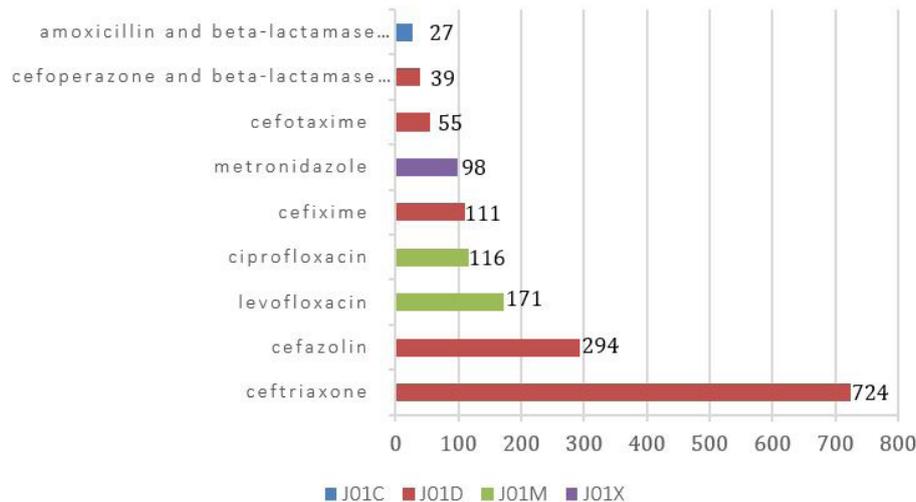


Figure 2. Top 10 antibiotics used in chapter XIV genitourinary disease (N00-N99).

with a total of 724 patients. Among the cephalosporins, Ceftriaxone was the most commonly prescribed (724 patients), followed by Cefazolin (294 patients), Cefixime (111 patients), Cefotaxime (55 patients), and Cefoperazone and beta-lactamase inhibitors (39 patients). Fluoroquinolones were also frequently used, with Levofloxacin prescribed to 171 patients and Ciprofloxacin to 116 patients. Combinations of penicillin, including beta-lactamase inhibitors, were less commonly prescribed, with amoxicillin and beta-lactamase inhibitor given to only 27 patients. Additionally, Metronidazole, an imidazole derivative, was prescribed to 98 patients [Figure 2](#).

Our research revealed that the most commonly used antibiotics in 2021 were cephalosporins, with ceftriaxone injection (CRO) namely 725. CRO injection is favored due to its broad-spectrum activity, safety, and tolerability, and is currently the recommended empirical treatment for complicated urinary tract infections (UTIs) in hospitalized patients [\[33\]](#). Its long half-life, intravenous potency, and comparable urinary secretion percentage to first-line oral UTI medications make CRO injection therapy, especially over a short duration of 3 days, more effective for UTI treatment [\[34\]](#). Additionally, Norrby *et al.* found a higher failure rate for oral beta-lactam antibiotics compared to CRO [\[35\]](#). Cefazolin was the second most commonly used antibiotic in our study. Cefazolin exhibits high susceptibility for uropathogens commonly implicated in cases of uncomplicated UTI, the most common UTI diagnosis among inpatients [\[36\]](#). Although ceftriaxone shows a higher susceptibility rate against these common uropathogens, it more than doubles the risk for HOCDI compared with cefazolin [\[37,38\]](#).

Inpatients with genitourinary infections are given cefoperazone and beta-lactamase inhibitors. Cefoperazone, a third-generation cephalosporin, is often used in genitourinary patients due to its broad spectrum of activity against both gram-positive and gram-negative bacteria, including beta-lactamase-producing strains [\[39,40\]](#). Studies have shown that cefoperazone, combined with beta-lactamase inhibitors, can effectively prevent postoperative infections in genitourinary surgery [\[41\]](#). In particular, cefoperazone is more effective than cefazolin in this regard [\[42\]](#). Furthermore, the safety profile of cefoperazone, with a low incidence of side effects, makes it a suitable choice for use in genitourinary patients [\[43\]](#).

Several limitations must be acknowledged. First, this study utilized only one year of data from the Cilacap Teaching Hospital. Second, the data were sourced from electronic medical records and pharmacy records, which may contain inaccuracies or incomplete information. Additionally, the study did not assess clinical outcomes or the effectiveness of the prescribed antibiotics, which would have provided a more comprehensive understanding of genitourinary infection management. Despite its limitations, this study offers foundational insights into antibiotic use among hospitalized patients with genitourinary infections during the COVID-19 pandemic. It sets the stage for future research to enhance antibiotic prescribing practices and treatment outcomes for this vulnerable population.

Conclusion

Genitourinary disorders, particularly prostatic hyperplasia and obstructive uropathy, significantly affect elderly men. This study highlights a prevalent trend in antibiotic prescribing for hospitalized patients with genitourinary infections, showing a high usage of broad-spectrum antibiotics such as ceftriaxone and cefazolin injection, both belonging to the cephalosporin class.

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