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Microbiological profile and antibiotic resistance of urinary tract infections in Maternity and Children Hospital, Hafr Al Batin, Saudi Arabia within 2022

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Abstract

Objective: This study aimed to characterize the antibiotic sensitivity, microbial resistance, and prevalence of the bacteria responsible for urinary tract infections (UTIs) at Maternity and Children Hospital (MCH), Hafr Al Batin, Saudi Arabia.

Methods: Analysis was done on 1273 culture samples that were processed in the microbiology lab between January and December of 2022.

Results: In all, 1273 urine culture (UC) samples were gathered. Gram-negative bacteria accounted for 46.9% of the 1273 positive UC, followed by Gram-positive bacteria with 28.8%, fungal pathogens with 13.1%, and Gram-negative non-fermenting bacteria with 11.2%. The most common uropathogenic organism (76.8%) was *Pseudomonas aeruginosa*, which was followed by *Escherichia coli* (55.6%), *Staphylococcus epidermidis* (22.9%), and *Klebsiella pneumonia* (24.3%). *Candida albicans* (69.5%) was determined to be the most frequent agent in terms of fungus, followed by *C. glabrata* (19.2%). The study revealed that the bacterial isolates exhibited effective resistance to antimicrobial drugs such as Amikacin, Cefepime, Ciprofloxacin, Gentamicin, imipenem, Levofloxacin, and Piperacillin/Tazobactam when administered against Gram-negative bacteria. Furthermore, the most effective antibiotics against Gram-positive was Erythromycin but were sensitive to Vancomycin.

Conclusions: One of the most typical infections that affect women is bacterial urinary tract infection. Using antibiotics for a very long time, and their misuse will result in the widespread growth of resistant bacteria.

Keywords: Urinary tract infections; Gram-negative Bacteria; Gram-positive Bacteria antibiotic susceptibilities; Fungi; Saudi Arabia

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1 Introduction

One of the most prevalent kinds of diseases is urinary tract infection (UTI) [1]. Women are often far more likely to get UTIs than males; 60% of women are expected to get at least one UTI in their lifetime [2,3]. In the Kingdom of Saudi Arabia (KSA), UTI continue to be a burden on the healthcare system; they represent 10% of all infections in the nation and are the second most frequent cause of admissions to emergency rooms [2,3]. Hospital admission is the next step for about 4% of UTI patients. Readmission is another problem; around 10% of patients are readmitted within a week of being discharged, with inadequate care being one of the primary causes [3]. Numerous research has revealed that similar issues are encountered globally [4,5]. The standard treatment for UTIs has been broad-spectrum antibiotics. Antimicrobial resistance has developed globally as a result of the treatment's frequent initiation without consideration for the bacterial culture or antimicrobial sensitivity patterns. Antimicrobial resistance is increasing at an alarming rate these days, which results in bacteria that are multidrug resistant (MDR) [6]. The same bacteria's antimicrobial susceptibility patterns can change depending on where they live [5]. The Infectious Diseases Society of America advises conducting regional surveillance to track variations in uropathogen susceptibility in certain areas [7].

The rate of antibiotic-resistant bacterial infections leading to human mortality is estimated by the European Union to be over 25,000 per year, with Gram-negative bacteria accounting for two-thirds of these infections [6,8]. Overdiagnosis, which leads to the abuse of potentially needless antibiotics, is one of the main causes of the rising rate of antimicrobial resistance [9,10]. Therefore, urine culture diagnosis is essential, particularly for complex UTIs, since it will validate the infection and give the doctor an antimicrobial pattern for that specific bacteria [4]. Once an infection has been confirmed by culture, the biggest obstacle to therapy prescription is time. The Saudi National Antimicrobial Therapy Guidelines state that empirical therapy can be used to treat asymptomatic bacteriuria in the absence of proof from a positive culture. Antimicrobials, which include imipenem, nitrofurantoin, co-trimoxazole, and ertapenem, are considered to be the basic defense [10,11]. However, a proven microbiological culture is necessary before treating symptomatic bacteriuria, and the microbiology lab requires two to three days to produce a culture report [9,10]. The World Health Organization (WHO) recommends nitrofurantoin and co-trimoxazole as the first line of treatment in international guidelines. The local guidelines likewise place a strong emphasis on these treatments [2,3]. In order to prevent the establishment of novel antibiotic resistance, every hospital must estimate the prevalence of the most isolated microorganisms and their patterns of antibiotic resistance. Planning an updated treatment regimen requires frequent knowledge of the local antimicrobial sensitivity pattern [12]. The prevalence of UTIs is high, and bacterial resistance to antibiotics is spreading globally, especially in Saudi Arabia [13].

Since *Escherichia coli* and *Klebsiella pneumoniae* are the most frequent etiologic agents of urinary tract infections (UTIs), the rising rate of antibiotic resistance in uropathogens makes it more difficult to choose appropriate empirical medication and achieve therapeutic success [14]. Since the 1930s and 1940s, when penicillin and sulfonamide were first used in clinical settings, people have been driven by the delusion that antibiotics could completely prevent infectious infections. However, the extensive use of antibiotics places a tremendous selection pressure on the emergence of antibiotic resistance, a significant contemporary public health issue [15]. The issue has gotten worse recently because of the advent of extended-spectrum beta-lactamases (ESBL), which cause resistance in these organisms to b-lactam antibiotics, particularly the third-generation cephalosporins. The ESBL-producing genes are typically plasmid-mediated and result from point mutations at the active site of the earlier b-lactamases. In addition, genes that give high degrees of resistance to numerous additional antibiotics are frequently carried by ESBL-positive and Gram-negative bacteria [16]. This study looked at the epidemiological information derived from bacteria that were isolated from urine samples taken over a one-year period from patients at Maternity and Children Hospital (MCH) in Hafr Al Batin. Resistance to antibiotics and susceptibility were included in the data.

2 Materials and Methods

Patients of all ages who visited the urology or medical laboratory departments at the MCH, Western Region in Saudi Arabia from January to December 2022 were included in this retrospective cohort study.

2.1 Study Participants

Urine sample data and the outcomes of every antibiogram were searched electronically within the laboratory information system. Patients who did not fit the clinical practice guidelines' (CPGs') definition of a UTI (17) based on their urine culture findings were not included in the study. In an additional form created especially for this study, patient data was gathered. Urine cultures and antibiograms were included in this data set. In this study, 1273 patients who were suspected of having a UTI were enrolled using a convenient sampling technique.

2.2 Laboratory Procedures

In the Microbiology Laboratory of the MCH, samples were prepared and examined as follows:

2.2.1 *Sample Collection*

In order to minimize the possibility of contamination, participants were instructed to wash their hands and genital area with water and a swab dipped in regular saline after entering the laboratory. Using a sterile, wide-mouthed urine cup, clean catch mid-stream urine samples were collected and processed as soon as they arrived at the microbiology laboratory. Urine samples that were not processed within one hour of collection had insufficient urine, or had poorly labeled urine were all removed from the study.

2.2.2 *Urine Sample Processing*

Using a 10μL calibrated loop, the urine sample taken from each patient was inoculated onto Blood Agar Base and MacConkey Agar. After that, it was aerobically incubated for 18 to 24 hours at 37 °C. The number of colonies was counted and a yield of bacterial growth $\geq 10^5$ CFU/mL of urine was considered significant for bacteriuria. Pure isolates of the bacterial pathogen were preliminarily characterized by colony morphology and gram staining before performing antimicrobial susceptibility testing (AST) procedures. Culture mediums were prepared and evaluated in accordance with the manufacturer's instructions and guidelines.

2.2.3 *Antimicrobial Susceptibility*

An automated technique (Vitek, Biomerieux®) was used to identify the isolated bacteria and their susceptibility to antibiotics. Estimates of susceptibility for species for which fewer than 30 isolates have been recorded have poor statistical validity. This study does not include several organisms for which there were fewer than 20 isolates or extremely small numbers of them.

3 Results

The MCH, Hafr Al Batin, Saudi Arabia's urology departments received 1273 patient presentations during the study period, which ran from January to December 2022.

3.1 Prevalence of Common Uropathogens groups

Gram-negative bacteria accounted for 46.9% of all uropathogenic organisms (out of 1273 isolates from UTI patients), with Gram-positive bacteria coming in second at 28.8%, fungal pathogens at 13.1%, and Gram-negative non-fermenting bacteria at 11.2% (Figure 1).

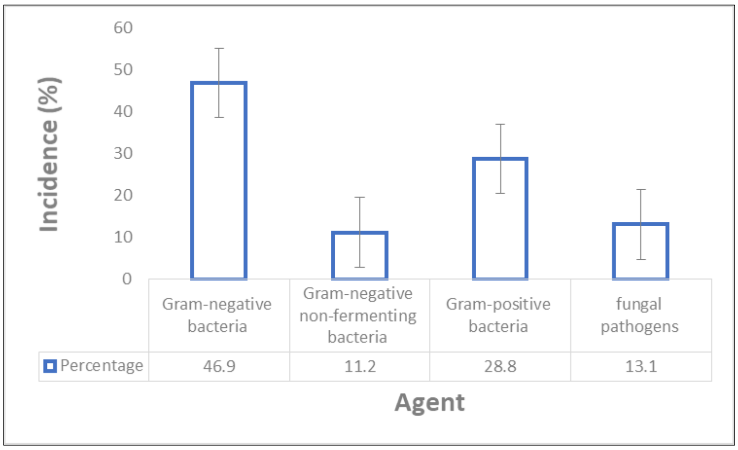

Figure 1 The prevalence percentage of various uropathogen groups in patients with UTIs from January to December of 2022

3.2 Distribution of agents of bacterial groups in Urine Samples

3.2.1 Distribution of Gram-negative Bacteria

597 isolates were obtained, these pathogens represented 46.9%. *E. coli* was the predominant uropathogenic organism (55.6%) followed by *K. pneumoniae* (24.3%), *Salmonella sp.* (5.4%), and *Proteus mirabilis* (4.7%) (Table 1).

Table 1 Gram-negative bacteria as etiological agents uropathogenic and susceptibility patterns

Isolate Name	MCH (n=596)		Susceptibility patterns					
	No.	%	<=69%*		70-79%**		>=80%***	
			Antibiotics	Antibiotics resistance pattern (n)	Antibiotics	Antibiotics resistance pattern (n)	Antibiotics	Antibiotics resistance pattern (n)
Escherichia coli	332	55.6	AMP,ATM,CZ,CTX,CAZ, CRO,CXM,MXF	R (9)	AMC,CPE,LVX	I (3)	AMK,CPE,CIP,GEN,IPM,LVX, MEM,TZP,TGC,TOB,SXT	S (11)
Klebsiellaa oxytoca	12	2.0	AMP,CZ,LVX	R (3)	ATM	I (1)	AMK,AMC,CPE,CTX,FOX, CAZ,CIP,GEN,IPM,MEM, MXF, TZB,TGC,TOB,SXT	S (15)
K. pneumonia	146	24.3	AMP,ATM,CZ,CTX, CXM,MXF,TOB	R (7)	AMC,CPE,CAZ, GEN,SXT	I (5)	AMK,FOX,CIP,IPM, LVX,MEM,TZP,TGC	S (8)
Proteus mirabilis	28	4.7	AMP,MXF,TGC,SXT	R (4)	AMC,GEM	I (2)	AMK,ATM,CZ,CPE,CTX,FOX, CAZ,CXM,CIP,LVX, MEM,TZP,TOB	S (13)
Serratia marcescens	7	1.2	AMC,AMP,ATM,CZ,FOX, CRO,CXM,IPM,MXF,TZP	R (10)	CPE,CAZ,TOB	I (3)	AMK,CIP,GEN,LVX, MEM,TGC,SXT	S (7)
Salmonella sp.	32	5.4	AMP	R (1)	CIP,LVX	I (2)	AMK,AMC,ATM,CPE,CTX,FOX, CAZ,CRO,GEN,IPM,MEM, MXF,TZP,TGC,TOB,SXT	S (16)
Shigella sp.	1	0.17	AMP,SXT	R (2)	NON	I (0)	AMC,CPE,CTX,CAZ,CIP, LVX,MEM,TZP,TGC	S (9)

*<=69% caution in selecting this antibiotic is advised, and discussion with a microbiologist ; **70-79% recommended empiric therapy if no other choice; ***>=80% reasonably good susceptibility, recommended as first-line empiric therapy for the suspected organism

3.2.2 Distribution of Non-fermenting Gram-negative Bacteria

142 isolates were obtained, these pathogens represented 11.2%. The *Pseudomonnas aeruginosa* (76.8%) and *Acinetobacter baumannii* complex (16.9%), were the most prevalent, while the other species, e.g., *Stenotrophomonas maltophilla, Aeromonas sp.* and *Brucella sp.* were in a minority (3.5, 1.4 and 1.4%, respectively) (Table 2).

3.2.3 Distribution of Gram-positive Bacteria

367 isolates were obtained, these pathogens represented 28.8%. the *Staphylococcus epidermidis* (22.9%) and *S. hominis* (20.2%), *Enterococcus faecalis* (13.9%), *Staphylococcus aureus* (10.6%), *S. haemolyticus* (7.6%) and *E. faecium* (7.1%) were the most prevalent, while *Streptococcus pneumonia* was 3% (Table 3).

3.2.4 Distribution of fungal infection

Out of 1273 total clinical Urine samples, 167 isolates were Candida species showing a prevalence of 13.1%. Of the total 167 fungal isolates, *Candida albicans* (69.5%) were more prevalent as compared to other species (Table 4).

3.3 Antibiotic Susceptibility Profiles of the Common Uropathogens

3.3.1 Gram-negative bacterial isolates

Most Gram-negative bacteria isolates demonstrated the highest level of sensitivity to antibiotics. *Escherichia coli* was sensitive to 11 types of antibiotics, but resistant to 9. *Klebsiellaa oxytoca* was sensitive to 15 types of antibiotics, but resistant to 3. *Salmonella sp.* is sensitive to 16 types of antibiotics, but resistant to 1 only. In general, the isolated bacteria showed sensitivity to a greater number of antibiotics compared to the number of antibiotics resistant to them, except for the *Serratia*, which showed resistance to 10 antibiotics, while they were sensitive to 7 **(Table 1 and 2)**. Resistance rates in Amikain, Aztreonam, Cefazolin, Cefotaxime, Cefatazidime, Ceftriaxone, Cefuroxime, Moxifloxacin, and Trimethoprim/Sulfamethoxazole having a value of <=69% were observed. On the other hand, for Gram-negative non-fermenting bacterial isolates, *Pseudomonas aeruginosa* demonstrated resistance to Cefazolin and was sensitive to Amikacin, Ciprofloxacin, and Colistin.

Table 2 Gram-negative non-fermenting bacteria as etiological agents uropathogenic and susceptibility patterns

Isolate Name	MCH (n=142)		Susceptibility patterns					
	No.	%	<=69%*		70-79%**		>=80%***	
			Antibiotics	Antibiotics resistance pattern (n)	Antibiotics	Antibiotics resistance pattern (n)	Antibiotics	Antibiotics resistance pattern (n)
Pseudomonnas aeruginosa	109	76.8	CZ	R (1)	CFM,CRO	I (2)	AML,CIP,CST	S (3)
Acinetobacter baumannii complex	24	16.9	nd	nd	nd	nd	nd	nd
Stenotrophomonas maltophilla	5	3.5	nd	nd	nd	nd	SXT,LVX	S (2)
Aeromonas sp.	2	1.4	nd	nd	nd	nd	nd	nd
Brucella sp.	2	1.4	nd	nd	nd	nd	nd	nd

*<=69% caution in selecting this antibiotic is advised, and discussion with a microbiologist ; **70-79% recommended empiric therapy if no other choice; ***>=80% reasonably good susceptibility, recommended as first-line empiric therapy for the suspected organism

3.3.2 Gram-positive bacteria isolates

Staphylococcus epidermidis has shown resistance to 10 antibiotics such as Amoxicillin/Clavulanate, Azithromycin, Clindamycin, Erythromycin, Gentamicin, Moxifloxacin, Oxacillin, Penicillin, Tetracycline and Tobramycin. *Enterococcus faecium*, *S. haemolyticus,* and *Staphylococcus aureus* were shown resistance to 7, 6 and 5 antibiotics, respectively (Table 3).

3.3.3 Fungal infection

From four, three species of Candida (*Candida albicans, C. tropicalis* and *C. parapsilosis*) showed sensitivity to Amphotericin B, Caspofungin, Fluconazole and Voriconazole. On the other hand, the fourth one (*C. glabrata*) demonstrated sensitivity to Amphotericin B, Fluconazole, and Voriconazole, where it demonstrated resistance to Caspofungin only (Table 4).

Table 3 Gram-positive bacteria as etiological agents uropathogenic and susceptibility patterns

Isolate Name	MCH (n=367)		Susceptibility patterns					
	No	%	<=69%*		70-79%**		>=80%***	
			Antibiotics	Antibiotics resistance pattern (n)	Antibiotic	Antibiotics resistance pattern (n)	Antibiotics	Antibiotics resistance pattern (n)
Enterococcus faecalis	51	13.9	ERY,TET	R (2)	CIP	I (1)	AMP,DAP,LVX,LZD, NIT,PEN,TGC,VAN	S (8)
E. faecium	26	7.1	AMP,CIP,ERY,LVX, NIT,PEN,TET	R (7)	NON	I (0)	DAP,LZD,TGC,VAN	S (4)
Staphylococcus aureus	39	10.6	AZM,ERY,LVX ,OXA,PEN	R (5)	AMC,CIP,CLI, IPM,MXF	I (5)	DAP,GEN,LZD,NIT, RFI, TET,TGC,TOB,SXT, VAN	S (10)
S. epidermidis	84	22.9	AMC,AZM,CLI,ERY, GEN, MXF,OXA,PEN,TET, TOB	R (10)	CIP,LVX,SXT	I (3)	DAP,LZD,NIT, RIF,TGC,VAN	S (6)
S. haemolyticus	28	7.6	CLI,ERY,OXA,TET,TOB,PEN	R (6)	GEN,LVX, MXF	I (3)	LZD,NIT,RFI, TGC,SXT,VAN	S (6)
S. hominis	74	20.2	CLI,ERY,OXA,PEN	R (3)	GEN,LVX, MXF, TET,TOB	I (5)	LZD,NIT,RIF, TGC,SXT,VAN	S (6)
Streptococcus pneumonia	11	3.0	AMX,CTX,CRO,ERY, IPM,PEN,TET,SXT	R (8)	NON	I (0)	LVX,LZD,MXF, RIF,VAN	S (5)

*<=69% caution in selecting this antibiotic is advised, and discussion with a microbiologist; **70-79% recommended empiric therapy if no other choice; ***>=80% reasonably good susceptibility, recommended as first-line empiric therapy for the suspected organism

Table 4 Fungal isolates as etiological agents uropathogenic and susceptibility patterns

Isolate Name	MCH (n=167)		Susceptibility patterns					
	No.	%	<=69%*		70-79%**		>=80%***	
			Antibiotics	Antibiotics resistance pattern (n)	Antibiotics	Antibiotics resistance pattern (n)	Antibiotics	Antibiotics resistance pattern (n)
Candida albicans	116	69.5	non	R (0)	non	I (0)	AMP,CAS,FLC,VRC	S (4)
C. glabrata	32	19.2	CAS	R (1)	non	I (0)	AMP,FLC,VRC	S (3)
C. tropicalis	14	8.4	non	R (0)	non	I (0)	AMP,CAS,FLC,VRC	S (4)
C. parapsilosis	5	3.0	non	R (0)	non	I (0)	AMP,CAS,FLC,VRC	S (4)

*<=69% caution in selecting this antibiotic is advised, and discussion with a microbiologist; **70-79% recommended empiric therapy if no other choice; ***>=80% reasonably good susceptibility, recommended as first-line empiric therapy for the suspected organism

4 Discussion

Out of the 1273 urine specimens, gram-positive and gram-negative bacteria accounted for 739 (58.1.9%) and 367 (28.8%) of the UTI cases, respectively. Gram-negative bacteria constituted most of the isolates in this investigation, and consistent results were obtained from research conducted in Uganda, Libya, and three other Indian studies [18-22]. Our results showed that the Gram-negative bacteria's highest incidence of UTI, followed by Gram-positive and fungi. *E. coli* was the most usually discovered isolate (55.6%) in this investigation, followed by *K. pneumoniae* and *P. mirabilis*, the three most reported uropathogens as demonstrated in other studies [23, 24]. Our findings are in line with those of two earlier studies that showed *E. coli* had the highest incidence (60.53–73.98%), followed by *K. pneumoniae* (5.32–8.33%) [24] and *E. coli* (70%), *K. pneumoniae* (14%), and *Pseudomonas* (5%) as the most common UTI isolates [25]. The difference between our results and Hayajneh's [25] results, that *Pseudomonnas aeruginosa* incidence in Hafr Al Batin was 76.8%. *E. coli* was the most prevalent isolate with a prevalence of 76.7%, followed by *Enterococcus faecalis, Staphylococcus saprophyticus, K. pneumoniae,* and *P. mirabilis* in the antibiotic resistance epidemiological survey on cystitis study. [26]. According to a study done in Uganda, *E. Coli* was the most common isolate of Gram-negative bacteria that displayed the highest resistance rates to Ampicillin, Aztreonam, Cefazolin, Cefotaxime, Ceftazidime, Ceftriaxone, Cefuroxime, Moxifloxacin, and Trimethoprim/Sulfamethoxazole in that order. [18].

For *E. coli* isolates the most effective antibiotics observed in our study were Amikacin, Cefepime, Ciprofloxacin, Gentamicin, imipenem, Levofloxacin, Piperacillin/Tazobactam. On the other hand, Amikacin, Ciprofloxacin, imipenem, Levofloxacin, and Piperacillin/Tazobactam showed similar susceptibilities for Klebsiella isolates. It is noteworthy in this study that all isolates of Gram-negative bacteria are sensitive to amikacin, and most of them are sensitive to Trimethoprim/Sulfamethoxazole which may be recommended as first-line empiric therapy for the suspected organism. From the total antimicrobial susceptibility profile performed in gram-positive bacteria isolates, *Enterococcus faecalis, E. faecium, Staphylococcus aureus, S. epidermidis, S. haemolyticus, S. hominis* and *Streptococcus pneumonia* together showed resistance to Erythromycin but were sensitive to Vancomycin. The results of this study differ from an Indian publication that found that norfloxacine was effective against isolates of Staphylococcus aureus, with a susceptibility range of 66.6% [27]. The pattern of *Enterococcus faecalis*, *E. faecium, Staphylococcus epidermidis, S. haemolyticus,* and *Streptococcus pneumonia* has proven different rates of resistance to Erythromycin and Tetracycline. This conclusion is highly corroborated by other study findings that were made in other places and explained in a manner comparable to the conclusion of this study [28, 29]. We accept that there were a number of limitations to our study, including its brief duration and missing data relating to some of the information gathered. The primary strength of this investigation was the dearth of information on the epidemiology of UTI and the profiles of antibiotic susceptibility at the Maternity and Children Hospital in Hafr Al Batin, Saudi Arabia in 2022.

5 Conclusion

In summary, among other uropathogens, *E. Coli* and *Pseudomonnas aeruginosa* were shown to be predominant in Hafr Al Batin women's UTI patients. These findings made clear how crucial it is to treat UTIs with a sufficient prescription for antibiotics. When treating patients with UTIs, doctors should prioritize clearing the infection, preventing recurrence, and being aware of antibiotic resistance. More research is still required to classify these illnesses according to severity and modify treatment as necessary.

Compliance with ethical standards

Disclosure of conflict of interest

There is no conflict of interest.

Statement of ethical approval

The committee registered with King Abdulaziz City for Science and Technology (KACST), Kingdom of Saudi Arabia (No. H-05-FT-083) and the Institutional Review Board (IRB) committee of Hafr Al-Batin (approved number: 132) provided ethical permission.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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