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Urinary Tract Infection and Antibiotic Resistance in Pregnant Women: A Single-Center Cross-Sectional Study

Maria Tasneem[1], Sadia Shoukat[2], Tehreem Zahid[3, *], Jahooran Mariyah Bibi Goolamnobee[2], Nabila Salman[4]

[1]Department of Gynecology and Obstetrics, Jinnah Medical and Dental College, Karachi, Pakistan

[2]Dr. Ruth K. M. Pfau Civil Hospital, Karachi, Pakistan

[3]Shifa International Hospitals Ltd, Islamabad, Pakistan

[4]Department of Gynecology and Obstetrics, NESCOM Hospital, Islamabad, Pakistan

Email address:

mariatasneem08@gmail.com (Maria Tasneem), Nadiashoukat2010@hotmail.com (Sadia Shoukat), dr.tehreemzahid@gmail.com (Tehreem Zahid), Mariyah_1986@hotmail.com (Jahooran Mariyah Bibi Goolamnobee), nabilasalman65@gmail.com (Nabila Salman)

[*]Corresponding author

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Abstract: Urinary tract infections are one of the most prevalent infectious diseases which frequently reoccur and are difficult to eradicate. OBJECTIVE: To determine the frequency of the most common gram-positive and gram-negative organisms causing urinary tract infections, as well as their sensitivity/resistance to various antibiotics in pregnant women. Methods: A total of 160 cases were included in this cross-sectional study, which was conducted at the in-patient Department of Obstetrics and Gynecology at NESCOM hospital Islamabad. All patients fulfilling the inclusion criteria were enrolled in the study. After taking consent from the patient and explaining the purpose of the study, early morning mid-stream urine samples were collected in a sterile bottle to report pus cells, epithelial cells, and bacteria. If the patient had a urinary tract infection according to the urine report, then a culture and sensitivity test was performed. Results: A total of 160 patients presenting with urinary tract infections were included in the study. The mean age of the patients was 25.06 + 10.04 years. Out of 160 patients, 120 (75%) had asymptomatic UTIs, while 40 (25%) patients had symptomatic UTIs. The most common organisms were Escherichia coli (55.6%) followed by Staphylococcus aureus (18.2%), Klebsiella pneumoniae (11.9%), Pseudomonas aeruginosa (6.9%), Staphylococcus saprophyticus (4.3%) Streptococci (1.9%) and Proteus vulgaris (1.2%). Organisms causing symptomatic UTI were Pseudomonas aeruginosa, followed by Klebsiella pneumoniae, Escherichia coli, Staphylococcus saprophyticus and Staphylococcus aureus. E. coli showed the highest sensitivity to ceftriaxone (71%) but was resistant to cephalexin (89%) and co-amoxiclav (82%). Klebsiella pneumoniae was only 76% sensitive to cefixime and 93% resistant to Co-Amoxiclav. Ceftazidime was 81% effective against Pseudomonas aeruginosa, while cefixime was 69% effective. Pseudomonas aeruginosa was 95% resistant to Cephalexin and 86% resistant to Nitrofurantoin. Staphylococcus aureus was 81% susceptible to cephalexin and 93% resistant to cefixime. Staphylococcus saprophyticus was 97% sensitive to Co-Amoxiclav and 85% resistant to Ceftazidime and Nitrofurantoin. Streptococci sp. were 95% sensitive to Cephalexin and 95% resistant to Ceftazidime 88%. Conclusion: In conclusion, the empirical evidence reaffirms that the selection of medications for the treatment of UTIs is limited due to antibiotic resistance that the prevalent microorganisms display to medications utilised in the past. Drugs like co-trimoxazole and aminopenicillins, which were once thought to be useful against uropathogens, are now infrequently used as empirical therapy in regions with high rates of antibiotic resistance.

Keywords: Sensitivity, Gram Positive, Gram Negative, Urinary Tract Infection

1. Introduction

A urinary tract infection (UTI) is a combination of upper and lower urinary tract infections [1]. It is one of the most common infectious diseases that warrant a visit to the clinic due to its frequency, recurrence, and difficulty in the eradication. This poses a challenge to medical professionals [2].

The most common urinary symptoms in pregnant women suffering from a UTI are abdominal pain, followed by irritative symptoms such as frequency and urgency and voiding difficulties. A history of sexual activity, a low socioeconomic status, a previous history of UTI, and multiparity are known risk factors for UTI in pregnant women [3]. Urinary tract infection increases the risk of intrauterine growth retardation and low birth weight [3]. Untreated asymptomatic bacteriuria leads to cystitis in 30% of cases and pyelonephritis in about 50% of cases. Pyelonephritis can then lead to urosepsis and has been associated with anemia. It is therefore essential to screen for urinary tract infections during pregnancy [3].

Due to several anatomical and hormonal changes, pregnant women are more susceptible to developing urinary tract infections [4]. It has been reported among 20% of pregnant women and it is the most common cause of admission the obstetrical wards. In pregnant women, 28% of women were symptomatic whereas 71.9% were asymptomatic [5]. The most common causes of UTI in pregnancy in hospitalized patients are increased bladder volume and decreased bladder tone, along with decreased ureteral tone, which contributes to increased urinary stasis and ureterovesical reflux [5, 6].

Gram-negative rods and gram-positive cocci both demonstrated significant resistance to the beta-lactam group of antimicrobials. Most alarming was the presence of extended-spectrum lactamase in 47% of isolates of Escherichia coli and 36.9% of isolates of Klebsiella pneumoniae, along with the presence of methicillin resistance in 41% of Staphylococcus aureus [7].

The purpose of this study was to determine the frequency of the most common gram-positive and gram-negative organisms causing urinary tract infections, as well as their sensitivity/resistance to various antibiotics in pregnant women, admitted via outpatient or emergency departments. This study is important for clinicians to facilitate the effective treatment of patients with symptoms of urinary tract infection and to promote the judicious use of these drugs in order to preserve their efficacy.

2. Materials and Methods

This observational cross-sectional study was carried out at the Obstetrics and Gynecology department of NESCOM hospital Islamabad. The inclusion criteria were all pregnant patients with urinary tract infections confirmed by urine routine examination (Urine R/E). Patients with the following characteristics were excluded from the study: Renal stones, connective tissue disorders and patients already taking antibiotics for 2 weeks' duration. Written informed consent was obtained from all patients.

Patients were asked to collect early morning mid-stream urine samples in a sterile bottle. The sample was sent to the hospital laboratory for a complete urine examination to see pus cells, epithelial cells and bacteria by using a Merk urinal strip. If urinary tract infection was confirmed according to the urine report, then another urine sample was taken in a sterile culture and sensitivity bottle. The culture and sensitivity results took 3–7 days and were done by using agar medias LB Miller Broth for E. coli that showed pink to rose-red colonies, Nutrient agar for P. aeruginosa that showed colourless to pink colonies, MacConkey agar medium for Klebsiella pneumoniae that showed yellow/pink mucoid colonies and was pinkish in color, and heart infusion agar for Proteus vulgaris that showed colourless colonies. The reports were verified by a consultant microbiologist.

3. Results

A total of 160 patients presenting with urinary tract infections were included in the study. The mean age of patients was 25.06 + 10.04 years ranging from 15 to 35years. The baseline characteristics of the patients in given in Table 1. Among 160 patients 120 (75%) had asymptomatic UTI while 40 (25%) Patients had symptomatic UTI. (Table 1).

Table 1. *Descriptive statistics of study patients (n = 160).*

	Number	Percentage
Age (years)		
Mean + SD	25.0 + 10.0	
Range (minimum-maximum)	15 - 35	
Duration of Pregnancy (weeks)	23.56 + 13.5	
Range of duration (minimum-maximum)	10-37	
Parity	4+3	
Range (minimum-maximum)	1-7	
Age categories (years)		
15 to 20	39	24.4%
21 to 30	90	56.3%
31 to 35	31	19.3%
Asymptomatic UTI	120	75%
Symptomatic UTI	40	25%

The overall most common organisms in our study were Escherichia coli 55.6%, followed by Staphylococcus aureus 18.2% Klebsiella pneumoniae 11.9% Pseudomonas aeruginosa 6.9% Staphylococcus saprophyticus 4.3% Proteus vulgaris 1.2% Streptococci 1.9% (Table 2).

The most common organism in our study causing symptomatic UTI was Pseudomonas Aeruginosa followed by Klebsiella pneumoniae, Escherichia coli, Staphylococcus saprophyticus and Staphylococcus aureus. Among 89 patients having E. Coli growth 58 had asymptomatic while 12 had symptomatic UTI. Among 21 patients having Klebsiella pneumoniae growth, 06 had asymptomatic while 12 had symptomatic UTI. Among 11 patients having Pseudomonas Aeruginosa growth 04 had asymptomatic while 02 had symptomatic UTI. Among 07 patients having Staphlococcus saprophyticus growth 05 had asymptomatic while 01had symptomatic UTI. Among 29 patients having

Staphlococcus saprophyticus growth 17 had asymptomatic while 01 had symptomatic UTI. Among 03 patients having Streptococci growth 03 had asymptomatic while none had symptomatic UTI. (Table 3).

Table 2. *Distribution of patients According to Type of Microorganisms causing UTI (n = 160).*

Type of Microorganism	Number of Patients having UTI n=160	%Age of patients
Escherichia coli	89	55.6%
Klebsiella pneumoniae	21	11.9%
Pseudomonas Aeruginosa	11	6.9%
Staphylococcus saprophyticus	07	4.3%
Staphylococcus aureus	29	18.2%
Streptococci	03	1.9%

Table 3. *Distribution of patients According to Type of Microorganisms causing symptomatic and asymptomatic UTI (n = 160).*

Type of Microorganism	Asymptomatic UTI (n = 120)		Symptomatic UTI (n = 40)	Total Number
Gram Negative				
Escherichia coli	YES	58	12	70
	NO	07	12	19
Klebsiella pneumoniae	YES	06	10	16
	NO	03	02	05
Pseudomonas Aeruginosa	YES	04	02	06
	NO	05	0	05
Gram Positive				
Staphlococcus saprophyticus n=7	YES	05	01	06
	NO	01	0	01
Staphlococcus saprophyticus n=29	YES	17	01	18
	NO	11	0	11
Streptococci n=03	YES	03	0	03
	NO	0	0	0

Urine culture sensitivity reports were analyzed in the present study. The predominant growth of single bacteria was seen in 89 (55.6%) samples. E. coli showed high sensitivity to ceftriaxone 71% followed by Cefexime 67%. E. coli showed high resistance to Cephalexin 89% followed by Co-Amoxiclav 82%. Klebsiella pneumoniae showed high sensitivity to Cefexime 76%. Klebsiella pneumoniae showed high resistance to Co-Amoxiclav 93% followed by Cephalexin 91% and Co-Trimoxazole 89%. Pseudomonas Aeruginosa showed high sensitivity to Ceftazidime 81% followed by Cefexime 69%. Pseudomonas Aeruginosa showed high resistance to Cephalexin 95% followed by Nitrofurantoin 86%. (Table 4).

Table 4. *Antibiotics Sensitivity & Resistance Pattern of isolated Microorganisms in UTI Gram Negative (n = 160).*

	E. Coli		K. Pneumoniae		P. Aeruginosa	
	Sensitivity	Resistance	Sensitivity	Resistance	Sensitivity	Resistance
Amoxicillin	25%	75%	19%	81%	21%	79%
Co-Trimoxazole	33%	67%	11%	89%	33%	67%
Co-Amoxiclav	18%	82%	07%	93%	41%	59%
Cefixime	67%	33%	76%	24%	69%	31%
Ceftazidime	41%	59%	23%	77%	87%	13%
Nitrofurantoin	56%	44%	15%	85%	14%	86%
Cephalexin	11%	89%	09%	91%	05%	95%
Ceftriaxone	71%	29%	43%	57%	51%	49%

Table 5. *Antibiotics Sensitivity & Resistance Pattern of isolated Microorganisms in UTI Gram Positive (n = 160).*

Type of Antibiotic	Staphylococcus aureus		Staph. Saprophyticus		Streptococci	
	Sensitivity	Resistance	Sensitivity	Resistance	Sensitivity	Resistance
Amoxicillin	19%	81%	23%	77%	92%	08%
Co-Trimoxazole	28%	72%	19%	81%	33%	67%
Co-Amoxiclav	78%	22%	97%	03%	41%	59%
Cefixime	07%	93%	17%	83%	33%	67%
Ceftazidime	11%	89%	15%	85%	12%	88%
Nitrofurantoin	35%	65%	15%	85%	14%	86%
Cephalexin	81%	19%	79%	21%	95%	5%
Ceftriaxone	07%	93%	23%	77%	51%	49%

Urine culture sensitivity reports were analyzed in the present study. Staphylococcus aureus showed high sensitivity to cephalexin 81% followed by Co-Amoxiclav 78%. Staphylococcus aureus showed high resistance to Cefexime 93% followed by Ceftazidime 93%. Staphylococcus. Saprophyticus showed high sensitivity to Co-Amoxiclav 97%

and Cephalexin 79%. Staphyloccocus Saprophyticus showed high resistance to Ceftazidime 85%, Nitrofurantoin 85%, co-trimoxazole 81% and ceftriaxone 77%. Streptococci showed high sensitivity to Cephalexin 95% and Amoxicillin 92%. Streptococci showed high resistance to Ceftazidime 88% followed by Nitrofurantoin 86 %. (Table 5).

Among 07 patients in which UTI was caused by Staphlococcus saprophyticus, 01 (14.2%) had age group 15-20 years, 3 (42.8%) had age group 21-30 years, while 01 (14.2%) had age group 31-35 years, (p value 0.0016). 29 patients in which UTI was caused by Staphlococcus Aureus, 06 (20.7%) had age group 15-20 years, 3 (10.35%) had age group 21-30 years, while 09 (31%) had age group 31-35 years, (p value 0.0043). 03 patients in which UTI was caused by Streptococci, 0 (0%) had age group 15-20 years, 01 (33.3%) had age group 21-30 years, while 01 (33.3%) had age group 31-35 years. (p value 0.000516). (Table 6).

Table 6. *Stratification of Gram Positive organisms with respect to age causing UTI Gram Positive Organisms (n = 160).*

Types of Organisms	Different Age Groups					
	15-20Years		21-30 Years	31-35 Years	Total Pts	P value
Staph Saprophyticus	YES	01	03	01	05	0.0016
	NO	01	0	01	02	
Staph Aureus	YES	06	03	09	18	0.0043
	NO	07	02	02	11	
Streptococci	YES	0	01	01	03	0.00051
	NO	0	01	0	0	
Total	YES	07	07	11	25	0.00017

Among 89 patients in which UTI was caused by E. Coli, 11 (12.3%) had age group 15-20 years, 43 (48.3%) had age group 21-30 years, while 06 (6.7%) had age group 31-35 years, (p value 0.0046). 38 patients in which UTI was caused by K. Pneumoniae, 06 (15.7%) had age group 15-20 years, 13 (34.2%) had age group 21-30 years, while 03 (7.9%) had age group 31-35 years, (p value 0.00231). 16 patients in which UTI was caused by P. Aeruginosa, 0 (0%) had age group 15-20 years, 05 (31.2%) had age group 21-30 years, while 01 (6.2%) had age group 31-35 years. (p value 0.00156). (Table 7).

Table 7. *Stratification of Gram Positive organisms with respect to age causing UTI Gram Negative Organisms (n = 160).*

Types of Organisms	Different Age Groups					
	15-20Years		21-30 Years	31-35 Years	Total Pts	P value
E. Coli	YES	11	43	06	60	0.0046
	NO	01	05	01	07	
K. Pneumoniae	YES	06	13	03	22	0.0023
	NO	07	07	02	16	
P. Aeruginosa	YES	0	05	01	06	0.00151
	NO	0	07	03	10	
Total	YES	17	61	10	88	0.0037
	NO	08	19	06	33	

Table 8. *Stratification According to the Gestational Age (n = 160).*

Typeof Microorganism	Gestational Age 10-20 weeks		Gestational Age 21-30 weeks	Gestational Age 31-37 weeks	P value
Gram Negative					
E. coli	YES	30	13	19	0.00011
	NO	15	07	05	
K. pneumoniae	YES	05	08	04	0.00053
	NO	0	02	02	
P. Aeruginosa	YES	03	02	03	0.00017
	NO	02	0	01	
Gram Positive					
Staph saprophyticus	YES	01	01	02	0.00039
n=7	NO	03	0	0	
Staph aureus	YES	13	06	04	0.00042
n=29	NO	02	03	01	
Streptococci	YES	03	0	0	0.00019
n=03	NO	0	0	0	

Among 07 patients in which UTI was caused by Staphlococcus saprophyticus, 01 (14.2%) had gestational age 10-20 weeks, 01 (14.2%) had gestational age group 21-30 weeks, while 02 (28.6%) had gestational age 31-37 weeks. (p value 0.00039). 29 patients in which UTI was caused by Staphlococcus Aureus, 13 (44.8%) had gestational age 10-20 weeks, 06 (20.7%) had gestational age group 21-30 weeks, while 04 (13.7%) had gestational age 31-37 weeks, (p value 0.00042). 03 patients in which UTI was caused by Streptococci, 03 (100%) had gestational age 10-20 weeks, 0

(0%) had gestational age group 21-30 weeks, while 0 (0%) had gestational age 31-37 weeks (p value 0.00196). Among 89 patients in which UTI was caused by E. Coli, 30 (33.7%) had gestational age 10-20 weeks, 13 (14.6%) had gestational age group 21-30 weeks, while 19 (21.3%) had gestational age 31-37 weeks, (p value 0.000116). 21 patients in which UTI was caused by K. Pneumoniae, 05 (23.8%) had gestational age 10-20 weeks, 08 (38%) had gestational age group 21-30 weeks, while 04 (19%) had gestational age 31-37 weeks, (p value 0.00053). 11 patients in which UTI was caused by P. Aeruginosa, 03 (27.2%) had gestational age 10-20 weeks, 02 (18.1%) had gestational age group 21-30 weeks, while 03 (27.2%) had gestational age 31-37 weeks. (p value 0.00176).(Table 8).

Among 07 patients in which UTI was caused by Staphlococcus saprophyticus, 04 (64.2%) had parity 0-2 weeks, 01 (14.2%) had parity 0-2 weeks, while 0 (0%) had parity >6 weeks. (p value 0.00039). 29 patients in which UTI was caused by Staphlococcus Aureus, 17 (64.2%) had parity 0-2 weeks, 03 (14.2%) had parity 0-2 weeks, while 05 (16.8%) had parity >6 weeks. (p value 0.00039). (p value 0.000142). 03 patients in which UTI was caused by Streptococci, 03 (100%) had parity 0-2 weeks, 0 (0%) had parity 0-2 weeks, while 0 (0%) had parity >6 weeks. (p value 0.000119). Among 89 patients in which UTI was caused by E. Coli, 37 (44.2%) had parity 0-2 weeks, 17 (19.2%) had parity 0-2 weeks, while 13 (12.8%) had parity >6 weeks. (p value 0.000539). 21 patients in which UTI was caused by K. Pneumoniae, 09 (43.2%) had parity 0-2 weeks, 03 (14.2%) had parity 0-2 weeks, while 02 (10%) had parity >6 weeks. (p value 0.000439). 11 patients in which UTI was caused by P. Aeruginosa, 05 (45%) had parity 0-2 weeks, 2 (18%) had parity 0-2 weeks, while 1 (9%) had parity >6 weeks. (p value 0.000171). (Table 9).

Table 9. *Stratification According to the Parity (n = 160).*

Typeof Microorganism	Parity 0-2 children		Parity 2-6 children	Parity > 6 children	P value
Gram Negative					
E. coli	YES	37	17	13	0.00053
	NO	08	03	11	
K. pneumoniae	YES	09	03	02	0.00043
	NO	0	02	05	
P. Aeruginosa	YES	05	02	01	0.000171
	NO	02	0	01	
Gram Positive					
Staph saprophyticus	YES	04	01	0	0.000339
n=7	NO	0	0	02	
Staph aureus	YES	17	03	05	0.000142
n=29	NO	02	01	01	
Streptococci	YES	03	0	0	0.000119
n=03	NO	0	0	0	

4. Discussion

UTIs are among the most common medical issues that arise during pregnancy. Pregnant women with UTIs have been associated with morbidity and mortality. Numerous mechanical and hormonal changes occur in the body during pregnancy. Ninety percent of pregnant women have uterine dilatation, which increases the risk of urinary stasis and vesicoureteral reflux, starting in the sixth week and peaking between the 22nd and 24th weeks. Additionally, during pregnancy, glycosuria and aminoaciduria serve as an ideal growing medium for bacteria in sites of urinary stasis. Pregnant women are more likely to get UTIs due to these changes, as well as narrow urethra, and difficulties in genital hygiene due to gravid uterus. Pregnancy-related untreated bacteriuria, whether asymptomatic or symptomatic, is linked to a 50% higher risk of low birth weight and a significantly higher risk of pre-eclampsia, hypertension, anaemia, and postpartum endometritis. In otherwise healthy pregnant women, a small and predictable spectrum of organisms can cause UTI. Escherichia coli comprises of 75–90% of isolates for simple UTIs, making it the main pathogen of the urinary tract. Other uropathogens include Klebsiella pneumoniae, Proteus mirabilis, and group B streptococci in fewer than 5% of episodes, and Staphylococcus saprophyticus in 5%–10% of incidents [7, 8].

Hamdan et al [4] showed the prevalence of UTI in pregnant women; 28% of women had symptomatic and 71.9% had asymptomatic urinary tract infections. In our study, out of 160 patients, 120 (75%) had asymptomatic UTI while 40 (25%) had symptomatic UTI. The results of our study correlate with the study by Hamdan et al. The prevalence of bacteriuria among symptomatic and asymptomatic pregnant women was 12.1% and 14.7%, respectively. Gram negative organisms such as E. coli (42.4%), Proteus vulgaris (25.8%), Staphylococcus aureus (39.3%), Klebsiella pneumoniae (9%), and Staphylococcus saprophyticus (64.5%). In our study, the most common organism causing symptomatic UTI was Pseudomonas aeruginosa, followed by Klebsiella pneumoniae, Escherichia coli, Staphylococcus saprophyticus, and Staphylococcus aureus [4]. A recent study on a large population-based cohort in Bangladesh revealed that E. coli resistance to ampicillin was high with only 34% of isolates sensitive. Azithromycin sensitivity was 28%, and cefixime, cotrimoxazole, and cephalexin were 69, 63, and 62% sensitive respectively. The majority of species were highly susceptible to nitrofurantoin,

with the exception of Klebsiella species, where 74% of strains were susceptible. Rates of susceptibility to azithromycin were low among the gram-negative species [9].

Asmat et al determined the prevalence of urinary tract infections (UTI) in pregnant women and they concluded that 65 of the 80 women in the study experienced a UTI, indicating that an average of 81% of pregnant women get a UTI. More than half of the bacteria found in urine samples came from the Escherichia, Klebsiella, Pseudomonas, Streptococcus, Enterococcus, and Proteus genera, as determined by biochemical characterization. A combination of amoxicillin and pipemidic acid was shown to be the most resistant to Escherichia, while Klebsiella and Pseudomonas were found to be the most resistant to ciprofloxacin and cefotaxime. Three organisms with the greatest MDR were identified by 16S rRNA as Pseudomonas, Escherichia coli, and Klebsiella pneumoniae strains UA17, UA32, and UA47 [10].

In Ethiopia, the prevalence of symptomatic UTI was 9% [11], but higher than a study conducted in Pakistan previously by Haider et al [12]. The difference between our research and the latter may be attributable to the small number of symptomatic pregnant women included in our investigation. The 8.5 percent frequency of ABU, on the other hand, is consistent with prior Ethiopian data. The low incidence rate of symptomatic UTI found in our study compared to previous studies is also attributable to substantial health education provided on a regular basis in health facilities and public awareness among pregnant women in the study region regarding prenatal care service follow-up during pregnancy.

Cohen et al [13] conducted a large cohort study enrolling 243,725 deliveries. Of them, 8034 (3.3%) were exposed to maternal UTI during pregnancy. Infectious-related hospitalizations were significantly prevalent in offspring to exposed mothers (12.3% vs. 11.0%, OR = 1.125, 95% CI 1.051–1.204, *Kaplan-Meier* log-rank $p < 0.001$). In the Cox regression model, while controlling for clinically relevant confounders, maternal UTI, preterm delivery and cesarean delivery were noted as independent risk factors for long-term infectious morbidity of the offspring.

Navarro et al conducted a study on 243,725 deliveries were eligible for participation in the research. 3.3% of the total patients had been exposed to a maternal UTI while pregnant. Hospitalizations connected to infectious diseases were more common in children whose mothers had been exposed (12.3 percent vs. 11.0%, OR = 1.125; 95% CI 1.051–1.204, Kaplan-Meier log rank p 0.001). Preterm birth (adjusted HR = 1.385) as well as caesarean delivery were revealed to be independent risk factors for long-term infectious morbidity of the children in the Cox regression model, while correcting for clinically relevant covariates [14].

5. Conclusion

To summarize, the range of medications for the treatment of UTI is rather limited nowadays due to the widespread resistance that typical UTI microorganisms exhibit to previously used treatments. Drugs that were once thought to be useful against uropathogens, such as cotrimoxazole and aminopenicillins, are now rarely administered as empirical treatment in places where resistance to these antibiotics is common.

The identification of bacterial infections resistant to a routinely prescribed antibiotic from both symptomatic and asymptomatic pregnant women begs for an early screening of all pregnant women for urinary tract infections.

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