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Hospital-acquired and Community-acquired Uropathogens; Modelling of Infection

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Abstract: *Urinary tract infections are among the most common human infections. They may be community-acquired or nosocomial, and caused by a variety of microorganisms. In the present study, we analysed more than 4000 urine samples collected from in-patients and out-patients, and registered the differences in the etiological spectrum of agents. The most widespread uropathogens are gram-negative rods, from them E. coli, Klebsiella spp. and the non-fermentive genus Pseudomonas. Women are more intensively affected by E. coli. From gram-positive cocci, the leading agents are coagulase negative Staphylococci, followed by S. aureus. No differences were registered between the genders. Polyresistance among gram-negative uropathogens is high.*

Keywords: *Urinary tract infection, Gram-positive cocci, Gram-negative rods, Antimicrobial susceptibility, Polyresistance*

Introduction

Urinary tract infections (UTIs), considered among the most common bacterial diseases, afflict a large part of the world's population.

A urinary tract infection may be defined as the presence of bacteria in urine with an associated host inflammatory reaction. UTIs account for a large proportion of antimicrobial drug consumption. Many infections of the urinary system appear to be opportunistic and related to a number of predisposing factors. They include diabetes mellitus, spinal cord injuries, obstructions to the flow of urine, pregnancy, etc. The urinary tract is nearly always invaded from the exterior *via* the urethra [1-4].

The gender and sexual anatomy are among the major determinants of UTIs. They are more common in women in comparison with men. UTIs are rare in males unless microorganisms are introduced artificially with catheters, etc. In women, the urethra is much shorter and very close to the anus, which is a constant source of faecal bacteria. An estimated 11 percent of women in the United States report at least one physician-diagnosed UTI per year, and the lifetime probability that a woman will have a urinary tract infection is 60 percent [10, 11].

According to Le Nicolle, at least 30% of all pre-menopausal women experience a UTI with an incidence of 0.5-0.7 per person-year in Canada. Approximately 2-3% of women experience frequent recurrent urinary infection [9].

Besides the gender, a person's age is also of importance.

Although UTIs frequently recur in young healthy women, more prevalent UTIs are among the elderly population. According to the recently published data, among persons older than 65,

between 20% and 25% of ambulatory women and approximately 10% of men have asymptomatic bacteriuria, and the incidence rises to 50% in women older than 80.

UTIs belong to the most widespread out-patient infections and are managed empirically. So, the information about the etiological spectrum and antimicrobial susceptibility is important for general practitioners.

At the same time, the condition belongs to the most common nosocomial infections in both acute-care hospitals and long-term-care hospitals. They account for approximately 40% of all nosocomial infections [5, 6]. Therefore, UTIs have large socio-economic impacts. The costs of prevention, detection and treatment of UTIs significantly affect a country's health-care budget. The consumption of antimicrobials contributes to the emergence of bacterial resistance, which has become one of the most complicated problems in medicine [10, 11, 13, 14].

To optimise the use of empirical antimicrobial therapy in patients, both in community and hospitals, detailed studies of agents and their antimicrobial susceptibility are necessary.

The aim of the present study was to establish the etiological structure of hospital-acquired and community-acquired urinary tract infections and to evaluate the antimicrobial resistance among hospital uropathogens.

We took into consideration the following factors:
1) in-patients (from hospitals with different profiles) and out-patients,
2) gender of patients,
3) character of the agent.

Materials and methods

The study was carried out between January 2001 and December 2004. Microbial isolates were collected from in-patients and out-patients in 4 hospitals in Riga. A total of 1859 bacterial strains were isolated and analysed in a multiprofile hospital (No. 1) and 2525 in 3 specialised hospitals (No. 2, 3, 4). Cultures of urine samples were performed by conventional methods. CHROM Agar Orientation (BBL) was used for rapid identification, differentiation and enumeration of the urinary pathogens.

Identification of microorganisms to the species level was performed by the automated Crystal and API systems.

The antimicrobial susceptibility to a panel of antimicrobials was tested by the standard agar disk diffusion test (BBL) according to NCCLS standards, and by the automated API system [12, 14].

Results and discussion

The identification of isolated uropathogens revealed the leading role of gram-negative rods. A comparison of the ratio of gram-positive and gram-negative agents registered in different hospitals is listed in Table 1.

Table 1. Cultures (%) of gram-positive and gram-negative microorganisms isolated from urine in different hospitals

Hospitals	Number of isolated cultures	Gram-negatives	Gram-positives
No. 1	1850	1063 (57.46%)	787 (42.54%)
No. 2, 3, 4	2525	1437 (56.9%)	1088 (43.1%)

So, no significant differences were found.

A comparison of the etiological structure of gram-positive agents of UTIs in in-patients and out-patients was performed in hospital No. 1 (Table 2).

Table 2. Cultures (%) of gram-positive cocci isolated in in-patient and out-patient departments*

Microorganisms	In-patient department	Out-patient department
S. epidermidis sensu stricto	6.74	9.39
S. saprophyticus	0.31	0
Other CoNS	48.90	46.98
S. aureus	32.92	24.16
Enterococcus spp.	7.05	6.04
Streptococcus spp.	4.08	13.42

***percentage is calculated only from gram-positive cocci**

Coagulase-negative Staphylococci were isolated most often, followed by *S. aureus*.

In out-patients, the spectrum of uropathogens was slightly different than in in-patients. The amount of isolated CoNS was the same – 56.37%, but more often, *S. epidermidis sensu stricto* was isolated – 9.39%, while no *S. saprophyticus* was identified.

The analysis of gram-negative rods, causative agents of UTI in out-patients, and the comparison between the genders are shown in Table 3.

Table 3. Cultures (%) of gram-negative rods isolated from out-patients*

Microorganisms	Male population		Female population	
	Total number of incidences	%	Total number of incidences	%
E. coli	13	39.39	58	68.23
Klebsiella pneumoniae	10	30.3	14	16.47
Proteus mirabilis	3	9.09	2	2.35
Serratia marcescens	2	6.06	3	3.52
Morganella morganii	0	0	1	1.17
Citrobacter spp.	0	0	3	3.52
Enterobacter spp.	0	0	1	1.17
Pseudomonas spp.	5	15.15	3	3.52

***percentage is calculated from gram-negative rods**

From gram-negative microorganisms, the most widespread are *E. coli* and *Klebsiella pneumoniae*, a glucose non-fermenting gram-negative bacterium, being the second most frequent representative of the family *Enterobacteriaceae.* Taking into account the gender, the

largest group of patients with UTI worldwide is women. They are more affected by *E. coli* than men (Table 3).

On the other hand, *E. coli* was the most frequent in males (39.39%), although females were affected comparatively more. When *K. pneumoniae* was considered, males were affected more (30.3%) than females (16.47%).

Antimicrobial susceptibility testing

The susceptibility of the isolated uropathogens to the panel of antimicrobials was tested on a regular basis.

In the present paper, the results of antimicrobial testing only for the most significant uropathogens – *E. coli*, *Pseudomonas* spp., and *Klebsiella* spp. are presented.

In the case of *E. coli*, 45% of isolates were resistant to ampicillin, 27.7% to trimethoprim/ sulfometoxazol, 14.1% to piperacillin, 12% to cefazolin, 4% to cefotaxime, ceftazidime, gentamicin and amikacin, 3.3% to nitrofurantoin, 2% to ciprofloxacin. No resistance was registered only to imipenem. Pseudomonads were highly resistant to all the tested antimicrobials. The highest resistance rates were registered to ampicillin/sulbactam – 100%, trimethoprim/sulfametoxazole – 82.6%, nitrofurantoin – 69.6%, piperacillin – 66.7%, ceftriaxone – 65.2%, cefataxime – 60.9%, cefperazone – 50%, ticarcillin – 47.6%, ciprofloxacin – 43.4%, norfloxacin – 42%, ceftazidime – 35.7%, imipenem – 25%, amikacin – 13.0%.

Klebsiella spp. were sensitive to amikacin, norfloxacin, imipenem. The highest resistance was found to ampicillin – 90%, trimethoprim/sulfametoxazol and cefazolin – 54.5%, amoxicillin/clavulanic acid – 62.5%, nitrofurantoin – 13%.

The analysis of polyresistance among the causative agents of UTI revealed the following. The highest rate of polyresistant isolates was registered in gram-negative non-fermenting rods. 72.5% of Pseudomonads and 1.9% of Acinetobacter occurred to be polyresistant. In the *Enterobacteriaceae* family, there were 53.8% of polyresistant strains among the isolated strains of the KES (Klebsiella, Enterobacter, Serratia) group and 56% of *Citrobacter freundii*. In the PMP (Proteus, Morganella, Providencia) group, 51.0% of strains were polyresistant, while only 18.5% of *E. coli* occurred to be polyresistant.

Conclusions

Gram-negative rods are the most widespread uropathogens. The leading agents are the representatives of the family *Enterobacteriaceae* - *E. coli* and *K. pneumoniae* as well as the non-fermentive genus Pseudomonas. Females were more affected by gram-negatives, especially *E. coli.* From the gram-positive flora, CoNS and *S. aureus* were isolated most often. No differences between the genders were found in the species spectrum. Polyresistance among gram-negative uropathogens is high.

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