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Urinary tract infections with alert pathogens in allogeneic kidney transplant recipients

Zakażenie układu moczowego szczepami alarmowymi u chorych po zabiegu przeszczepienia nerki

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Keywords

kidney transplantation, urinary tract infection, alert pathogens

Słowa kluczowe

przeszczepienie nerki, zakażenie układu moczowego, szczepy alarmowe

Summary

Introduction. Multidrug-resistant (MDR) urinary tract infections (UTI) are a major clinical problem after kidney transplantation.

Aim. Data analysis on the incidence, microbiology, risk factors as well as the effects of MDR UTIs on renal function.

Material and methods. The study included 132 renal transplant recipients with UTI.

Results. Positive cultures for alert patogen (AP) were obtained in 29.6% patients. The use of JJ stents was associated with an over 3-fold increase in the risk of MDR infections (OR = 3.69; $p < 0.007$). Positive culture for *Klebsiella*, *Enterococcus faecalis* and *faecium* was associated with an increased risk of obtaining AP. The odds ratios were as follows: 9.89 ($p < 0.001$), 2.57 ($p < 0.053$) and 11.13 ($p < 0.001$). *Escherichia coli* infection was associated with reduced risk of AP infection (OR = 0.12; $p < 0.001$). Community-acquired infections vs hospital-acquired infections was associated with 5 times higher risk of MDR (OR = 4.72; $p < 0.001$). The risk of infection with AP in patients admitted immediately after KTx was over 10-fold higher compared to those hospitalized for 'other reasons' (OR = 10.20; $p < 0.007$). Patients infected with AP had worse renal function on admission ($p < 0.001$) compared to those infected with non-alert pathogens. However, no significant differences in renal function were found between patients infected with AP and those infected with non-alert pathogens at the end of hospitalization ($p < 0.091$).

Conclusions. MDR UTI have become an important clinical problem in patients after kidney transplantation, every efforts should be made to reduce their occurrence.

Streszczenie

Wstęp. Zakażenie układu moczowego szczepami alarmowymi u chorych po zabiegu przeszczepienia nerki stanowi istotny problem kliniczny.

Cel pracy. Ocena częstości występowania, czynników ryzyka oraz wpływu rodzaju szczepu alarmowego wywołującego zakażenie układu moczowego (UTI) na czynność nerki przeszczepionej.

Materiał i metody. Analizie poddano 132 chorych po zabiegu przeszczepienia nerki hospitalizowanych z powodu UTI.

Wyniki. Dodatni wynik posiewu moczu szczepami alarmowymi uzyskano u 29,6% chorych z UTI. Obecność cewnika JJ była związana z ponad 3-krotnie zwiększonym ryzykiem rozwoju UTI szczepami alarmowymi (OR 3,69; $p < 0,007$). UTI wywołane *Klebsiella*, *Enterococcus faecalis*, *faecium* było związane ze zwiększonym ryzykiem rozwoju szczepów alarmowych, OR wynosiło odpowiednio: 9,89 ($p < 0,001$), 2,57 ($p < 0,053$) oraz 11,13 ($p < 0,001$). UTI wywołane przez *Escherichia coli* było związane ze zmniejszonym ryzykiem rozwoju szczepu alarmowego OR 0,12 ($p < 0,001$). Zakażenie szpitalne, okres bezpośredni po transplantacji nerki były związane odpowiednio z 5-krotnie (OR 4,72; $p < 0,001$) oraz ponad 10-krotnie (OR 10,20; $p < 0,007$) zwiększonym ryzykiem powstania szczepu alarmowego. Chorzy zakażeni szczepami alarmowymi przy przyjęciu do szpitala mieli wyjściowo gorszą czynność nerki przeszczepionej w porównaniu z chorymi zakażo-

Conflict of interest
Konflikt interesów

None
Brak konfliktu interesów

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nymi szczepem niealarmowym ($p < 0,001$), aczkolwiek nie obserwowano istotnej różnicy w czynności przeszczepu nerkowego pomiędzy chorymi z UTI wywołanymi szczepami alarmowymi w porównaniu z chorymi z UTI wywołanym przez szczepy niealarmowe pod koniec hospitalizacji.

Wnioski. Zakażenia układu moczowego szczepami alarmowymi stanowią coraz większy problem kliniczny. Należy opracować odpowiednią politykę postępowania z taki chorymi, aby ograniczyć częstość ich występowania.

Urinary tract infection (UTI) in kidney transplant recipients is one of the most common infectious complications encountered in both in- and outpatient setting (36-75%), with about 30% of UTI patients developing sepsis. UTIs can also promote cytomegalovirus (CMV) infections and acute graft rejection as well as exert adverse indirect effects on transplanted kidney function (1, 2).

As a result of recurrent infections and broad-spectrum antibiotic therapy, alert pathogens able to develop defense mechanisms against different groups of antibiotics are often isolated. Microbial resistance to antibiotics is determined by genetic information encoded in chromosomes and/or transportable elements (plasmids, integrons, transposons). Bacterial resistance to a certain group of antibiotics can be intrinsic or acquired via genetic processes (mutations, transfer of genetic information through direct cell-to-cell contact) (3). Microbial resistance to drugs is currently one of the major problems in UTI antibiotic therapy, particularly in hospital-acquired infections. Hospital-acquired UTIs account for 40% of all hospital-acquired infections, including 82% of Gram-negative infections. Hospitalized UTI patients are a reservoir for typical hospital bacterial strains, which are more resistant to antibiotics compared to strains causing other infections (4). The most common mechanisms of antibiotic resistance include:

- ESBL (extended-spectrum β-lactamases) – most often found in *Escherichia coli*, *Klebsiella* spp., *Enterobacter* spp., *Seratia* spp. and *Proteus mirabilis*. They confer resistance to penicillins and cephalosporins (except for cephamycins). Of lactam antibiotics, only carbapenems (imipenem, meropenem) are active against these bacterial strains. They probably account for about 40% of UTIs in renal transplant recipients,
- HLAR (high-level aminoglycoside resistance) – the resistance to high aminoglycoside concentrations is acquired and results from the effects of enzymes that modify aminoglycosides. Isolated from *Enterococcus* strains (*Streptococcus*, *Enterococcus faecalis* and *Enterococcus faecium*), which are naturally resistant to cephalosporins and low aminoglycoside concentrations,
- VRE (vancomycin resistant *Enterococcus*) – resistance to vancomycin and teicoplanin in *Enterococcus* strains, which is a major therapeutic problem in hospital-acquired infections,
- MRCNS – methicillin-resistant coagulase-negative *Staphylococcus*,
- KPC (*Klebsiella pneumoniae* carbapanemase) – strains of Enterobacteriaceae resistant to carbapenems (imipenem, meropenem, ertapenem) as well as other β-lactam antibiotics (penicillins, cephalosporins). Isolated among the strains of Enterobacteriaceae as well as the family of *Pseudomonas*, *Acinetobacter*,
- MRSA – methicillin resistant *Staphylococcus aureus*,
- AmpC – chromosomal cephalosporinases (constitutive or inducible) – resistance mechanism resulting from the production of chromosomal cephalosporinase encoded by the AmpC gene (AmpC β-lactamase). Most often isolated among *E. coli* and *Klebsiella* spp. (5).

Therefore, data analysis on the incidence, microbiology, risk factors as well as the effects of alert pathogen-related UTIs on the function of the transplanted kidney seems to be important not only for medical, but also economic reasons as the costs of both diagnostics and treatment in alert pathogen-related UTIs require considerable financial resources (2, 6-8).

AIM

Data analysis on the incidence, microbiology, risk factors and influence of AP on the renal function of transplanted kidney.

MATERIAL AND METHODS

The study included 132 renal transplant recipients hospitalized in the Department of Transplantation Medicine, Nephrology and Internal Medicine between 2010 and 2011, with a positive bacteriological culture and diagnosed UTI on admission. Patients with asymptomatic bacteriuria were excluded from the analysis. Data for the study group is shown in table 1.

We have analyzed selected factors potentially determining infections with alert pathogens. These included patient's medical history (age, sex, BMI, HD duration), perioperative factors such as the use of induction (ATG Fresenius, Thymoglobulin), urinary tract defects, the need for JJ catheter, the reason for hospitalization, hospitalization-related events as well as the type of bacteria present in the urine.

A midstream specimen of urine was collected into a sterile container following a thorough washing of the external genitalia. The urine samples were then either delivered to a microbiological laboratory within 2 hours or stored in the Department for up to 24 hours at 4°C, and then sent to a microbiological laboratory. Urine culture was performed in the Department of Microbiology, Medical University of Warsaw. Data collection

Tab. 1. Characteristics of the study group

Factors	n	x ± SD or percentage (%)	Median	Q1-Q3
Age (years)	132	49.0 ± 14.2	51.3	37.4-59.2
BMI (kg/m^2)	108	24.2 ± 4.6	23.8	20.6-26.5
Female sex	132	67.4%		
Total HD duration (years)	129	2.8 ± 2.0	2.0	1.0-4.0
Recurrent UTIs	132	61.4%		
Post-transplantation diabetes mellitus	130	15.4%		
ATG/ Thymoglobulin	132	5.3%		
JJ stent	132	16.7%		
Urinary tract defects	132	11.4%		
Hospital-acquired infections	132	31.8%		
Reinfection	132	37.9%		
Sepsis	131	29.8%		
Reasons for hospitalization: UTI KTx	 132 132	 57.6% 20.5%		
Deterioration in renal function	132	11.4%		
Other	132	10.6%		
Creatinine levels (mg/dl)	132	2.9 ± 2.1	2.1	1.6-3.4
eGFR (ml/min/1.73 m^2)	132	28.8 ± 15.7	26.9	16.7-38.8
Alert pathogens	132	29.6%		

x ± SD – mean value ± standard deviation

was based on a thorough analysis of medical history.

A total of 132 positive urine cultures were obtained in renal transplant recipients who were admitted to the Department due to: UTI, treatment continuation immediately after kidney transplantation (KTx), deterioration in renal function as well as other reasons, such as: transplanted kidney biopsy, anemia, the need for JJ stent placement, weight loss, diarrhea, leukopenia, pleural effusion. Patients with UTI were included in the analysis – every patient could have a medical history of multiple urinary tract infections in the studied period, but only the first infection was evaluated.

Statistical analysis

Statistical analysis was performed to investigate the relationship between factors describing the condition of the patient (age, sex, BMI), pre-hospitalization and hospitalization conditions (diabetes, total HD duration, UTI recurrence, reinfection, the presence of JJ stent, ATG/Thymoglobulin treatment, reasons for hospitalization, hospital-acquired infections, urinary tract defects), medical management after admission and assays: alert pathogens, sepsis, creatinine and eGFR. Logistic regression analysis was used for this purpose. The strength of the relationship between the assessed factors and the risk of infection with alert pathogens was expressed as the odds ratio (OR) with 95% confidence interval (95% CI). In order to assess the differences in creatinine levels and eGFR, the significance of the differences in these parameters (Wilcoxon signed-ranks test) was evaluated for each group, followed by their comparison between the groups of alert and non-alert pathogens (Mann-Whitney U test). The results are presented as a mean value ± SD and as a median with quartile 1 and quartile 3.

Calculations were performed in the Department of Epidemiology using SAS 9.4 (9). The methodology of the study was based on the textbook by van Belle et al. (10).

RESULTS

Between 2010 and 2011, UTIs were observed in 8.9% of patients after kidney transplantation, hospitalized in the Department of Transplantation Medicine and Nephrology. Among these patients (n = 132), positive cultures for alert pathogens were obtained in 39 patients (29.6%). Characteristics of the study group are presented in table 1, 2.

It was found that the risk of a positive culture for alert pathogen in women was 63% lower compared to men (OR = 0.37; 95% CI = 0.17-0.80; $p < 0.012$). None of the other factors in medical history (age, BMI, total HD duration) was significantly associated with an increased risk of alert pathogen infection. Details are presented in table 3.

Peritransplantation factors, such as the presence of JJ stent, induction therapy with antithymocyte globulin and anti-CD25 antibodies, urinary tract defects, antithymocyte globulin treatment for acute rejection were also included in the analysis of the risk of alert pathogen-related infections. Only the use of JJ stents was significantly associated with an over 3-fold increase in the risk of alert pathogen-related infections (OR = 3.69; $p < 0.007$). Details are presented in table 4.

As opposed to other bacterial strains, a positive culture for *Klebsiella*, *Enterococcus faecalis* and *faecium* was associated with an increased risk of obtaining alert pathogens. The odds ratios were as follows: 9.89 ($p < 0.001$), 2.57 ($p < 0.053$) and 11.13 ($p < 0.001$). *E. coli* infection, on the other hand, was associated with a significantly reduced risk (by 88%) of alert pathogen infection ($p < 0.001$). Details are presented in table 5.

As opposed to community-acquired infections, hospital-acquired infections was associated with an almost 5 times higher risk of alert pathogen infection (OR = 4.72; $p < 0.001$). Details are presented in table 6.

Patients with positive urine culture were classified into the following groups on the basis of the reason for

Tab. 2. Characteristics of the study group with classification into alert and non-alert pathogens

Factors	Alert pathogens (n = 39)		Non-alert pathogens (n = 93)		p#
	x ± SD or percentages (%)	median (Q1-Q3)	x ± SD or percentages (%)	median (Q1-Q3)	
Age (years)	59.9 ± 14.1	51.3 38.9-61.4	48.3 ± 14.2	51.3 36.4-58.9	0.504
BMI (kg/m^2)	24.3 ± 4.1	24.4 20.4-26.8	24.2 ± 4.8	23.4 20.8-26.2	0.518
Female sex	51.3%		74.2%		0.014#
Total HD duration (years)	2.6 ± 1.8	2.0 2.0-4.0	2.8 ± 2.1	2.0 1.0-4.0	0.844
Post-transplantation diabetes mellitus	10.5%		17.4%		0.427
ATG/Thymoglobulin	7.7%		4.3%		0.421
JJ stent	30.8%		10.8%		0.009#
Urinary tract defects	15.4%		9.7%		0.375
Hospital-acquired infections	56.4%		21.5%		0.000#
Recurrent UTIs	69.2%		58.1%		0.247
Reinfection	41.0%		36.6%		0.696
Sepsis	34.2%		28.0%		0.530
Reasons for hospitalization: UTI KTx	 41.0% 43.6%		 64.5% 10.8%		 0.020# 0.000#
Deterioration in renal function	10.3%		11.8		1.000
Other	5.1%		12.9%		0.230
Creatinine levels (mg/dl)	4.0 ± 2.6	2.9 2.0-5.8	2.4 ± 1.7	1.9 1.5-2.8	0.000#
eGFR (ml/min/1.73 m^2)	21.8 ± 14.4	19.6 8.1-32.3	31.8 ± 15.3	29.7 20.2-41.6	0.001#

#the level of significance for the Mann-Whitney U test (a comparison of medians), mean values or Fisher's exact test

Tab. 3. The risk of infection with alert pathogens. Demographics

Medical history	Alert pathogens (%/n)	OR	95% CI	p-value
Sex Male Female	 42.2 (19) 22.5 (20)	 1.00 0.37	 0.17-0.80	 0.012#
Age (per 1 year)	50.9 ± 14.1	1.01	0.99-1.04	0.339
BMI (per 1 kg/m^2)	24.3 ± 4.1	1.01	0.92-1.10	0.857
Total HD duration (per 1 year)	2.0 (2.0-4.0)	0.92	0.78-1.08	0.299

#istotność statystyczna (p < 0.05)

Tab. 4. The risk of infection with alert pathogens. Peritransplantation factors

Peritransplantation factors	Alert pathogens	OR	95% CI	p-value
Post-KTx induction: – +	 31.6% (36) 16.8% (3)	 1.00 0.43	 0.12-1.59	 0.208
ATG Fresenius/ Thymoglobulin: – +	 28.8% (36) 42.86% (3)	 1.00 1.86	 0.40-8.70	 0.434
JJ stent: – +	 24.5% (27) 54.5% (12)	 1.00 3.69	 1.43-9.49	 0.007#
Urinary tract defects: – +	 28.2% (33) 40.0% (6)	 1.00 1.70	 0.56-5.14	 0.350

#istotność statystyczna (p < 0.05)

Tab. 5. The type of bacteria predisposing to alert pathogen-related UTIs

Cultured pathogen	Alert pathogens# (%)	OR	95% CI	p-value
E. coli: – +	 53.6% (30) 11.8% (9)	 1.00 0.12	 0.05-0.28	 < 0.001#
Klebsiella: – +	 23.3% (27) 75.0% (12)	 1.00 9.89	 2.95-33.19	 < 0.001#
Enterococcus faecalis: – +	 26.1% (29) 47.6% (10)	 1.00 2.57	 0.99-6.68	 0.053
Enterococcus faecium: – +	 22.6% (26) 76.5% (13)	 1.00 11.13	 3.34-37.04	 < 0.001#
Other bacteria: – +	 31.7% (21) 22.6% (18)	 1.00 0.63	 0.25-1.61	 0.334

#the rate of infections with alert pathogens for those infected and uninfected with the study pathogens

Tab. 6. The risk of alert pathogen-related infection depending on the type of infection: hospital-acquired vs. community-acquired

The type of infection	Alert pathogens	OR	95% CI	p-value
Infection: community-acquired hospital-acquired	 18.9% (17) 52.4% (22)	4.72	2.12-10.55	< 0.001#

#istotność statystyczna (p < 0.05)

hospital admission: UTI (n = 76), hospitalization immediately after kidney transplantation (KTx) (n = 27), deterioration in renal function (n = 15) as well as other reasons (n = 14): biopsy (n = 4), anemia (n = 2) and other causes (n = 8) such as JJ stent placement, body weight loss, diarrhea, leukopenia, pleural effusion. The risk of infection with alert pathogens in patients admitted immediately after KTx was over 10-fold higher compared to those hospitalized for 'other reasons' (OR = 10.20; p < 0.007) (tab. 7). No significant differences in relation to the risk of alert pathogen-related infection were observed between the UTI group or the group of patients hospitalized due to deterioration in renal function and 'hospitalization for other reasons'. Also, hospitalization due to recurrent UTI, reinfection and diabetes as well as a history of sepsis had no significant effects on the incidence of alert pathogen infections. Details are presented in table 7.

Tab. 7. The risk of alert pathogen-related infection depending on the reason for hospitalization and admission-related events

Factors	Alert pathogens (%)	OR	95% CI	p
Reasons for hospitalization:				
other	14.3% (2)	1.00		
UTI	21.1% (16)	1.60	0.33-7.89	0.564
KTx	63.0% (17)	10.20	1.89-55.19	0.007#
Deterioration in renal function	26.7% (4)	2.18	0.33-14.36	0.417
Admission-related events				
UTI recurrence on admission:				
–	23.5% (12)	1.00		
+	33.3% (27)	1.63	0.73-3.60	0.231
Reinfection on admission:				
–	28.1% (23)	1.00		
+	32.0% (16)	1.21	0.56-2.59	0.630
Post-transplantation diabetes mellitus:				
–	30.9% (34)	1.00		
+	20.0% (4)	0.56	0.17-1.80	0.329
Sepsis:				
–	27.2% (25)	1.00		
+	33.3% (13)	1.34	0.60-3.01	0.478

#istotność statystyczna (p < 0.05)

The relationship between alert pathogen-related urinary tract infection and transplanted kidney function based on glomerular filtration rate (eGFR) was also assessed. The eGFR median was 19.6 ml/min/1.73 m^2 at the onset of infection and 31.8 ml/min/1.73 m^2 after recovery in patients with UTIs caused by alert pathogens (tab. 8). Renal function improvement was observed in both, patients infected with alert and non-alert pathogens.

Patients infected with alert pathogens had significantly worse renal function on admission (p < 0.001) compared to those infected with non-alert pathogens. However, no significant differences in renal function were found between patients infected with alert pathogens and those infected with non-alert pathogens at the end of hospitalization (p < 0.091). Details are presented in table 8.

DISCUSSION

Urinary tract infections, particularly those caused by multidrug-resistant alert pathogens, are a major clinical problem in patients after kidney transplantation. These infections not only require hospitalization and increase treatment costs, but they also involve higher risk of graft rejection or death.

In our department between 2010 and 2011, UTIs were observed in 8.9% of patients hospitalized due to: UTI, treatment continuation immediately after kidney transplantation (KTx), deterioration in renal function as well as other reasons, such as: transplanted kidney biopsy, anemia, the need for JJ stent placement, weight loss, diarrhea, leukopenia, pleural effusion. A similar incidence of UTIs (6.8 up to 7.3%) in kidney transplant recipients is also reported by other authors (Singh et al.) (11). Between 2010 and 2011, UTIs due to alert pathogens were observed in up to 1/3 of patients hospitalized in our department. A similar and even higher incidence of UTIs caused by alert pathogens (47%) was observed by Pilmis et al. (12). Unfortunately, an increasing trend in the incidence of UTIs caused by alert pathogens, including those resistant to carbapenems (13) has been observed recently. In our study, only 2 cases of UTI caused by strains resistant to carbapenems were observed (data not shown).

Multiple risk factors predisposing to UTI, including infections caused by alert pathogens, occur in patients after kidney transplantation. Our analysis showed that UTIs caused by alert pathogens were significantly more common in men compared to women. Although other authors (Lim et al.) tend to show higher incidence of UTIs in females (14), researchers from Gdańsk reported higher incidence of UTIs related to ESBL-producing *Klebsiella* spp. in men (15). Perhaps prostatic

Tab. 8. Comparison of renal function during hospitalization

eGFR ml/min/1.73 m^2	Alert pathogens				Non-alert pathogens				p#
	n	x ± SD	Median	Q1-Q3	n	x ± SD	Median	Q1-Q3	
During UTI	39	21.8 ± 14.4	19.6	8.1-32.3	93	31.8 ± 5.3	29.7	20.2-41.6	0.001
After recovery from UTI	38	34.6 ± 18.0	31.8	20.5-48.8	92	40.9 ± 17.9	38.7	26.2-54.6	0.091
Delta eGFR	38	12.3 ± 13.0	7.3	2.6-17.3	92	8.9 ± 11.2	5.6	0.8-14.2	0.195

#the level of significance for the Mann-Whitney U test (a comparison of medians)

hyperplasia, which is often observed in this group of patients, and which can be a potential site for colonization by bacteria that are difficult to eradicate, is the cause of the high incidence of alert pathogen-related UTIs in this group of patients.

It was also shown that ureteral stenting with JJ catheter causes a 3-fold increase in the risk of alert pathogen-related UTIs. The JJ stent is also reported by other researchers as a risk factor for UTIs (16-18). A "preventive" insertion of JJ stents during the peritransplantation period to avoid potential ureteral stenosis in the transplanted kidney, and thus impaired urine flow in the early post-transplantation period, is a routine management in many transplantation centers (19). In the light of our findings, it seems that this practice should be revised and JJ stenting should be limited only to necessary indications in the case of high risk of ischemic ureteral stenosis or if such a stenosis has already occurred.

The highest risk of urinary tract infection with alert pathogens was observed for *Enterococcus faecium* (11 times more common) and *Klebsiella pneumoniae* (10 times more common). UTIs due to alert pathogens were significantly more common for *Enterococcus faecalis* (2.6 times more common). *Escherichia coli*-induced UTIs involved a reduced risk of alert pathogen-related infection in our patient population compared to patients not infected with this pathogen. *E. coli* is often described as resistant to antibiotics (20). This data should be considered when establishing policy for the use of antibiotics to prevent UTIs in the early peritransplantation period and when making decisions on antibiotic treatment. Patients with UTIs caused by alert strains of *Enterococcus faecium* or *Klebsiella pneumoniae* should be isolated during hospitalization and receive through education. Also, appropriate preventive measures to reduce the spread of infections should be implemented.

It was also shown that alert pathogen-related UTIs were 5 times more common in the case of hospital-acquired infections compared to community-acquired infections. Similar findings were reported by other authors (21). It therefore seems necessary to minimize the length of hospitalization in order to reduce this risk factor for alert pathogen-related UTIs. Early post-transplantation period was also a risk factor for alert pathogen-related UTIs. This may result from the strong immunosuppression in the early post-transplantation period, the need for preventive antibiotic therapy or the therapeutic management of infections associated not only with the urinary tract (22).

It was also found that despite baseline differences in eGFR between groups of patients with alert pathogen-related UTIs vs. non-alert pathogen-related UTIs (to the benefit of the latter), comparable treatment outcomes in terms of glomerular filtration rate were achieved (tab. 8). All patients received empiric antibiotic therapy at baseline, which was adjusted if necessary, depending on antibiogram results or the clinical response. These findings indicate a well-established antibiotic policy for alert pathogen-related UTIs in our center. Deterioration in the function of the transplanted kidney, which can adversely affect the distant graft function, has also been observed by many authors (Espinar et al.) (23). It probably results from dehydration during fever or severe infection due to tubulointerstitial inflammation in the transplanted kidney.

We have observed no effects of antithymocyte globulin therapy, urinary tract defects, diabetes or sepsis on the incidence of alert pathogen-related UTIs. This was observed by many, although not all, researchers (23). This may be due to the small size of groups of patients with the above-mentioned conditions in the study population.

UTI recurrence on admission and reinfections occurred in about 1/3 of patients. These findings correspond to the findings of other authors (Lim et al.) (14). Although neither UTI recurrence nor reinfections were risk factors for alert pathogen-related UTIs in the study group of patients, such relationships have been observed by many researchers (14, 24). Again, it was probably the small sample size of patients that did not allow to demonstrate such relationships.

CONCLUSIONS

Between 2010 and 2011, UTIs were observed in 8.9% of patients hospitalized in the Department of Transplantation Medicine, Nephrology and Internal Medicine, with alert pathogen-related infections diagnosed in almost 1/3 of patients (29.6%). An increased risk of harboring alert pathogens was observed in men, patients requiring the use of JJ stent, patients with positive urine culture of *Klebsiella*, *Enterococcus faecalis* and *Enterococcus faecium*, patients with hospital-acquired UTI as well as kidney recipients in the early post-transplantation period (the perioperative period). *E. coli* infections were associated with a decreased risk of harboring alert pathogens. Since alert pathogen-related urinary tract infections have become an important clinical problem in patients after kidney transplantation, every efforts should be made to reduce their occurrence. The present study aimed to assess the scale of the problem in our department as well as to determine risk factors associated with their occurrence. This was a retrospective study. Prospective studies are needed to assess the effects of modifiable risk factors on alert pathogen-related UTIs.

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