

Urinary Tract Infections and Asymptomatic Bacteriuria in Renal Transplant Recipients

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ABSTRACT

Asymptomatic bacteriuria and urinary tract infection are common complications after kidney transplantation. In this population, if urinary tract infection occurred in the first six months post procedure, it carries a grave impact on both graft and patient survival. Renal transplant recipients with urinary tract infection are often clinically asymptomatic as a consequence of immunosuppression. Urinary tract infection, however, may progress to acute pyelonephritis, bacteremia and the full blown picture of urosepsis. PubMed and Cochrane databases were searched. The purpose of this review is to discuss the screening and treatment of urinary tract infection and asymptomatic bacteriuria in renal transplant recipients and to evaluate the guidelines on the basis of a review of published evidence.

Key words: Asymptomatic bacteriuria, Graft survival, Renal transplantation, Screening, Urinary tract infection, Uropathogens

REVIEW CRITERIA

PubMed and Cochrane databases were searched for articles including early release publications. Search terms included asymptomatic bacteriuria, urinary tract infection, renal transplant, kidney transplant, and renal transplant infections. Abstracts of retrieved citations were reviewed and prioritized by relevance. Full articles were obtained and reference lists were reviewed for additional articles when appropriate. Efforts to identify ongoing trials included searches for published protocols on clinical trials registry (available at <http://clinicaltrials.gov/ct2/home>). Clinical studies include prospective, randomized clinical trials, prospective cohort studies, case-control studies, and other descriptive studies. Studies were excluded if the study population was not adequately characterized to assess generalizability, or if there were insufficient numbers of patients enrolled to support valid statistical analysis. Inclusion criteria included all articles studying asymptomatic bacteriuria, urinary tract infection in renal transplant recipients regarding prevalence, incidence,

treatment, prophylaxis, and complications. Figure 1 illustrates the search methodology.

INTRODUCTION

Asymptomatic bacteriuria is a common complication after renal transplantation and the need for antibiotic therapy is controversial. If urinary tract infection (UTI) occurred in this population it has proved harmful effect on allograft function and survival, in addition to infectious complications and bacteremia.^[1] The bacteremia-associated mortality of kidney allograft recipients is around 11% during the first month post transplant.^[2] On the other hand, if treating asymptomatic bacteriuria would not be of any benefit it may impose a burden of potential side effects as well as the excessive costs on these patients. In this review we present the rationale behind identifying and treating special groups of patients with asymptomatic bacteriuria, especially renal transplant recipients.

Definition: To diagnose a patient with bacteriuria, whether it was symptomatic or asymptomatic, the presence of pyuria (≥ 10 leukocytes/mm³ of uncentrifuged urine) is not sufficient.^[3-5] Asymptomatic bacteriuria is defined as isolation of a specified quantitative count of bacteria in an appropriately collected urine specimen from an individual

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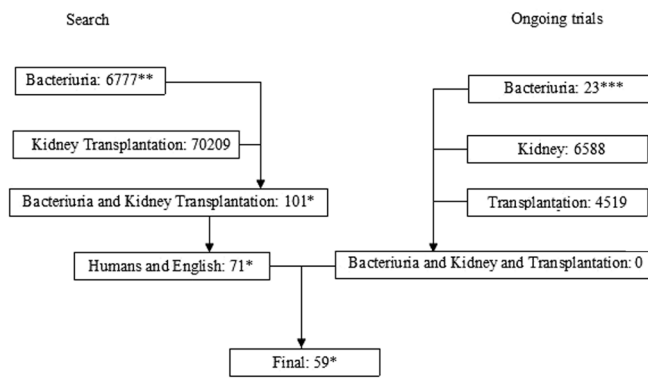


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* All articles were reviewed in full text.

** All clinical trial abstracts (512) were reviewed.

*** All study protocols were reviewed as provided in the website.

Figure 1: Search methodology

without symptoms or signs of urinary tract infection. It may precede symptomatic urinary tract infection, which is characterized by dysuria, frequency, pain, and fever. The quantitative thresholds are different for voided clean catch specimens and catheterized specimens. Two consecutive positive tests are needed in women to make the diagnosis compared to one single positive test in men.

Bacteriuria in women is defined by the 2005 Infectious Diseases Society of America (IDSA) guidelines as two consecutive clean-catch voided urine specimens with isolation of the same organism in quantitative counts of $\geq 10^5$ cfu/mL. Based on the fact that external contamination during voiding among men is an extremely unlikely cause of significant bacteriuria, the 2005 IDSA guidelines defined bacteriuria in men as a single clean-catch voided urine specimen with isolation of a single organism in quantitative counts of $\geq 10^5$ cfu/mL. Bacteriuria is also defined by the IDSA guidelines as a single specimen with isolation of a single organism in quantitative counts of $\geq 10^2$ cfu/mL obtained by urethral catheterization.^[6]

EPIDEMIOLOGY AND RISK FACTORS

Asymptomatic bacteriuria is common, but the prevalence in populations varies widely with age, sex, and the presence of genitourinary abnormalities.

In women: The prevalence of asymptomatic bacteriuria among healthy women increases with advancing age, from about one percent among schoolgirls to $>20\%$ among women over 80 years residing in the community.^[3, 7-8]

There is no significant difference regarding the prevalence of asymptomatic bacteriuria between pregnant and non-pregnant women,^[8] while sexual activity was found to

increase the incidence and prevalence of the disease.^[9]

In men: Asymptomatic bacteriuria is rare among healthy young men,^[10] but prevalence increases with advancing age to reach about six percent at 60 years of age and to 15% of men over 75 years of age.^[8]

Prevalence among diabetic women is 8–14% higher than the prevalence in the general population and is usually correlated with duration and presence of long term complications of diabetes.^[11] This is not the case of diabetic male patients.^[12]

Irrespective of sex, patients with indwelling urinary devices, permanent ureteric stent, spinal cord injuries and on hemodialysis are at increased risk of having asymptomatic bacteriuria.^[6] Short-term indwelling urethral catheters acquire bacteriuria at the rate of two to seven percent per day,^[13] this risk reaches 100% in patients with long term indwelling urethral catheters and patients with permanent ureteric stent.^[14-15] Patients with spinal cord injury have a prevalence of $>50\%$.^[16-17] Patients undergoing hemodialysis have a prevalence of asymptomatic bacteriuria of 28%.^[18] Twenty five percent to 50% of elderly women and 15%–40% of elderly men in long-term care facilities are bacteriuric.^[19]

In renal transplant recipients, risk factors include pretransplant UTI, prolonged period of hemodialysis before hospitalization, polycystic kidney disease, diabetes mellitus, postoperative bladder catheterization, immunosuppression, allograft trauma, cadaveric donor, history of vesicoureteral reflux, and technical complications associated with ureteral anastomosis. Female transplant recipients have twice the incidence of male transplant recipients. Other post transplant risk factors of having delayed UTI ($>$ six months post procedure) include patients with serum creatinine levels >2 mg/dL, a daily prednisone dose >20 mg, multiple rejection therapy, or chronic viral infection.^[20]

PATHOPHYSIOLOGY

In general population

The absence of symptoms in patients with asymptomatic bacteriuria could reflect characteristics specific to the pathogen, the host or both. Some bacteria needs specific mechanism to cause symptomatic disease, such as attachment of bacteria via fimbrial adhesions, while some others with reduced capability for fimbriae expression appear to have the capacity for relatively rapid growth that thus allows them to cause asymptomatic bacteriuria.^[21] Also,

many organisms that cause asymptomatic bacteriuria may be less virulent.^[22-25]

The absence of symptoms in patients with asymptomatic bacteriuria could also reflect differences in the host response. Lower levels of neutrophil Toll-like receptor 4 (TLR4) expression, which controls the mucosal response to *Escherichia coli* (*E. coli*),^[26] was found in patients with asymptomatic bacteriuria.^[26-27] The microbiology of asymptomatic bacteriuria is similar to that of cystitis and pyelonephritis with *E. coli* being the most offending organism. Fungi and viruses can also cause UTIs, but infections caused by these organisms are less common than those caused by bacteria.

In renal transplant recipients

Gram-negative bacterial infections account for more than 70% of UTI and *E. coli* is the most common clinical isolate in patients with UTIs; not only in the general population but also after kidney transplantation.^[28] Enterobacteriaceae, enterococci, staphylococci, and pseudomonas are commonly found pathogens. Other less frequent microorganisms are Salmonella, *Candida*, and *Corynebacterium urealyticum*. It is also important to remember the possibility of infection caused by unusual pathogens such as *Mycoplasma hominis*, *Mycobacterium tuberculosis*, or BK virus (a member of the polyomavirus family) and JC virus (John Cunningham virus formerly known as papovavirus).^[29] Polyomavirus was described as a cause of interstitial nephritis, mainly in patients receiving mycophenolate mofetil (MMF).^[30] Salmonella and *C. urealyticum* are important usually unrecognized uropathogen in renal transplant recipients.^[31-32] *Candidal* UTIs can have serious consequences and may cause ascending infection and/or obstructing fungal balls at the ureterovesical junction. Thus, it is general practice to treat even asymptomatic candiduria in renal transplant recipients.^[33] A large proportion (63–100%) of *E. coli* isolates from renal allograft recipients have been shown to be resistant to trimethoprim and sulfamethoxazole, which raises the question of the effectiveness of using these medications prophylactically.^[34-35]

SCREENING AND TREATMENT IN NON RENAL TRANSPLANT RECIPIENTS

U.S. Preventive Services Task Force (USPSTF),^[36] recommends screening for asymptomatic bacteriuria with a urine culture for pregnant women at 12–16 weeks of gestation, and concluded that there is insufficient evidence to recommend for or against routine screening

for asymptomatic bacteriuria with leukocyte esterase or nitrite testing in ambulatory elderly women, women with diabetes, asymptomatic school-aged girls, or adults.

Infectious Diseases Society of America Guidelines for the diagnosis and treatment of asymptomatic bacteriuria in adults (IDSA)^[6] recommends: All pregnant women should be screened for bacteriuria by urine culture at least once in early pregnancy, and they should be treated if the results are positive (level of evidence A-I). Screening for and treatment of asymptomatic bacteriuria is warranted for patients undergoing transurethral resection of the prostate (level of evidence A-I) and other urologic procedures in which mucosal bleeding is anticipated (level of evidence A-III). No recommendation can be made for screening for or treatment of asymptomatic bacteriuria in renal transplant or other solid organ transplant recipients (level of evidence C-III).

To reduce the development of antibiotic resistance, many experts advise against treating asymptomatic bacteriuria in cases other than those recommended.^[37] Non pregnant premenopausal women with asymptomatic bacteriuria are at increased risk for symptomatic urinary tract infection,^[3] but treatment does not reduce the frequency of symptomatic infection or recurrent asymptomatic bacteriuria,^[7, 38] nor it does affect their survival or kidney function.^[7, 39]

URINARY TRACT INFECTIONS AND ASYMPTOMATIC BACTERIURIA IN RENAL TRANSPLANT RECIPIENTS

Prevalence

Asymptomatic bacteriuria in renal-transplant recipients in the early post-transplantation period is a serious disease. In this group, it is harmful secondary to the profound neutropenia these patients have, and adverse outcomes can be prevented with antimicrobial-drug therapy.

In all renal transplant patients, an induction therapy is used to decrease the rate of rejection along with maintenance therapy. Of the used protocols thymoglobulin, a potent lymphocyte depleting agent, and basiliximab, a non lymphocyte depleting agent, both increases the risk of urinary tract infection post transplant. On the other hand, Campath-1H, a humanized CD52 specific cytotoxic IgG1 monoclonal antibody with complement fixing activity, was reported to have reduced overall infections in renal transplant recipients when compared to the previous protocols.^[40-41] After the transplant procedure, patient remain on maintenance immunosuppressive therapy for

lifelong, most common used regimen is a combination therapy of tacrolimus and MMF with or without prednisone. Tacrolimus-based immunosuppression in conjunction with azathioprine and corticosteroids following kidney transplantation was assessed in a Phase III randomized, multicenter, non-blinded, prospective study. A study based on tacrolimus in conjunction with azathioprine and corticosteroids showed that 34% of patients had UTI, while subjects treated with tacrolimus-based immunosuppression in conjunction with MMF and corticosteroids had UTI in a rate of 26%.^[42]

Symptoms

The clinical presentation of early post-transplantation UTI is variable. Asymptomatic bacteriuria may precede symptoms, whereas others present with fever, chills, and graft pain and tenderness. Allograft dysfunction can also occur in this setting.

Morbidity and mortality

The effect of bacteriuria on transplant recipients can be divided into its effect on morbidity and mortality caused by the infection; and second, potential effects of infection on developing rejection and its clinical course.^[43] Risk of bacteremia accompanying UTI in these patients is nearly 12% and gram negative bacteria are the most common pathogens; however, gram positive bacteria such as *Enterococcus* and *Staphylococcus* could also cause bacteremia.^[44]

UTI is very common in the first weeks after transplantation. If left untreated, it often results in pyelonephritis and bacteremia.^[45] Thus, treatment should be started with parenteral antibiotic therapy and be continued until the culture is negative. Thereafter, depending on the sensitivity of organism, the oral antibiotic therapy should be administered for 2 to 6 weeks. Urinary infection in outpatients during the first three months after renal transplantation should be also treated with oral antibiotic therapy for six weeks. A shorter treatment period of 10 to 14 days is usually accompanied by higher risk of recurrence.^[46]

Abbott *et al*,^[43] analyzed 33,479 renal transplant recipients in the United States using renal data system from 1994 to 1997, and found that renal transplant recipients had an adjusted incidence ratio of hospitalizations for septicemia of 41.52. Of these hospitalizations, UTI was the cause of septicemia in 30.6% of cases. They also found that recipients hospitalized for septicemia had a mean patient survival of 9.03 years compared to 15.73 years for those who never had UTI.

Graft outcome

Muller *et al*,^[11] retrospectively analyzed the role of UTI and its impact on long-term graft survival in renal transplant recipients. They studied 225 patients with biopsy proven chronic rejection and compared them with 351 patients with no pathology features of rejection, they concluded that UTI is an important risk factor for the onset of chronic rejection, and early and intense treatment is critical. Theories regarding this increment in rejection risk are the presence of microbial antibodies which can result in TNF- α , IF- δ , and IL-6 production affecting the grafted kidney, with direct action of the inflammation to the kidney in cases of pyelonephritis and hyperfiltration.^[47]

In contrast, many studies have not reported an association between asymptomatic bacteriuria and graft survival.^[48-49] These results were biased by the fact that transplant recipients with poor graft survival could suffer from urinary infections due to urologic abnormalities.

Treatment

The management of urinary tract infections is not different from those seen in patients who have not been transplanted. Due to high prevalence of urinary infection within the first post-transplant months and its correlation with worse patient and graft outcome, most centers use prophylactic oral antibiotic therapy continuously during the first months, and in some centers this treatment could last up to one year.^[50] In their study Fox *et al*,^[51] recommended that patients with diabetes, those receiving cyclophosphamide or high doses of corticosteroids, and those with a history of infection during transplant hospitalization or a history of recurrent UTIs before transplantation seem to be candidates for indefinite prophylaxis (Level of evidence B-III).

Most of the authors recommend antibiotic therapy for asymptomatic bacteriuria in the first months after transplantation. There is no consensus about the period of therapy and also it is not clear yet whether to treat every episode of asymptomatic bacteriuria after the first months or not. Stein and Funfstuck recommend treating every episode of bacteriuria with or without symptoms.^[52] On the other hand, many others recommend that asymptomatic bacteriuria, occurring after the first post-transplant months, must be carefully followed and patients should be warned of symptoms and begin antibiotic therapy when clinical manifestations are present.^[43] The most common antibiotic used prophylactically is trimethoprim-sulfamethoxazole (TMP-SMZ) as this regimen has been shown to significantly reduce the incidence of UTI and

resultant bacteremia in renal transplant recipients.^[51,53] Fox *et al.*^[51] studied 132 adult patients selected to undergo renal transplantation participated in a randomized, double-blind, placebo-controlled trial and found that 320/1600 mg daily dose of TMP-SMZ (adjusted based on post-transplant renal function) significantly reduces the incidence of bacterial infection following renal transplantation, especially infection of the urinary tract and bloodstream, can provide protection against *Pneumocystis carinii* pneumonia, and is cost beneficial. No significant differences in colonization by TMP-SMZ-resistant gram-negative bacilli were identified between the two groups. This result contradict the newest publications regarding the developing of TMP-SMZ resistant strains in transplant recipients, Thus studies need to be conducted for further elucidation.

Patients who are allergic to TMP-SMZ can be treated with any of the oral quinolones, such as ciprofloxacin or norfloxacin.^[54-55]

Any febrile renal transplant patient with an abrupt deterioration of renal function should be treated with empiric antibacterial therapy aimed at gram negative bacteria, including *Pseudomonas aeruginosa*, after blood and urine samples have been obtained.^[56]

Evolution in the management of transplantation has introduced routine perioperative prophylaxis, minimization of use of indwelling urethral catheters, and long term antimicrobial prophylaxis to prevent pneumonia and other infections. These interventions also prevent both asymptomatic bacteriuria and symptomatic urinary infection.^[51,57] Perioperative antibiotic prophylaxis for routine renal transplantation surgery has been recommended; a single dose of a second-generation or third-generation cephalosporin before induction of anesthesia seems to provide wound and urinary tract protection as effectively as a prolonged course of antibiotics.^[58] It is a common practice to prophylactically administer a single-dose antibiotic before removal of urethral catheters.

If an early post-transplantation UTI develops, ureteric stents placed for prophylactic purposes during transplantation can be removed around 2 weeks post-transplantation. This procedure should be delayed in patients receiving sirolimus, which can delay wound healing.^[59] Routine pretransplantation nephrectomy in atosomal dominant polycystic kidney disease (ADPKD) is not recommended, but if the native kidneys act as a 'reservoir' for infection, then bilateral native nephrectomy might be indicated.^[20]

SUMMARY

UTI is the most common infective complication following renal transplantation. The infection can precipitate graft dysfunction, sepsis, and death. The risk of post-transplantation UTI is multifactorial and is determined by host, organism, and anatomical factors that are interrelated.

Patient education and early treatment with antimicrobials are key to early detection and prevention of post-transplantation UTI.

Robust definitions of UTI, bacteriuria, bacteremia and pyuria in renal transplant recipients are important so that clinicians can communicate accurately and act promptly.

Asymptomatic bacteriuria screening in the first six months post renal transplantation is mandatory, and patients should be treated until negative urine culture is obtained.

Prolonged prophylaxis using TMP-SMZ has proved to reduce the incidence of UTI and bacteremia, although it has no major impact on overall patient or graft survival. Optimal drug, dose, and length of prophylaxis are other issues that need further elucidation.

Asymptomatic candiduria should be treated promptly in all renal transplant recipients because individuals with fungal UTIs are at a high risk of developing serious complications.

Asymptomatic catheter-related bacteriuria is relatively common problem; consideration should be given to replacing or removing the catheter.

REFERENCES

1. Muller V, Becker G, Delfs M, Albrecht KH, Philipp T, Heemann U. Do urinary tract infections trigger chronic kidney transplant rejection in man? *J Urol* 1998;159:1826-9.
2. Wagener MM, Yu VL. Bacteremia in transplant recipients: a prospective study of demographics, etiologic agents, risk factors, and outcomes. *Am J Infect Control* 1992;20:239-47.
3. Hooton TM, Scholes D, Stapleton AE, Roberts PL, Winter C, Gupta K, *et al.* A prospective study of asymptomatic bacteriuria in sexually active young women. *N Engl J Med* 2000;343:992-7.
4. Boscia JA, Abrutyn E, Levison ME, Pitsakis PG, Kaye D. Pyuria and asymptomatic bacteriuria in elderly ambulatory women. *Ann Intern Med* 1989;110:404-5.
5. Stamm WE. Measurement of pyuria and its relation to bacteriuria. *Am J Med* 1983;75:53-8.
6. Nicolle LE, Bradley S, Colgan R, Rice JC, Schaeffer A, Hooton TM. Infectious Diseases Society of America guidelines for the diagnosis and treatment of asymptomatic bacteriuria in adults. *Clin Infect Dis* 2005; 40:643-54.
7. Bengtsson C, Bengtsson U, Bjorkelund C, Lincoln K, Sigurdsson JA. Bacteriuria in a population sample of women: 24-year follow-up study. Results from the prospective population-based study of women in Gothenburg, Sweden. *Scand J Urol Nephrol* 1998;32:284-9.

8. Nicolle LE. Asymptomatic bacteriuria: when to screen and when to treat. *Infect Dis Clin North Am* 2003;17:367-94.
9. Kunin CM, McCormack RC. An epidemiologic study of bacteriuria and blood pressure among nuns and working women. *N Engl J Med* 1968;278:635-42.
10. Lipsky BA. Urinary tract infections in men. Epidemiology, pathophysiology, diagnosis, and treatment. *Ann Intern Med* 1989;110:138-50.
11. Zhanel GG, Nicolle LE, Harding GK. Prevalence of asymptomatic bacteriuria and associated host factors in women with diabetes mellitus. The Manitoba Diabetic Urinary Infection Study Group. *Clin Infect Dis* 1995;21:316-22.
12. Zhanel GG, Harding GK, Nicolle LE. Asymptomatic bacteriuria in patients with diabetes mellitus. *Rev Infect Dis* 1991;13:150-4.
13. Stamm WE. Catheter-associated urinary tract infections: epidemiology, pathogenesis, and prevention. *Am J Med* 1991;91:65S-71S.
14. Warren JW, Tenney JH, Hoopes JM, Muncie HL, Anthony WC. A prospective microbiologic study of bacteriuria in patients with chronic indwelling urethral catheters. *J Infect Dis* 1982;146:719-23.
15. Riedl CR, Plas E, Hubner WA, Zimmer H, Ulrich W, Pfluger H. Bacterial colonization of ureteral stents. *Eur Urol* 1999;36:53-9.
16. Bakke A, Digranes A. Bacteriuria in patients treated with clean intermittent catheterization. *Scand J Infect Dis* 1991;23:577-82.
17. Waites KB, Canupp KC, DeVivo MJ. Epidemiology and risk factors for urinary tract infection following spinal cord injury. *Arch Phys Med Rehabil* 1993;74:691-5.
18. Chaudhry A, Stone WJ, Breyer JA. Occurrence of pyuria and bacteriuria in asymptomatic hemodialysis patients. *Am J Kidney Dis* 1993;21:180-3.
19. Nicolle LE. Asymptomatic bacteriuria in the elderly. *Infect Dis Clin North Am* 1997;11:647-62.
20. Munoz P. Management of urinary tract infections and lymphocele in renal transplant recipients. *Clin Infect Dis* 2001;33 Suppl 1:S53-7.
21. Roos V, Nielsen EM, Klemm P. Asymptomatic bacteriuria *Escherichia coli* strains: adhesins, growth and competition. *FEMS Microbiol Lett* 2006;262:22-30.
22. Roos V, Schembri MA, Ulett GC, Klemm P. Asymptomatic bacteriuria *Escherichia coli* strain 83972 carries mutations in the foc locus and is unable to express F1C fimbriae. *Microbiology* 2006;152:1799-806.
23. Hull RA, Rudy DC, Wieser IE, Donovan WH. Virulence factors of *Escherichia coli* isolates from patients with symptomatic and asymptomatic bacteriuria and neuropathic bladders due to spinal cord and brain injuries. *J Clin Microbiol* 1998;36:115-7.
24. Hull RA, Rudy DC, Donovan WH, Wieser IE, Stewart C, Darouiche RO. Virulence properties of *Escherichia coli* 83972, a prototype strain associated with asymptomatic bacteriuria. *Infect Immun* 1999;67:429-32.
25. Plos K, Carter T, Hull S, Hull R, Svanborg Eden C. Frequency and organization of pap homologous DNA in relation to clinical origin of uropathogenic *Escherichia coli*. *J Infect Dis* 1990;161:518-24.
26. Fischer H, Yamamoto M, Akira S, Beutler B, Svanborg C. Mechanism of pathogen-specific TLR4 activation in the mucosa: fimbriae, recognition receptors and adaptor protein selection. *Eur J Immunol* 2006;36:267-77.
27. Ragnarsdottir B, Samuelsson M, Gustafsson MC, Leijonhufvud I, Karpman D, Svanborg C. Reduced toll-like receptor 4 expression in children with asymptomatic bacteriuria. *J Infect Dis* 2007;196:475-84.
28. Rice JC, Peng T, Kuo YF, Pendyala S, Simmons L, Boughton J, et al. Renal allograft injury is associated with urinary tract infection caused by *Escherichia coli* bearing adherence factors. *Am J Transplant* 2006;6:2375-83.
29. Miranda C, Carazo C, Banon R, Mendoza J, Montes A, de la Rosa M. *Mycoplasma hominis* infection in three renal transplant patients. *Diagn Microbiol Infect Dis* 1990;13:329-31.
30. Howell DN, Smith SR, Butterly DW, Klassen PS, Krigman HR, Burchette JL, et al. Diagnosis and management of BK polyomavirus interstitial nephritis in renal transplant recipients. *Transplantation* 1999;68:1279-88.
31. Mussche MM, Lameire NH, Ringoir SM. *Salmonella typhimurium* infections in renal transplant patients. Report of five cases. *Nephron* 1975;15:143-50.
32. García Bravo M, Aguado JM, Morales JM, Hayek M, Díaz González R, Gimeno Fernández C, et al. *Corynebacterium urealyticum* in kidney transplant patients. *Med Clin (Barc)* 1995;104:561-4.
33. Tolckoff-Rubin NE, Rubin RH. The infectious disease problems of the diabetic renal transplant recipient. *Infect Dis Clin North Am* 1995;9:117-30.
34. Alangaden GJ, Thyagarajan R, Gruber SA, Morawski K, Garnick J, El-Amm JM, et al. Infectious complications after kidney transplantation: Current epidemiology and associated risk factors. *Clin Transplant* 2006;20:401-9.
35. Senger SS, Arslan H, Azap OK, Timurkaynak F, Cagir U, Haberal M. Urinary tract infections in renal transplant recipients. *Transplant Proc* 2007;39:1016-7.
36. Screening for asymptomatic bacteriuria in adults: U.S. Preventive Services Task Force reaffirmation recommendation statement. *Ann Intern Med* 2008;149:43-7.
37. Gross PA, Patel B. Reducing antibiotic overuse: a call for a national performance measure for not treating asymptomatic bacteriuria. *Clin Infect Dis* 2007;45:1335-7.
38. Asscher AW, Sussman M, Waters WE, Evans JA, Campbell H, Evans KT, et al. Asymptomatic significant bacteriuria in the non-pregnant woman. II. Response to treatment and follow-up. *Br Med J* 1969;1:804-6.
39. Tencer J. Asymptomatic bacteriuria—a long-term study. *Scand J Urol Nephrol* 1988;22:31-4.
40. Malek SK, Obmann MA, Gotoff RA, Foltzer MA, Hartle JE, Potdar S. Campath-1H induction and the incidence of infectious complications in adult renal transplantation. *Transplantation* 2006;81:17-20.
41. Knechtle SJ, Fernandez LA, Pirsch JD, Becker BN, Chin LT, Becker YT, et al. Campath-1H in renal transplantation: The University of Wisconsin experience. *Surg* 2004;136:754-60.
42. Prograf. 2009. (Accessed 08/2010, at http://www.accessdata.fda.gov/drugsatfda_docs/label/2009/050708s027,050709s021lbl.pdf)
43. Abbott KC, Oliver JD, 3rd, Hypolite I, Lepler LL, Kirk AD, Ko CW, et al. Hospitalizations for bacterial septicemia after renal transplantation in the united states. *Am J Nephrol* 2001;21:120-7.
44. Burgos Revilla FJ, Pascual Santos J, Marcen Letosa R, Gomez Do Santos V, Sanchez-Encinas M, Escudero Barrilero A. Renal transplantation and urinary infection. Review. *Actas Urol Esp* 1999;23:95-104.
45. Tolckoff-Rubin NE, Rubin RH. Urinary tract infection in the immunocompromised host. Lessons from kidney transplantation and the AIDS epidemic. *Infect Dis Clin North Am* 1997;11:707-17.
46. Saemann M, Horl WH. Urinary tract infection in renal transplant recipients. *Eur J Clin Invest* 2008;38 Suppl 2:58-65.
47. Kamath NS, John GT, Neelakantan N, Kirubakaran MG, Jacob CK. Acute graft pyelonephritis following renal transplantation. *Transpl Infect Dis* 2006;8:140-7.
48. Takai K, Tollemar J, Wilczek HE, Groth CG. Urinary tract infections following renal transplantation. *Clin Transplant* 1998;12:19-23.
49. Lyerova L, Lacha J, Skibova J, Teplan V, Vitko S, Schuck O. Urinary tract infection in patients with urological complications after renal transplantation with respect to long-term function and allograft survival. *Ann Transplant* 2001;6:19-20.
50. Barry JM. Renal transplantation. *Curr Opin Urol* 1999;9:121-7.
51. Fox BC, Sollinger HW, Belzer FO, Maki DG. A prospective, randomized, double-blind study of trimethoprim-sulfamethoxazole for prophylaxis of infection in renal transplantation: clinical efficacy, absorption of trimethoprim-sulfamethoxazole, effects on the microflora, and the cost-benefit of prophylaxis. *Am J Med* 1990;89:255-74.
52. Stein G, Funfstuck R. Asymptomatic bacteriuria. *Med Klin (Munich)* 2000;95:195-200.
53. Tolckoff-Rubin NE, Cosimi AB, Russell PS, Rubin RH. A controlled study of trimethoprim-sulfamethoxazole prophylaxis of urinary tract infection in renal transplant recipients. *Rev Infect Dis* 1982;4:614-8.
54. Rubin RH. Infectious disease complications of renal transplantation. *Kidney Int* 1993;44:221-36.
55. Hernandez Poblete G, Morales JM, Prieto C, Andres A, Ortuno T, Rodicio JL. Usefulness of norfloxacin prophylaxis in late recurrent urinary tract infection after renal transplantation. *Nephron* 1990;54:193-4.
56. Peterson PK, Anderson RC. Infection in renal transplant recipients. Current approaches to diagnosis, therapy, and prevention. *Am J Med* 1986;81:2-10.

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57. Hoy WE, Kissel SM, Freeman RB, Sterling WA, Jr. Altered patterns of posttransplant urinary tract infections associated with perioperative antibiotics and curtailed catheterization. *Am J Kidney Dis* 1985; 6:212-6.
58. Naber KG, Bergman B, Bishop MC, Bjerklund-Johansen TE, Botto H, Lobel B, *et al.* EAU guidelines for the management of urinary and male genital tract infections. Urinary Tract Infection (UTI) Working Group of the Health Care Office (HCO) of the European Association of Urology (EAU). *Eur Urol* 2001;40:576-88.
59. Valente JF, Hricik D, Weigel K, Seaman D, Knauss T, Siegel CT, *et al.* Comparison of sirolimus vs. mycophenolate mofetil on surgical complications and wound healing in adult kidney transplantation. *Am J Transplant* 2003;3:1128-34.

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