American Journal of Infection Control ■■ (2016) ■■-■■

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

The prevalence and predictive factors of urinary tract infection in patients undergoing renal transplantation: A meta-analysis

Xiaohui Wu MS [a,b], Yanyan Dong MD [c], Yunhong Liu MS [b], Yingxia Li MS [d], Yu Sun MS [e], Jingna Wang MS [f], Shuihui Wang MD [a,*]

[a] Division of Hospital Infection Management, Qilu Hospital of Shandong University, Jinan, Shandong Province, China
[b] School of Nursing, Shandong University, Jinan, Shandong Province, China
[c] Department of Gastroenterology, Qilu Hospital of Shandong University, Jinan, Shandong Province, China
[d] Department of Intensive Care, Qilu Hospital of Shandong University, Jinan, Shandong Province, China
[e] Department of Gastrointestinal Surgery, Qilu Hospital of Shandong University, Jinan, Shandong Province, China
[f] Department of Neonatology, Qilu Hospital of Shandong University, Jinan, Shandong Province, China

Key Words:
Risk factors
Kidney transplant
Preventive measures
Rate

Background: Urinary tract infections (UTIs) are the main cause of infectious complications in renal transplant (RTx) recipients and are considered as a potential risk factor for poorer graft outcomes. However, the risk factors of UTIs are controversial. We estimated the incidence and predisposing factors of UTIs in patients undergoing RTx.

Methods: Seventeen studies (6,671 patients) evaluated the prevalence and the risk factors of UTIs in patients with RTx published January 2000-October 2014 were included. The data were pooled using the fixed effect model or DerSimonian-Laird random effect model according to I^2.

Results: Thirteen eligible articles with a total of 3,364 patients were evaluated and the pooled prevalence of UTIs was 38.0% (95% confidence interval [CI], 29%-47%; $P < .01$). The estimated risk factors for UTI include female sex (odds ratio [OR], 3.11; 95% CI, 2.10-4.13), older age (OR, 1.032; 95% CI, 1.01-1.04), duration of catheter (OR, 1.52; 95% CI, 1.03-2.03), acute rejection episodes (OR, 1.64; 95% CI, 1.11-2.41), and receiving a kidney from a deceased donor (OR, 1.28; 95% CI, 1.09-1.52).

Conclusions: More than one-third of RTx patients had at least 1 UTI after surgery. Female sex, older age of the recipient, long duration of catheter, acute rejection episodes, and cadaveric donor were associated with higher risk of UTI.

Urinary tract infections (UTIs) are major causes of morbidity and hospitalization after kidney transplantation[1,2] and seriously threaten successful outcomes.[3] Early diagnosis and prevention measures are necessary to reduce the occurrence of life-threatening complications and graft loss. However, the significance of UTIs is controversial because of the wide discrepancy in how frequently UTIs occur in renal transplant (RTx) recipients. For example, the prevalence of UTIs in renal allograft recipients ranges from 21% (1,166 RTx reported by Lee et al[4]) to 79%.[5,6] Reasons for the wide variation in the reported incidence of UTIs are unknown, but most likely are associated with differences in the definition of UTI, length of follow-up, and variation in the use of posttransplant antibiotic prophylaxis.[7]

In addition to its widely divergent prevalence and potentially serious complications, the characteristics of RTx that increase the risk for developing posttransplant UTI have been clarified. Certain studies have shown the risk factors associated with the development of UTIs include gender, age, invasive urologic maneuvers, and original kidney disease, as well as the dose and duration of immunosuppression.[8-10] Nevertheless, there is great variability regarding these associations. Thus, realizing the significance of infectious complications and making clear the risk factors of UTIs becomes essential. Long-term outcomes of RTx can be improved by

* Address correspondence to Shuihui Wang, MD, Division of Hospital Infection Management, Qilu Hospital, 107 Wenhua West Rd, Rm 202F, Jinan, Shandong Province 250012, China.
E-mail address: wangshqlyy@163.com (S. Wang).

Financial support was provided by the National Natural Science Foundation of China (grant No. 81400598) and Shandong Province Science and Technology Development Plan of China (grant No. 2013GSF11801).
Conflicts of Interest: None to report.
XW conceived and designed the experiments and performed the experiments. XW, YL, and YL analyzed the data. XW, YS, and JW contributed materials and analysis tools. XW drafted the manuscript. YD revised the manuscript critically for important intellectual content. SW provided final approval of the version to be published. XW and YD agreed to be accountable for all aspects of the work.

0196-6553/© 2016 Published by Elsevier Inc. on behalf of Association for Professionals in Infection Control and Epidemiology, Inc.
http://dx.doi.org/10.1016/j.ajic.2016.04.222

preventing UTIs. In this article, we gathered different studies' original data about rate and factors implicated in UTIs among RTx recipients to elucidate the incidence of UTI and identify risk factors associated with its development.

METHODS

Literature search

PubMed, Elsevier Science Direct, and EMBASE were searched and articles published before October 31, 2014, were included. A combination of title and subject heading-based search strategies was used with the following search terms in all databases: *kidney transplant*, *kidney transplantation*, *renal transplant*, *solid organ transplant*, *organ transplantation*, *organ transplant*, *UTIs*, *urinary tract infection*, *factor*, and *factors*. Two authors (WXH and LYH) performed the initial screening of titles and abstracts independently. A second screening was done via a full-text review by the reviewers. Any disagreement was resolved after being reviewed by the third author (WSH), if applicable, were recorded to ensure a final consensus among the 3 reviewers.

Selection criteria

A study was included in the meta-analysis if it satisfied the following criteria:

1. Study subjects were patients with a history of RTx;
2. Patients were adults (age > 18 years);
3. The major outcomes were incidence or risk factors of UTI or provided sufficient information to calculate the incidence and odds ratios (ORs);
4. The definition and diagnostic criteria for UTIs were identical to those of the Centers for Disease Control and Prevention;
5. Guidelines about immunosuppressive therapy after RTx were similar (eg, antibody induction therapy with either antithymocyte globulin or basiliximab, maintenance with a calcineurin inhibitor like cyclosporine A, or an antimetabolite medication like mycophenolate mofetil or sirolimus/tacrolimus; and
6. Observational articles with prevalence outcome of UTIs and longitudinal cohort studies with risk factors outcome.

Exposure definition

A UTI was diagnosed based on Centers for Disease Control and Prevention guidelines: a positive urine culture ($\geq 10^5$ microorganisms/cc urine) or clinical manifestations of fever (>38°C), dysuria, frequency, urinary urgency in the absence of pyelonephritis, and cystitis criteria.

Data extraction

Data extraction was completed by 2 authors (WXH and WJN) independently using a predesigned form that included first author, publication year, country, study design, total number of patients, female/male, age, variables, deceased donors/living donors, and number of UTIs (Table 1). The primary outcome was the occurrence of UTIs and further outcome of interest was related risk factors. More detailed information about included articles are shown in Supplemental Table S1.

Quality control

The outcome variables in the literature had a big divergence. For this review, only studies that had the same objects (ie, RTx), definition of UTI (ie, cystitis and pyelonephritis), research design, and outcome variables were pooled to ensure consistency across studies. Other quality assurances like application by trained personnel were checked by the third author. In addition, 3 reviewers (DYY, LYX, and YS) assessed the articles for quality against 3 criteria (ie, selection, comparability, and exposure) using the Newcastle-Ottawa scale.

Statistical analysis

The pooled prevalence of UTIs was calculated among RTx patients and a subgroup analysis was performed with a special focus on the studies' region, follow-up period, and type of antibiotics using STATA version 11.0 (StataCorp, College Station, TX). We pooled the data based on study area, patients' gender, age, duration of catheter, occurrence of acute rejection (ACR), and donor source for allograft. The ORs and corresponding 95% confidence intervals (CIs) were calculated for dichotomous outcomes by applying a fixed-effects model or a random-effects model according to heterogeneity, which was evaluated using the χ^2-based I^2 test. The ORs and 95% CIs were estimated using the fixed-effects model for high heterogeneity ($P > .05$ or $I^2 < 25\%$) and otherwise a random-effects model

Table 1
Characteristics of the articles included in the meta-analysis

	Study design	Country	No. of participants	No. of urinary tract infections	Male/female (n)	Mean age (y)	Mean follow-up (mo)	Deceased donor/ living donor
G. Bonkat[11] 2012	Cohort	Switzerland	78	3	51/27	56	24	50/28
P.A. Cepeda[12] 2005	Cohort	Spanish	226	55	na	na	48	na
G. J. Alangaden[13] 2006	Observational	USA	127	35	76/51	47.1	21	94/33
R. Sorto[14] 2010	Cohort	Mexico	176	63	96/80	37	48	38/138
J. Golebiewska[15] 2011	Cohort	Poland	89	49	52/37	48.13	12	88/1
D. Wojciechowski[1] 2013	Cohort	San Francisco	236	77	145/91	51.6	12	141/95
A. Farr[16] 2014	Cohort	Austria	598	185	389/209	54	18	57/521
M. Papasotirioul[17] 2011	Cohort	Greece	122	74	75/47	44	67.8	na
E. Vidal[18] 2012	Cohort	Spain	2,172	156	1,381/671	52	18	na
J. A. Giullian[19] 2008	Cohort	USA	158	25	109/49	47	36	67/76
S. Dantas[20] 2006	Cohort	Brazil	163	73	98/65	42.5	24	110/53
P. Chuang[21] 2005	Cohort	USA	500	213	331/169	44	42	105/395
G. Pellè[22] 2007	Cohort	France	177	133	117/60	46.5	21.84	153/24
K. O. Memikoglu[23] 2007	Cohort	Turkey	136	56	88/48	32	38	33/103
F. López-Medrano[24] 2014	Cohort	Spain	163	16	107/56	44.8	26.2	na
N. Safdar[25] 2005	Cohort	USA	384	192	166/218	47	96	140/244
J. R. Lee[4] 2013	Cohort	New York	1,166	247	714/452	53	60	607/595

na, not recorded or available.