

The top 100 cited articles in urology

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See related article on page 303

Abstract

Background: We identified and analyzed the characteristics of the 100 most frequently cited articles published between 1965 and 2007 in journals pertaining to urology and related fields.

Methods: We selected 69 of the highest impact urology and subspecialty journals and 22 of the highest impact general medical and medical research journals from the 2006 edition of Journal Citation Reports: Science edition. We identified the 100 most frequently cited urological articles published in these 91 journals using the Science Citation Index Expanded (1965–present). We reviewed and analyzed the articles.

Results: The top 100 articles were cited a mean of 629 times (range 418–1435) and published between 1965 and 2003, with 89% published after 1979 and 54% published in the 1990s. Fifteen journals were represented, led by *The New England Journal of Medicine* (30), *The Journal of Urology* (22) and *Lancet* (11). Ninety publications originated from North America (81) or the United Kingdom (9). Johns Hopkins University (13), Harvard University (5), Stanford University (5) and University of California, Los Angeles (5) published the most articles. Five urologists were first authors of 2 or more of the articles. Fifty-six articles reported observational studies. Oncology (51) and transplantation (20) were the most commonly represented urological subfields.

Conclusion: These top-cited articles in urology identify topics and authors that contributed to major advances in urology. Observational studies and randomized controlled trials in oncology published in high-impact urological or medical journals constitute the most common type of highly cited publications.

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Résumé

Renseignements généraux : Nous avons dégagé et analysé les caractéristiques des 100 articles les plus souvent cités publiés dans des périodiques spécialisés en urologie et dans les domaines connexes entre 1965 et 2007.

Méthodologie : Soixante-neuf des périodiques les plus influents en urologie et dans les domaines connexes et 22 des périodiques les plus influents en médecine générale et en recherche médicale ont été choisis à partir du Journal Citation Reports: Science Edition de

2006. Les 100 articles les plus souvent cités dans le domaine de l'urologie ayant paru dans ces 91 périodiques ont été dégagés à partir du Science Citation Index Expanded (de 1965 à aujourd'hui). Les articles ont été passés en revue et analysés.

Résultats : Les 100 principaux articles ont été cités en moyenne 629 fois (écart : 418 à 1435) et publiés entre 1965 et 2003; 89 % ont été publiés après 1979 et 54 %, dans les années 90. Quinze périodiques étaient représentés, avec en tête le *New England Journal of Medicine* (30), le *Journal of Urology* (22) et *Lancet* (11). Quatre-vingt-dix périodiques étaient publiés en Amérique du Nord (81) ou au Royaume-Uni (9). Johns Hopkins (13), Harvard (5), Stanford (5), et l'Université de la Californie à Los Angeles (5) sont les universités qui ont publié le plus d'articles. Cinq urologues étaient les premiers auteurs de plus de 2 articles. Cinquante-six articles signalaient les résultats d'études observationnelles. L'oncologie (51) et les transplantations (20) étaient les sous-domaines les plus souvent représentés.

Conclusion : Ces articles les plus cités en urologie permettent de cerner les auteurs et les sujets qui se trouvent au cœur des principales percées dans le domaine de l'urologie. Les études observationnelles et les études contrôlées avec randomisation publiées dans les périodiques influents traitant d'urologie ou de médecine générale constituent le type le plus fréquemment observé parmi les articles les plus souvent cités.

Introduction

Citation analysis is the field of bibliometrics that examines the citation relationships between authors or their work.¹ The number of times that articles are referenced in other articles is widely used to measure the impact an article or individual researcher has on the scientific community. It is often seen as a direct measure of the recognition that work has warranted in its scientific field. In some circumstances, this number is also viewed as a measure of quality.² However, there is considerable debate regarding the value of citation rates when used to assess the quality of research.²

Recently, various specialties have attempted to identify and analyze the “citation classics” in their field.²⁻⁴ In addition, several journals have published their own citation classics.^{5,6} To date, a comprehensive list of the top-cited articles in the field of urology is not available.

The purpose of this study was to identify and analyze the characteristics of the 100 most frequently cited articles published in journals dedicated to urology and its related fields.

Methods

We selected 63 of the highest impact journals dedicated to urology and its subspecialty areas and 22 of the highest impact general medical and medical research journals from the 2006 edition of Journal Citation Reports [JCR]: Science edition (Box 1). The impact factor of journals is calculated based on a 2-year period. It can be viewed as the mean number of citations in a year given to those papers in a journal that were published during the 2 preceding years. We found the 63 urology and subspecialty journals under the subject categories "Urology & Nephrology" and "Transplantation" in the JCR 2006. We included all journals except 4 nephrology journals and 5 transplant journals because they did not pertain to urology. We selected the 22 general medical and medical research journals by searching the JCR 2006 subject categories "Medicine, General & Internal" and "Medicine Research & Experimental." We then ranked the journals in these subject categories by impact factor. We included all journals whose top-cited articles received greater than 10 citations.

To be as comprehensive as possible, we attempted to identify any further urological journals in existence. Employing an internet search for [urology journals] via the search engine Google yielded an additional 2 urological journals, *Urologic Radiology* and *Urologic Oncology*. We then cross-referenced this new compiled list of 87 journals with the list of journals searched in the textbook *Classic Papers in Urology*⁷ and subsequently included 4 additional urological journals. In total, we searched 91 journals (69 urological/subspecialty, 22 medical/research).

We identified the 100 most frequently cited urological articles from the 91 journals using the database of the Science Citation Index Expanded (1965–present).⁸ This database includes publications from the 42-year period 1965–2007. We searched each of the 91 journals using the database and we included every article that received greater than 100 citations in a comprehensive ranked list. The top 100 articles from this list made up our final list of the top 100 cited articles in urology. We accessed and reviewed the articles online using MEDLINE. When relevant information was unavailable online, we obtained the articles in print format. We analyzed the articles and tabulated the data according to the following predefined parameters: number of citations, year of publication, country of origin, institution, journal, type of article, subfield of urology and authorship.

Results

The top 100 cited articles are listed in Table 1 in descending order, according to the number of citations they received. The mean number of citations per article was 629 (range 418–1435). The top 100 cited articles were published between 1965 and 2003. The oldest article was published in 1965 (Stamey et al., *Medicine*, 1965) and the most recent article in 2003 (Yang et al., *New England Journal of Medicine*, 2003). Overall, 89% of the articles were published after 1979.

The 100 articles originated from 12 countries (Table 2). Twelve institutions published 2 or more of the top-cited articles (Table 3). Five investigators were first authors of 2 or more of the top-cited articles (Table 4).

Despite the fact that we searched 91 high-impact journals, only 15 (16%) of these journals were represented by the top 100 articles (Table 5). Table 6 depicts the types of studies that constitute the top-cited articles. A total of 56 (56%) were observational studies. Oncology (51, 51%) and transplantation (20, 20%) were the most commonly represented subspecialties (Table 7).

Discussion

Analysis of most frequently cited articles and the journals in which they appear serves several purposes. It identifies and emphasizes the impact of the work of our colleagues and predecessors, recognizes key advances in urology and adds useful perspective on historical developments in our specialty.³ Use of citation analysis to examine the urological literature also reveals quantitative information about authors, topics and journals that is helpful in identifying classic works and high-impact journals.³

Although it is not possible to provide a detailed analysis of all 100 articles, some interesting observations can be made about the top 10. These reflect major advances in urology and a number of "hot topics" over the years. Three of the top 10 articles represent the monumental contribution of prostate-specific antigen (PSA) and gleason grading to the investigation and management of prostate cancer. At position 2, Stamey and colleagues describe PSA as a serum marker for prostate cancer in 1987. At position 5, Catalona and coauthors introduce PSA as a screening test for prostate cancer in 1991, and at position 9, Gleason and Mellinger describe the combination of histological grading with clinical stage to predict prostate cancer prognosis in 1974. Other major advances in the treatment of urological diseases are represented by Einhorn and Donohue in 1977 at position 3, with treatment of disseminated testicular cancer using cisplatin-based chemotherapy; Palermo and coworkers in

Box 1. Journals selected for screening

Urology and subspecialty journals

Advances in Chronic Kidney Disease
Advances in Renal Replacement Therapy
Aktuelle Urologie
American Journal of Kidney Diseases
American Journal of Nephrology
American Journal of Physiology — Renal Physiology
American Journal of Transplantation
Annales d'Urologie
Artificial Organs
ASAIO Journal
Asian Journal of Andrology
BJU International
Blood Purification
Cell Transplantation
Clinical Nephrology
Clinical Transplantation
Contributions to Nephrology
Current Opinion in Nephrology and Hypertension
Current Opinion in Urology
Dialysis & Transplantation
European Urology
European Urology Supplements
Infections in Urology
International Journal of Artificial Organs
International Journal of Impotence Research
International Journal of Urology
International Urogynecology Journal
International Urology and Nephrology
Journal d'Urologie et de Nephrologie
Journal of Endourology
Journal of Nephrology
Journal of Renal Nutrition
Journal of Sexual Medicine
Journal of the American Society of Nephrology
Journal of Urology
Kidney and Blood Pressure Research
Kidney International
Molecular Urology
Nature Clinical Practice Urology
Nefrologia
Nephrology
Nephrology Dialysis Transplantation
Neurourology and Urodynamics
Pediatric Nephrology
Pediatric Transplantation

Peritoneal Dialysis International
Progres en Urologie
Prostate
Prostate Cancer and Prostatic Diseases
Renal Failure
Scandinavian Journal of Urology and Nephrology
Seminars in Dialysis
Seminars in Nephrology
Therapeutic Apheresis and Dialysis
Transplantation
Transplantation Proceedings
Transplant Immunology
Transplant International
Urologia Internationalis
Urologic Clinics of North America
Urologic Oncology
Urologic Oncology: Seminars and Original Investigations
Urologic Radiology
Urological Research
Urological Survey
Urologe
Urology
World Journal of Urology
Xenotransplantation

General medical and medical research journals

American Journal of Medicine
American Journal of Preventive Medicine
Annals of Family Medicine
Annals of Internal Medicine
Annals of Medicine
Annual Review of Medicine
Archives of Internal Medicine
BMJ
Canadian Medical Association Journal
Current Medical Research and Opinion
European Journal of Clinical Investigation
Journal of General Internal Medicine
Journal of Internal Medicine
Journal of the American Medical Association
Lancet
Mayo Clinic Proceedings
Medicine
Nature
New England Journal of Medicine
PLoS Medicine
QJM: An International Journal of Medicine
Science

Table 1. The top 100 cited articles in urology (part 1 of 4)

Rating	Article	No. of citations
1	Feldman HA, Goldstein I, Hatzichristou DG, et al. Impotence and its medical and psychosocial correlates: results of the Massachusetts Male Aging Study. <i>J Urol</i> 1994;151:54-61.	1435
2	Stamey TA, Yang N, Hay AR, et al. Prostate-specific antigen as a serum marker for adenocarcinoma of the prostate. <i>N Engl J Med</i> 1987;317:909-16.	1250
3	Einhorn LH, Donohue J. Cis-diamminedichloroplatinum, vinblastine, and bleomycin combination chemotherapy in disseminated testicular cancer. <i>Ann Intern Med</i> 1977;87:293-8.	1209
4	Palermo G, Joris H, Devroey P, et al. Pregnancies after intracytoplasmic injection of single spermatozoon into an oocyte. <i>Lancet</i> 1992;340:17-8.	1122
5	Catalona WJ, Smith DS, Ratliff TL, et al. Measurement of prostate-specific antigen in serum as a screening-test for prostate-cancer. <i>N Engl J Med</i> 1991; 324:1156-61.	1052
6	Goldstein I, Lue TF, Padma-Nathan H, et al. Oral sildenafil in the treatment of erectile dysfunction. <i>N Engl J Med</i> 1998;338:1397-404.	973
7	Racusen LC, Solez K, Colvin RB, et al. The Banff 97 working classification of renal allograft pathology. <i>Kidney Int</i> 1999;55:713-23.	957
8	Barry MJ, Fowler FJ, O'Leary MP, et al. The American Urological Association symptom index for benign prostatic hyperplasia. <i>J Urol</i> 1992;148:1549-57.	942
9	Gleason DF, Mellinger GT. Prediction of prognosis for prostatic adenocarcinoma by combined histological grading and clinical staging. <i>J Urol</i> 1974;111:58-64.	924
10	Sharpe RM, Skakkebaek NE. Are estrogens involved in falling sperm counts and disorders of the male reproductive tract. <i>Lancet</i> 1993;341:1392-5.	910
11	Rosen RC, Riley A, Wagner G, et al. The international index of erectile function (IIEF): a multidimensional scale for assessment of erectile dysfunction. <i>Urology</i> 1997;49:822-30.	901
12	Chan JM, Stampfer MJ, Giovannucci E, et al. Plasma insulin-like growth factor I and prostate cancer risk: a prospective study. <i>Science</i> 1998;279:563-6.	901
13	Oesterling JE. Prostate specific antigen: a critical assessment of the most useful tumor-marker for adenocarcinoma of the prostate. <i>J Urol</i> 1991;145:907-23.	877
14	Crawford ED, Eisenberger MA, McLeod DG, et al. A controlled trial of leuprolide with and without flutamide in prostatic-carcinoma. <i>N Engl J Med</i> 1989;321:419-24.	870
15	Solez K, Axelsen RA, Benediktsson H, et al. International standardization of criteria for the histologic diagnosis of renal-allograft rejection: the Banff working classification of kidney transplant pathology. <i>Kidney Int</i> 1993;44:411-22.	862
16	Calne RY, Pentlow BD, White DJG, et al. Cyclosporin-A in patients receiving renal allografts from cadaver donors. <i>Lancet</i> 1978;2:1323-7.	850
17	Carlsen E, Giwercman A, Keiding N, et al. Evidence for decreasing quality of semen during past 50 years. <i>BMJ</i> 1992;305:609-13.	849
18	Robson CJ, Churchil BM, Anderson W. Results of radical nephrectomy for renal cell carcinoma. <i>J Urol</i> 1969;101:297-301.	845
19	Opelz G, Sengar DPS, Mickey MR, et al. Effect of blood transfusions on subsequent kidney transplants. <i>Transplant Proc</i> 1973;5:253-9.	839
20	Loehrer PJ, Einhorn LH. Drugs 5 years later: Cisplatin. <i>Ann Intern Med</i> 1984;100:704-13.	828
21	Gabrilove JL, Jakubowski A, Scher H, et al. Effect of granulocyte colony-stimulating factor on neutropenia and associated morbidity due to chemotherapy for transitional-cell carcinoma of the urothelium. <i>N Engl J Med</i> 1988;318:1414-22.	826
22	Sollinger HW. Mycophenolate mofetil for the prevention of acute rejection in primary cadaveric renal allograft recipients. <i>Transplantation</i> 1995;60:225-32.	803
23	Mebust WK, Holtgrewe HL, Cockett ATK, et al. Transurethral prostatectomy: immediate and postoperative complications: a cooperative study of 13 participating institutions evaluating 3883 patients. <i>J Urol</i> 1989;141:243-7.	784
24	Pound CR, Partin AW, Eisenberger MA, et al. Natural history of progression after PSA elevation following radical prostatectomy. <i>JAMA</i> 1999;281:1591-7.	774
25	Droller MJ, Anderson JR, Beck JC, et al. Impotence. <i>JAMA</i> 1993;270:83-90.	761

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Table 1. The top 100 cited articles in urology (part 2 of 4)

Rating	Article	No. of citations
26	Belzer FO, Southard JH. Principles of solid organ preservation by cold storage. <i>Transplantation</i> 1988;45:673-6.	759
27	Partin AW, Kattan MW, Subong ENP, et al. Combination of prostate-specific antigen, clinical stage, and gleason score to predict pathological stage of localized prostate cancer: a multi-institutional update. <i>JAMA</i> 1997;277:1445-51.	755
28	Berry SJ, Coffey DS, Walsh PC, et al. The development of human benign prostatic hyperplasia with age. <i>J Urol</i> 1984;132:474-9.	751
29	Starzl TE, Todo S, Fung J, et al. FK-506 for liver, kidney, and pancreas transplantation. <i>Lancet</i> 1989;2:1000-4.	721
30	Abrams P, Cardozo L, Fall M, et al. The standardisation of terminology of lower urinary tract function: report from the Standardisation Sub-Committee of the International Continence Society. <i>Neurourol Urodyn</i> 2002;21:167-78.	716
31	Sidransky D, Voneschenbach A, Tsai YC, et al. Identification of P53 gene-mutations in bladder cancers and urine samples. <i>Science</i> 1991;252:706-9.	709
32	Bolla M, Gonzalez D, Warde P, et al. Improved survival in patients with locally advanced prostate cancer treated with radiotherapy and goserelin. <i>N Engl J Med</i> 1997;337:295-300.	683
33	Hariharan S, Johnson CP, Bresnahan BA, et al. Improved graft survival after renal transplantation in the United States, 1988 to 1996. <i>N Engl J Med</i> 2000;342:605-12.	665
34	Cohen DJ, Loertscher R, Rubin MF, et al. Cyclosporine: a new immunosuppressive agent for organ transplantation. <i>Ann Intern Med</i> 1984;101:667-82.	663
35	Oesterling JE, Jacobsen SJ, Chute CG, et al. Serum prostate-specific antigen in a community-based population of healthy men: establishment of age-specific reference ranges. <i>JAMA</i> 1993;270:860-4.	658
36	Catalona WJ, Richie JP, Ahmann FR, et al. Comparison of digital rectal examination and serum prostate-specific antigen in the early detection of prostate cancer: results of a multicenter clinical trial of 6630 men. <i>J Urol</i> 1994;151:1283-90.	657
37	Williams SD, Birch R, Einhorn LH, et al. Treatment of disseminated germ-cell tumors with cisplatin, bleomycin, and either vinblastine or etoposide. <i>N Engl J Med</i> 1987;316:1435-40.	653
38	Gormley GJ, Stoner E, Bruskewitz RC, et al. The effect of finasteride in men with benign prostatic hyperplasia. <i>N Engl J Med</i> 1992;327:1185-91.	629
39	Grinyo J, Groth C, Pichlmyer R, et al. Placebo-controlled study of mycophenolate mofetil combined with cyclosporine and corticosteroids for prevention of acute rejection. <i>Lancet</i> 1995;345:1321-5.	619
40	Hricik DE, Browning PJ, Kopelman R, et al. Captopril-induced functional renal-insufficiency in patients with bilateral renal-artery stenoses or renal-artery stenosis in a solitary kidney. <i>N Engl J Med</i> 1983;308:373-6.	608
41	Cosimi AB, Colvin RB, Burton RC, et al. Use of monoclonal antibodies to T-cell subsets for immunological monitoring and treatment in recipients of renal allografts. <i>N Engl J Med</i> 1981;305:308-14.	606
42	Partin AW, Yoo J, Carter HB, et al. The use of prostate-specific antigen, clinical stage and gleason score to predict pathological stage in men with localized prostate cancer. <i>J Urol</i> 1993;150:110-4.	594
43	Pirsch JD, Miller J, Deierhoi MH, et al. A comparison of tacrolimus (FK506) and cyclosporine for immunosuppression after cadaveric renal transplantation. <i>Transplantation</i> 1997;63:977-83.	589
44	Bookstein R, Shew JY, Chen PL, et al. Suppression of tumorigenicity of human prostate carcinoma cells by replacing a mutated RB gene. <i>Science</i> 1990;247:712-5.	587
45	Wolfe RA, Ashby VB, Milford EL, et al. Comparison of mortality in all patients on dialysis, patients on dialysis awaiting transplantation, and recipients of a first cadaveric transplant. <i>N Engl J Med</i> 1999;341:1725-30.	584
46	Carter HB, Pearson JD, Metter J, et al. Longitudinal evaluation of prostate-specific antigen levels in men with and without prostate disease. <i>JAMA</i> 1992;267:2215-20.	581
47	Catalona WJ, Smith DS, Ratliff TL, et al. Detection of organ-confined prostate cancer is increased through prostate-specific antigen-based screening. <i>JAMA</i> 1993;270:948-54.	579
48	Chodak GW, Thisted RA, Gerber GS, et al. Results of conservative management of clinically localized prostate cancer. <i>N Engl J Med</i> 1994;330:242-8.	576
49	Keown P, Hayry P, Mathew T, et al. A blinded, randomized clinical trial of mycophenolate mofetil for the prevention of acute rejection in cadaveric renal transplantation. <i>Transplantation</i> 1996;61:1029-37.	574

Continued on next page

Table 1. The top 100 cited articles in urology (part 3 of 4)

Rating	Article	No. of citations
50	Henev NM, Ahmed S, Flanagan MJ, et al. Superficial bladder cancer progression and recurrence. <i>J Urol</i> 1983;130:1083-6.	562
51	Walsh PC, Donker PJ. Impotence following radical prostatectomy: insight into etiology and prevention. <i>J Urol</i> 1982;128:492-7.	561
52	Morales A, Eidinger D, Bruce AW. Intracavitary bacillus calmette-guerin in treatment of superficial bladder tumors. <i>J Urol</i> 1976;116:180-3.	557
53	Cohen AJ, Li FP, Berg S, et al. Hereditary renal-cell carcinoma associated with a chromosomal translocation. <i>N Engl J Med</i> 1979;301:592-5.	551
54	Clayman RV, Kavoussi LR, Soper NJ, et al. Laparoscopic nephrectomy: initial case report. <i>J Urol</i> 1991;146:278-82.	537
55	Hodge KK, McNeal JE, Terris MK, et al. Random systematic versus directed ultrasound guided transrectal core biopsies of the prostate. <i>J Urol</i> 1989;142:71-5.	524
56	Rajfer J, Aronson WJ, Bush PA, et al. Nitric-oxide as a mediator of relaxation of the corpus cavernosum in response to nonadrenergic, noncholinergic neurotransmission. <i>N Engl J Med</i> 1992;326:90-4.	523
57	Patel R, Terasaki PI. Significance of positive crossmatch test in kidney transplantation. <i>N Engl J Med</i> 1969;280:735-9.	519
58	Yang JC, Haworth L, Sherry RM, et al. A randomized trial of bevacizumab, an antivascular endothelial growth factor antibody, for metastatic renal cancer. <i>N Engl J Med</i> 2003;349:427-34.	516
59	Rayman MP. The importance of selenium to human health. <i>Lancet</i> 2000;356:233-41.	514
60	Chajek T, Fainaru M. Behçets disease: report of 41 cases and a review of literature. <i>Medicine</i> 1975;54:179-96.	512
61	Litwin MS, Hays RD, Fink A, et al. Quality-of-life outcomes in men for localized prostate cancer. <i>JAMA</i> 1995;273:129-35.	504
62	Childs R, Chernoff A, Contentin N, et al. Regression of metastatic renal-cell carcinoma after nonmyeloablative allogeneic peripheral-blood stem-cell transplantation. <i>N Engl J Med</i> 2000;343:750-8.	503
63	Almond PS, Matas A, Gillingham K, et al. Risk-factors for chronic rejection in renal allograft recipients. <i>Transplantation</i> 1993;55:752-7.	502
64	Thomas TM, Plymat KR, Blannin J, et al. Prevalence of urinary incontinence. <i>BMJ</i> 1980;281:1243-5.	499
65	Neal DE, Bennett MK, Hall RR, et al. Epidermal growth factor receptors in human bladder cancer: comparison of invasive and superficial tumors. <i>Lancet</i> 1985;1:366-8.	498
66	Cooner WH, Mosley BR, Rutherford CL, et al. Prostate cancer detection in a clinical urological practice by ultrasonography, digital rectal examination and prostate specific antigen. <i>J Urol</i> 1990;143:1146-54.	487
67	Taplin ME, Bublely GJ, Shuster TD, et al. Mutation of the androgen receptor gene in metastatic androgen-independent prostate cancer. <i>N Engl J Med</i> 1995;332:1393-8.	481
68	Legha SS, Benjamin RS, Mackay B, et al. Reduction of doxorubicin cardiotoxicity by prolonged continuous intravenous infusion. <i>Ann Intern Med</i> 1982;96:133-9.	481
69	Stamey TA, Kabalin JN, McNeal JE, et al. Prostate specific antigen in the diagnosis and treatment of adenocarcinoma of the prostate. II. Radical prostatectomy treated patients. <i>J Urol</i> 1989;141:1076-83.	479
70	Epstein JI, Walsh PC, Carmichael M, et al. Pathological and clinical findings to predict tumor extent of nonpalpable (stage-t1c) prostate-cancer. <i>JAMA</i> 1994;271:368-74.	475
71	Cartwright RA, Rogers HJ, Barhamhall D, et al. Role of n-acetyltransferase phenotypes in bladder carcinogenesis: a pharmacogenetic epidemiological approach to bladder cancer. <i>Lancet</i> 1982;2:842-6.	474
72	Motzer RJ, Bander NH, Nanus DM. Renal-cell carcinoma. <i>N Engl J Med</i> 1996;335:865-75.	472
73	Christensson A, Bjork T, Nilsson O, et al. Serum prostate-specific antigen complexed to alpha-10antichymotrypsin as an indicator of prostate cancer. <i>J Urol</i> 1993;150:100-5.	463
74	Messing EM, Manola J, Sarosdy M, et al. Immediate hormonal therapy compared with observation after radical prostatectomy and pelvic lymphadenectomy in men with node-positive prostate cancer. <i>N Engl J Med</i> 1999;341:1781-8.	460
75	Terasaki PI, Cecka JM, Gjertson DW, et al. High survival rates of kidney transplants from spousal and living unrelated donors. <i>N Engl J Med</i> 1995;333:333-6.	460

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Table 1. The top 100 cited articles in urology (part 4 of 4)

Rating	Article	No. of citations
76	Smith JR, Freije D, Carpten JD, et al. Major susceptibility locus for prostate cancer on chromosome 1 suggested by a genome-wide search. <i>Science</i> 1996;274:1371-4.	459
77	Willett WC, Morris JS, Pressel S, et al. Prediagnostic serum selenium and risk of cancer. <i>Lancet</i> 1983;2:130-4.	458
78	Oesterling JE, Chan DW, Epsetin JI, et al. Prostate specific antigen in the preoperative and postoperative evaluation of localized prostatic cancer treated with radical prostatectomy. <i>J Urol</i> 1988;139:766-72.	454
79	Auger J, Kunstmann JM, Czyglik F, et al. Decline in semen quality among fertile men in Paris during the past 20 years. <i>N Engl J Med</i> 1995;332:281-5.	454
80	Dong JT, Lamb PW, Rinkerschaeffer CW, et al. KAI1, a metastasis suppressor gene for prostate cancer on human chromosome 11P11.2. <i>Science</i> 1995;268:884-6.	453
81	Corey L, Adams HG, Brown ZA, et al. Genital herpes simplex virus infections: clinical manifestations, course, and complications. <i>Ann Intern Med</i> 1983;98:958-72.	452
82	McNeal JE, Kindrachuk RA, Freiha FS, et al. Patterns of progression in prostate cancer. <i>Lancet</i> 1986;1:60-3.	448
83	Partin AW, Pound CR, Clemens JQ, et al. Serum PSA after anatomic radical prostatectomy: the Johns Hopkins experience after 10 years. <i>Urol Clin North Am</i> 1993;20:713-25.	445
84	Carani C, Qin K, Simoni M, et al. Effect of testosterone and estradiol in a man with aromatase deficiency. <i>N Engl J Med</i> 1997;337:91-5.	445
85	Esrig D, Elmajian D, Groshen S, et al. Accumulation of nuclear P53 and tumor progression in bladder cancer. <i>N Engl J Med</i> 1994;331:1259-64.	442
86	Stamey TA, Govan DE, Palmer JM. Localization and treatment of urinary tract infections: role of bactericidal urine levels as opposed to serum levels. <i>Medicine</i> 1965;44:1-36.	438
87	Lapides J, Silber SJ, Lowe BS, et al. Clean, intermittent self-catheterization in treatment of urinary-tract disease. <i>J Urol</i> 1972;107:458-61.	436
88	Roos NP, Wennberg JE, Malenka DJ, et al. Mortality and reoperation after open and transurethral resection of the prostate for benign prostatic hyperplasia. <i>N Engl J Med</i> 1989;320:1120-4.	433
89	Chillon M, Casals T, Mercier B, et al. Mutations in the cystic fibrosis gene in patients with congenital absence of the vas deferens. <i>N Engl J Med</i> 1995;332:1475-80.	431
90	Fleming C, Wasson JH, Albertsen PC, et al. A decision analysis of alternative treatment strategies for clinically localized prostate cancer. <i>JAMA</i> 1993;269:2650-8.	427
91	Partin AW, Carter HB, Chan DW, et al. Prostate specific antigen in the staging of localized prostate cancer: influence of tumor differentiation, tumor volume and benign hyperplasia. <i>J Urol</i> 1990;143:747-52.	427
92	Chaussy C, Schmiedt E, Jocham D, et al. First clinical experience with extracorporeally induced destruction of kidney stones by shock waves. <i>J Urol</i> 1982;127:417-20.	424
93	Drach GW, Dretler S, Fair W, et al. Report of the United States cooperative study of extracorporeal shock wave lithotripsy. <i>J Urol</i> 1986;135:1127-33.	422
94	Walsh PC, Lepor H, Eggleston JC. Radical prostatectomy with preservation of sexual function: anatomical and pathological considerations. <i>Prostate</i> 1983;4:473-85.	422
95	Groth CG, Backman L, Morales JM, et al. Sirolimus (rapamycin)-based therapy in human renal transplantation: Similar efficacy and different toxicity compared with cyclosporine. <i>Transplantation</i> 1999;67:1036-42.	422
96	Balfour HH, Chace BA, Stapleton JT, et al. A randomized, placebo-controlled trial of oral acyclovir for the prevention of cytomegalovirus disease in recipients of renal allografts. <i>N Engl J Med</i> 1989;320:1381-7.	421
97	Vincenti F, Kirkman R, Light S, et al. Interleukin-2-receptor blockade with daclizumab to prevent acute rejection in renal transplantation. <i>N Engl J Med</i> 1998;338:161-5.	420
98	Krane RJ, Goldstein I, Detejada IS. Impotence. <i>N Engl J Med</i> 1989;321:1648-59.	420
99	Garraway WM, Collins GN, Lee RJ. High prevalence of benign prostatic hyperplasia in the community. <i>Lancet</i> 1991;338:469-71.	419
100	D'Amico AV, Whittington R, Malkowicz SB, et al. Biochemical outcome after radical prostatectomy, external beam therapy, or interstitial therapy for clinically localized prostate cancer. <i>JAMA</i> 1998;280:969-74.	418

1992 at position 4, with the introduction of intracytoplasmic sperm injection for the treatment of infertility; and Goldstein and colleagues at position 6, reporting on sildenafil for the treatment of erectile dysfunction. Men's health has been a topic generating much discussion in recent years and is represented by Feldman and coauthors in 1994 at position 1, with the results of the Massachusetts Male Aging Study, along with Sharpe and Skakkebaek in 1993 at position 10, with the effects of estrogen on men's fertility. The remaining

2 articles within the top 10 positions reflect the development of important clinical tools in urology, namely, Racusen and colleagues in 1999 with the Banff histological classification of renal allograft rejection, and Barry and coworkers in 1992 with the AUA [American Urological Association] symptom index score for benign prostatic hyperplasia.

Table 2. Countries of origin of the top 100 cited articles in urology

Country	No. of articles
United States	76
United Kingdom	9
Canada	5
Germany	2
France	2
Denmark	1
Sweden	1
Italy	1
Spain	1
Australia	1
Belgium	1

Table 3. Institutions of origin with 2 or more top-cited articles in urology

Rank	Institution	No. of articles
1	Johns Hopkins University	13
2	Harvard University	5
3	Stanford University	5
4	University of California, Los Angeles	5
5	Washington University	4
6	Boston University	3
7	National Institute of Health	3
8	Indiana University	3
9	Mayo clinic	2
10	Memorial Sloan Kettering Cancer Center	2
11	University of Michigan	2
12	University of Minnesota	2

Table 4. Most common first and second authors of the top 100 cited articles in urology

Author	No. of articles	First author	Second author
Partin A	5	4	1
Osterling J	4	3	1
Catalona W	3	3	—
Stamey T	3	3	—
Walsh P	3	2	1

Table 5. Journals in which the top 100 cited urological articles were published

Rank	Journal	No. of articles	Impact factor (2006)
1	<i>New England Journal of Medicine</i>	30	51.296
2	<i>Journal of Urology</i>	22	3.956
3	<i>Lancet</i>	11	25.800
4	<i>Journal of the American Medical Association</i>	10	23.175
5	<i>Transplantation</i>	7	3.972
6	<i>Science</i>	5	30.028
7	<i>Annals of Internal Medicine</i>	5	14.780
8	<i>BMJ</i>	2	9.245
9	<i>Medicine</i>	2	5.167
10	<i>Kidney International</i>	1	4.773
11	<i>Urology</i>	1	2.130
12	<i>Clinical Transplantation</i>	1	2.051
13	<i>Neurology and Urodynamics</i>	1	2.688
14	<i>Urologic Clinics of North America</i>	1	1.819
15	<i>Prostate</i>	1	3.724

Table 6. Study design of the top 100 cited articles in urology

Study design	No. of articles
Observational	56
Randomized controlled trial	14
Basic science	14
Review article	14
Systematic review	1
Validation study	1

Table 7. Most common subspecialties represented in the top 100 cited articles in urology

Subspecialty	No. of articles
Oncology	51
Transplantation	20
Sexual function/infertility	13
Voiding dysfunction	10
Urolithiasis	2
Infection/inflammation	2
Physiology/medicine	1
Surgery	1

The finding that most top-cited articles originated from the United States is not surprising and is consistent with the origin of citation classics in the fields of anesthesia² and general surgery.⁴ The size of the American surgical community, its wealth and scientific output is larger than anywhere else worldwide, and does create bias in publication and citation rates.⁴ In addition, US authors tend to cite US articles, and US reviewers prefer US manuscripts.⁴

Our most frequently cited articles were published in high-impact journals. This is consistent with the finding that leading journals attract articles that are most likely to be the most highly cited publications, which in turn maintain the high impact factor of these journals.⁴ Further, one journal has actually published an open call for authors to cite more recent articles from journals with a high impact factor to raise the former's impact factor.⁹ This makes apparent the motivation and demonstrates one way in which citation counts may be manipulated.

Most of the articles retrieved were observational studies. This is contrary to many studies of the top-cited articles in other fields which report that review articles and methodological publications predominate.² This has been explained by the need for authors to summarize and critically evaluate the rapidly expanding literature, but could also be a result of the restriction on the maximum number of allowed references of manuscripts enforced by many journals today.² It is encouraging that original research predominated in our study. Urologists and clinicians in general need to continue to produce well-designed research studies, and readers need to continue to keep abreast of the most original and important scientific and medical advances.

One cannot assume that the top 100 cited articles presented here represent true "classics" or landmark articles owing to multiple sources of bias in the use of citation counts to rank articles. It should be noted that citation ranking is not intended to be a measure of quality, but rather a measure of recognition, that is, the absolute number of citations an article has accumulated cannot be used as the sole determinant of its importance. Time can have multiple effects on an article's citation ranking. With increasing age, each paper has more time in which to have been cited; therefore, the group of highest ranking articles can be dominated by some of the oldest.⁶ It has been reported that the true impact and eminence of an article often cannot be accurately assessed for at least 2 decades.² Conversely, as time passes, even "landmark" papers may gradually become less cited because their content is absorbed into current knowledge without the need for referencing, as described by Garfield⁵ in 1987 — a process known as "obliteration by incorporation." Older publications may also become obsolete or simply forgotten. Papers that present novel techniques or methods that were

once "popular" but have since ceased to be so can be over-represented.⁴ Another criticism of citation analysis is that databases do not distinguish between positive or negative citations.² A paper that is repeatedly cited because it was flawed or subsequently disproved could conceivably rank highly in a study such as ours; however, most readers probably would agree that it should not be included in the pantheon of landmark urological articles. Authors are supposed to acknowledge works that have influenced them the most, but this is not always the case. Both journal and author self-citation are prevalent sources of bias in citation analysis.⁹ Author and journal self-citations are not removed from citation counts or from the calculation of impact factors. As a result, both sources of bias may misrepresent the importance of individual articles, skew the calculation of journal impact factors and bias perceptions of the importance of a publication.⁹

Citations of original articles are generated when subsequent original articles reference that work; however, other types of papers such as reviews, meeting proceedings, abstracts and editorials also generate citations and are included in the Institute for Scientific Information database.¹ Should citations from subsequent original articles be weighted differently? Incomplete citing and omission bias (bias toward not referencing competitors or sources contradictory to one's own results) are also problematic.² Related to this, many journals, including *The Journal of Urology*, restrict the reference list to 20 original scientific publications, partly to control journal size but also to ensure that only the most recent and relevant papers are cited.¹⁰ This could lead to both incomplete and biased reference lists.

Our use of the 2006 impact factors to identify journals could be criticized since the citation counts of articles spanned the period of 1965 to present. To account for this we attempted to identify all urological journals from 1965 to 2007 using the Internet, consulting librarians and reviewing Gerharz and colleagues' book *Classic Papers in Urology*. Even with this technique, there is no doubt that articles related to urology exist in journals we did not search. A search for articles in journals of pathology, obstetrics and gynecology, cancer, pediatrics and further basic-science research, to name a few, would likely yield a different, if not more comprehensive, list. In addition, important historical articles were omitted because of the lack of electronic data before 1965.

Conclusion

Citation analysis reveals useful and interesting information about scientific communications in our specialty. Observational studies and randomized controlled trials in oncology

published in high-impact English urological or general medical journals constitute the most common type of highly cited publications in urology. Our findings reflect the attention that articles have received over the past 42 years, can be interpreted in many ways and should provoke informed debate. This information, along with current bibliometric indices, should assist urologists to optimize their time spent reading the medical literature and help guide future investigative efforts.

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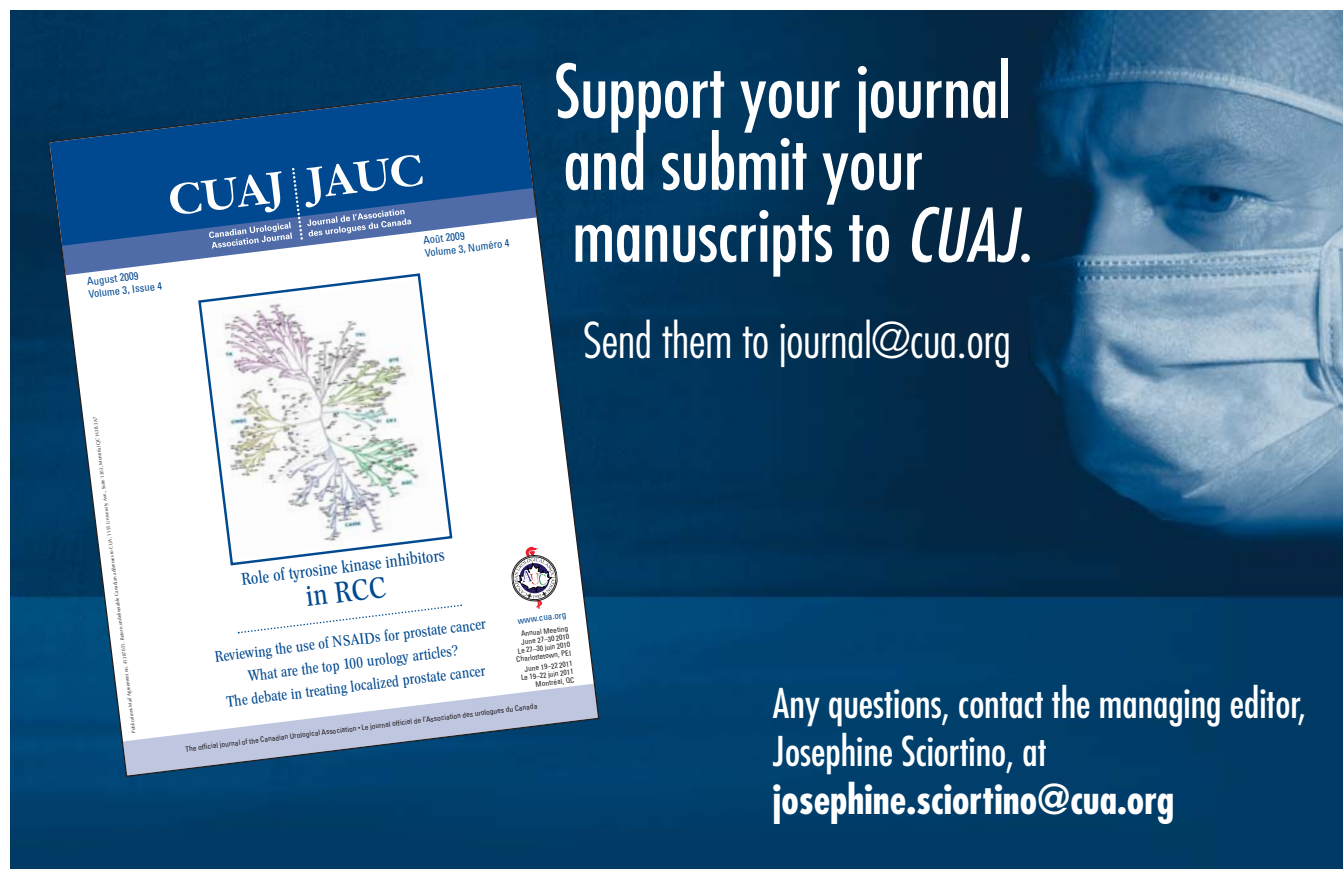
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References

1. *Bibliometrics* [homepage]. Available: www.gslis.utexas.edu/~palmquis/courses/biblio.html (accessed 2009 June 30).

2. Balhussen A, Kindler CH. Citation classics in anesthetic journals. *Anesth Analg* 2004;98:443-51.
3. Dubin D, Hafner AW, Arndt KA. Citation classics in clinical dermatologic journals. Citation analysis, biomedical journals, and landmark articles, 1945–1990. *Arch Dermatol* 1993;129:1121-9.
4. Paladugu R, Schein M, Gardezi S, et al. One hundred citation classics in general surgical journals. *World J Surg* 2002;26:1099-105.
5. Garfield E. 100 citation classics from the journal of the American Medical Association. *JAMA* 1987;257:52-9.
6. Picknett T, Davis K. The 100 most-cited articles from JMB. *J Mol Biol* 1999;293:171-6.
7. Gerharz EW, Emberton M, O'Brien T. The top 100 papers in urology: Chapter 16. In: *Classic papers in urology*. Gerharz EW, Emberton M, O'Brien T, editors. Oxford (UK): Isis Medical Media; 1999. p. 339-61.
8. Web of knowledge. ISI web of knowledge [homepage]. Available: <http://isiwebofknowledge.com> (accessed 2009 June 30).
9. Gami AS, Montori VM, Wilczynski NL, et al. Author self-citation in the diabetes literature. *CMAJ* 2004;170:1925-7.
10. Smith JA Jr. References and citations—what do they really mean? *J Urol* 2007;178:2246.

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The advertisement features a blue background. On the left, there is a tilted image of the journal cover for August 2009, Volume 3, Issue 4. The cover includes the title 'CUAJ | JAUC' and 'Canadian Urological Association Journal | Journal de l'Association des urologues du Canada'. The main article on the cover is 'Role of tyrosine kinase inhibitors in RCC'. Other articles listed include 'Reviewing the use of NSAIDs for prostate cancer', 'What are the top 100 urology articles?', and 'The debate in treating localized prostate cancer'. On the right, there is a close-up image of a surgeon's face wearing a surgical mask and cap. Overlaid on the right side of the advertisement is the text: 'Support your journal and submit your manuscripts to CUAJ. Send them to journal@cua.org'. At the bottom right, it says: 'Any questions, contact the managing editor, Josephine Sciortino, at josephine.sciortino@cua.org'.