The top 100 cited articles in urology: An update

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Abstract

Background: In this paper, we identify and analyze the top 100 cited articles in urology since 1965 and assess changes in the top 100 since 2007.

Methods: We selected highest impact journals in both urological and general medicine journals from the 2011 edition of Journal Citation Reports: Science edition. We identified and analyzed the 100 most cited articles using the Science Citation Index Expanded (1965-present).

Results: The top 100 articles were cited a mean of 892 times (range: 529-2088) and published between 1966 and 2009, with 21 published since 2000. In 2012, 19 new articles appeared in the updated top 100 cited articles. Also, 16 journals were represented, led by the *New England Journal of Medicine* (n=36), the *Journal of Urology* (n=16) and the *Lancet* (n=12). In total, 81 articles were published from North America (USA=77, Canada=4). From the United States, the following institutes were among the top 5 represented: Johns Hopkins University (n=12), Harvard University, Memorial Sloan Kettering Cancer Centre, National Institute of Health and Washington University (all 5). Only one institute outside the United States published more than one article in the top 100 (Institut Gustave Roussy, France). Nine urologists were first authors of 2 or more articles. Oncology (n=54) and transplantation (n=22) were the most common subspecialties represented.

Conclusion: It is important to acknowledge the top cited articles as they mark key topics and advances in urology. There has been a 19% change in the top 100 cited articles in the past 5 years. Oncology and transplantation remain the most highly cited topics.

Introduction

There are an ever increasing number of medical and specialty journals publishing articles at a prolific rate, but to a varying degree of quality.[1] Urology is a highly competitive surgical subspecialty and some trainees may be tempted to improve their curriculum vitae without adhering to the rigors of academic probity.[2] Almost 1 in every 6 original articles published in leading surgical journals include some form of redundancy.[3] A redundant publication is one which duplicates previous, simultaneous or future publications by the same author or group or, alternatively, could have been combined with the latter into one paper.

The establishment of a citation rank list has been often used in medicine to identify works that have had the greatest intellectual influence.[4] When a peer-reviewed article references another publication, a "citation" is received. Citation analysis involves ranking and evaluating an article or journal based on the number of citations it receives. In addition to determining the most frequently cited articles, this analysis is also used to rank journals in terms of impact. Multiple medical fields have used a rank list to determine the impact of articles and journals within its specialty, such as otolaryngology,[5] general surgery,[6] plastic surgery,[7] urology,[8] orthopaedics[9] and pediatric orthopaedics.[10] Although the significance of citation analysis remains controversial, proponents point out that this method provides the only objective method to determine the significance of an article or journal.[11,12]

Hennessey and colleagues published "the top 100 cited articles in urology" reviewing articles up to 2007.[13] A list of the most influential papers was compiled and their characteristics assessed for authorship and content. The paper identified topics and authors that contributed to major advances in urology. In this study, we identify and update the 100 most frequently cited articles published in urology and determine if there have been changes since 2007.

Methods

To identify the most frequently cited articles published in urology, we selected 90 of the highest impact journals dedicated to urology and its subspecialty areas (Transplantation, Nephrology, Infectious Diseases and Sexual Health), as well as 32 of the highest impact general medical and medical research journals from the 2011 edition of Journal Citation Reports (JCR): Science Edition.

Table 1. The top 100 cited articles in urology, 2007 and 2012

Ranking 2012 (2007)	Article	No. citations (2012)	No. citations (2007)
1 (1)	Feldman HA, et al. Impotence and its medical and psychosocial correlates: results of the Massachusetts Male Aging Study. J Urol 1994151:54-61.	2088	1435
2 (30)	Abrams P, et al. The standardisation of terminology of lower urinary tract function: Report from the International Standardisation Sub-Committee Continence Society. Neurourol Urodyn 2002;21:167-78.	2030	716
3 (*)	Motzer RJ, et al. Sunitinib versus interferon alfa in metastatic renal-cell carcinoma. N Engl J Med 2007;356:115-24.	1792	
4 (*)	Laumann EO, et al. Sexual dysfunction in the United States - Prevalence and predictors. JAMA 1999;281:537-44.	1742	
5 (*)	Escudier B, et al. Sorafenib in advanced clear-cell renal-cell carcinoma. N Engl J Med 2007;356:125-34.	1723	
6 (7)	Racusen LC, et al. The Banff 97 working classification of renal allograft pathology. Kidney Int 1999;55:713-23.	1694	957
7 (11)	Rosen RC, et al. The international index of erectile function (IIEF): A multidimensional scale for assessment of erectile dysfunction. Urology 1997;49:822-30.	1688	901
8 (*)	Tannock IF, et al. Docetaxel plus prednisone or mitoxantrone plus prednisone for advanced prostate cancer. N Engl J Med 2004;351:1502-12.	1529	
9 (4)	Palermo G, et al. Pregnancies after intracytoplasmic injection of single spermatozoon into an oocyte. Lancet 1992;340:17-8.	1525	1122
10 (2)	Stamey TA, et al. Prostate-specific antigen as a serum marker for adenocarcinoma of the prostate. N Engl J Med 1987;317:909-16.	1491	1250
11 (58)	Yang JC, et al. A randomized trial of bevacizumab, an anti-vascular endothelial growth factor antibody, for metastatic renal cancer. N Engl J Med 2003;349:427-34.	1488	516
12 (8)	Barry MJ, et al. The American Urological Association symptom index for benign prostatic hyperplasia. The Measurement Committee of the American Urological Association. J Urol 1992;148:1549-57.	1397	942
13 (24)	Pound CR, et al. Natural history of progression after PSA elevation following radical prostatectomy. JAMA 1999;281:1591-7.	1348	774
14 (45)	Wolfe RA, et al. Comparison of mortality in all patients on dialysis, patients on dialysis awaiting transplantation and recipients of a first cadaveric transplant. N Engl J Med 1999;341:1725-30.	1312	584
15 (5)	Catalona WJ, et al. Measurement of prostate-specific antigen in serum as a screening test for prostate cancer. N Engl J Med 1991;324:1156-61.	1304	1052
16 (12)	Chan JM, et al. Plasma insulin-like growth factor-I and prostate cancer risk: a prospective study. Science 1998;279:563-6.	1303	901
17 (3)	Einhorn LH, et al. Cis-diamminedichloroplatinum, vinblastine, and bleomycin combination chemotherapy in disseminated testicular cancer. Ann Intern Med 1977;87:293-8.	1277	1209
18 (59)	Rayman MP. The importance of selenium to human health. Lancet 2000;356:233-41.	1268	514
19 (*)	Petrylak DP, et al. Docetaxel and estramustine compared with mitoxantrone and prednisone for advanced refractory prostate cancer. N Engl J Med 2004;351:1513-20.	1253	
20 (6)	Goldstein I, et al. Oral sildenafil in the treatment of erectile dysfunction. Sildenafil Study Group. N Engl J Med 1998;338:1397-404.	1238	973
21 (17)	Carlsen E, et al. Evidence for decreasing quality of semen during past 50 years. BMJ 1992;305:609-13.	1225	849
22 (9)	Gleason DF, et al. Prediction of prognosis for prostatic adenocarcinoma by combined histological grading and clinical staging. J Urol 1974;111:58-64.	1208	924
23 (10)	Sharpe RM, et al. Are oestrogens involved in falling sperm counts and disorders of the male reproductive tract? Lancet 1993;341:1392-5.	1193	910
24 (100)	D'Amico AV, et al. Biochemical outcome after radical prostatectomy, external beam radiation therapy, or interstitial radiation therapy for clinically localized prostate cancer. JAMA 1998;280:969-74.	1112	418
25 (27)	Partin AW, et al. Combination of prostate-specific antigen, clinical stage, and Gleason score to predict pathological stage of localized prostate cancer. A multi-institutional update. JAMA 1997;277:1445-51.	1107	755
26 (*)	Thompson IM, et al. The influence of finasteride on the development of prostate cancer. N Engl J Med 2003;349:215-24.	1093	
27 (25)	Droller MJ, et al. Impotence. JAMA 1993;270:83-90.	1086	761
28 (14)	Crawford ED, et al. A controlled trial of leuprolide with and without flutamide in prostatic carcinoma. N Engl J Med 1989;321:419-24.	1022	870

*New articles, not included in the top 100 in 2007.

Table 1. The top 100 cited articles in urology, 2007 and 2012 (cont'd)

Ranking 2012 (2007)	Article	No. citations (2012)	No. citations (2007)
29 (18)	Robson CJ, et al. The results of radical nephrectomy for renal cell carcinoma. J Urol 1969;101:297-301.	1020	845
30 (28)	Berry SJ, et al. The development of human benign prostatic hyperplasia with age. J Urol 1984;132:474-9.	997	751
31 (33)	Hariharan S, et al. Improved graft survival after renal transplantation in the United States, 1988 to 1996. N Engl J Med 2000;342:605-12.	994	665
32(13)	Oesterling JE. Prostate specific antigen: a critical assessment of the most useful tumor marker for adenocarcinoma of the prostate. J Urol 1991;145:907-23.	978	877
33 (15)	Solez K, et al. International standardization of criteria for the histologic diagnosis of renal allograft rejection: the Banff working classification of kidney transplant pathology. Kidney Int 1993;44:411-22.	978	862
34 (22)	Sollinger HW. Mycophenolate mofetil for the prevention of acute rejection in primary cadaveric renal allograft recipients. U.S. Renal Transplant Mycophenolate Mofetil Study Group. Transplantation 1995;60:225-32.	956	803
35 (19)	Opelz G, et al. Effect of blood transfusions on subsequent kidney transplants. Transplant Proc 1973;5:253-9.	934	839
36 (20)	Loehrer PJ, et al. Drugs 5 years on: Cisplatin. Ann Intern Med 1984;100:704-13.	933	828
37 (32)	Bolla M, et al. Improved survival in patients with locally advanced prostate cancer treated with radiotherapy and goserelin. N Engl J Med 1997;337:295-300.	929	683
38 (23)	Mebust WK, et al. Transurethral prostatectomy: immediate and postoperative complications. A cooperative study of 13 participating institutions evaluating 3,885 patients. J Urol 1989;141:243-7.	920	784
39 (16)	Calne RY, et al. Cyclosporin A in patients receiving renal allografts from cadaver donors. Lancet 1978;2:1323-7.	914	850
40 (26)	Belzer FO, et al. Principles of solid organ preservation by cold storage. Transplantation 1988;45:673-6.	890	759
41 (21)	Gabrilove JL, et al. Effect of granulocyte colony-stimulating factor on neutropenia and associated morbidity due to chemotherapy for transitional-cell carcinoma of the urothelium. N Engl J Med 1988;318:1414-22.	856	826
42 (35)	Oesterling JE, et al. Serum prostate-specific antigen in a community-based population of healthy men. Establishment of age-specific reference ranges. JAMA 1993;270:860-4.	813	658
43 (36)	Catalona WJ, 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 6,630 men. J Urol 1994;151:1283-90.	811	657
44 (51)	Walsh PC, et al. Impotence following radical prostatectomy: insight into etiology and prevention. J Urol 1982;128:492-7.	809	561
45 (54)	Clayman RV, et al. Laparoscopic nephrectomy: initial case report. J Urol 1991;146:278-82.	806	537
46 (*)	Gardner SD, et al. New human papovavirus (B.K.) isolated from urine after renal transplantation. Lancet 1971;1:1253-7.	799	
47 (72)	Motzer RJ, et al. Renal-cell carcinoma. N Engl J Med 1996;335:865-75.	796	472
48 (*)	Thompson IM, et al. Prevalence of prostate cancer among men with a prostate-specific antigen level < or =4.0 ng per milliliter. N Engl J Med 2004;350:2239-46.	794	
49 (37)	Williams SD, et al. Treatment of disseminated germ-cell tumors with cisplatin, bleomycin, and either vinblastine or etoposide. N Engl J Med 1987;316:1435-40.	786	653
50 (70)	Epstein JI, et al. Pathologic and clinical findings to predict tumor extent of nonpalpable (stage T1c) prostate cancer. JAMA 1994;271:368-74.	781	475
51(29)	Starzl TE, et al. FK 506 for liver, kidney, and pancreas transplantation. Lancet 1989;2:1000-4.	774	721
52 (42)	Partin AW, et al. The use of prostate specific antigen, clinical stage and Gleason score to predict pathological stage in men with localized prostate cancer. J Urol 1993;150:110-4.	758	594

*New articles, not included in the top 100 in 2007.

The impact factor of a journal is calculated based on a 2-year period. It is 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 90 urology and subspecialty journals under the subject categories "Urology and Nephrology" and "Transplantation" in the JCR 2011. We included all journals except 3 nephrology journals and 2 transplant journals, as they did not pertain to urology. We selected 32 general medical and medical research journals by searching the JCR 2011 subject categories

Table 1. The top 100 cited articles in urology, 2007 and 2012 (cont'd)

Ranking 2012 (2007)	Article	No. citations (2012)	No. citations (2007)
53 (39)	Grinyo JM. Placebo-controlled study of mycophenolate mofetil combined with cyclosporin and corticosteroids for prevention of acute rejection. European Mycophenolate Mofetil Cooperative Study Group. Lancet 1995;345:1321-5.	749	619
54 (31)	Sidransky D, et al. Identification of p53 gene mutations in bladder cancers and urine samples. Science 1991;252:706-9.	747	709
55 (*)	Andriole GL, et al. Mortality results from a randomized prostate-cancer screening trial. N Engl J Med 2009;360:1310-9.	746	
56 (*)	Harisinghani MG, et al. Noninvasive detection of clinically occult lymph-node metastases in prostate cancer. N Engl J Med 2003;348:2491-9.	741	
57 (46)	Carter HB, et al. Longitudinal evaluation of prostate-specific antigen levels in men with and without prostate disease. JAMA 1992;267:2215-20.	738	581
58 (55)	Hodge KK, et al. Random systematic versus directed ultrasound guided transrectal core biopsies of the prostate. J Urol 1989;142:71-4.	738	524
59 (*)	Escudier B, et al. Bevacizumab plus interferon alfa-2a for treatment of metastatic renal cell carcinoma: a randomised, double-blind phase III trial. Lancet 2007;370:2103-11.	729	
60 (38)	Gormley GJ, et al. The effect of finasteride in men with benign prostatic hyperplasia. The Finasteride Study Group. N Engl J Med 1992;327:1185-91.	726	629
61 (57)	Patel R, et al. Significance of the positive crossmatch test in kidney transplantation. N Engl J Med 1969;280:735-9.	719	519
62 (43)	Pirsch JD, et al. A comparison of tacrolimus (FK506) and cyclosporine for immunosuppression after cadaveric renal transplantation. FK506 Kidney Transplant Study Group. Transplantation 1997;63:977-83.	711	589
63 (*)	Motzer RJ, et al. Efficacy of everolimus in advanced renal cell carcinoma: a double-blind, randomised, placebo-controlled phase III trial. Lancet 2008;372:449-56.	707	
64 (34)	Cohen DJ, et al. Cysclosporine: a new immunosuppressive agent for organ transplantation. Ann Intern Med 1984;101:667-82.	696	663
65 (47)	Catalona WJ, et al. Detection of organ-confined prostate cancer is increased through prostate-specific antigen-based screening. JAMA 1993;270:948-54.	695	579
66 (52)	Morales A, et al. Intracavitary Bacillus Calmette-Guerin in the treatment of superficial bladder tumors. J Urol 1976;116:180-3.	693	557
67 (*)	Rosen RC, et al. Development and evaluation of an abridged, 5-item version of the International Index of Erectile Function (IIEF-5) as a diagnostic tool for erectile dysfunction. Int J Impot Res 1999;11:319-26.	692	
68 (74)	Messing EM, et al. Immediate hormonal therapy compared with observation after radical prostatectomy and pelvic lymphadenectomy in men with node-positive prostate cancer. N Engl J Med 1999;341:1781-8.	691	460
69 (49)	Keown P. A blinded, randomized clinical trial of mycophenolate mofetil for the prevention of acute rejection in cadaveric renal transplantation. The Tricontinental Mycophenolate Mofetil Renal Transplantation Study Group. Transplantation 1996;61:1029-37.	683	574
70 (62)	Childs R, et al. Regression of metastatic renal-cell carcinoma after nonmyeloablative allogeneic peripheral-blood stem-cell transplantation. N Engl J Med 2000;343:750-8.	682	503
71 (*)	Bill-Axelson A, et al. Radical prostatectomy versus watchful waiting in early prostate cancer. N Engl J Med 2005;352:1977-84.	678	
72 (50)	Heney NM, et al. Superficial bladder cancer: progression and recurrence. J Urol 1983;130:1083-6.	670	562
73 (61)	Litwin MS, et al. Quality-of-life outcomes in men treated for localized prostate cancer. JAMA 1995;273:129-35.	666	504

*New articles, not included in the top 100 in 2007.

"Medicine, General and Internal" and "Medicine Research and Experimental." We then ranked the journals by their respective impact factors.

We cross-referenced this list with the list of journals searched in the textbook *Classic Papers in Urology*[14] and the 2009 paper by Hennessey and colleagues entitled "The top 100 cited articles in urology."[13] In total, we searched 122 journals (90 urological/subspecialty and 32 medical/research).

We identified the 100 most frequently cited urological articles from the 132 journals using the database of the Science Citation Index expanded (1956-present). We

Table 1. The top 100 cited articles in urology, 2007 and 2012 (cont'd)

Ranking 2012 (2007)	Article	No. citations (2012)	No. citations (2007)
74 (48)	Chodak GW, et al. Results of conservative management of clinically localized prostate cancer. N Engl J Med 1994;330:242-8.	658	576
75 (75)	Terasaki PI, et al. High survival rates of kidney transplants from spousal and living unrelated donors. N Engl J Med 1995;333:333-6.	647	460
76 (67)	Taplin ME, et al. Mutation of the androgen-receptor gene in metastatic androgen-independent prostate cancer. N Engl J Med 1995;332:1393-8.	635	481
77 (41)	Cosimi AB, et al. Use of monoclonal antibodies to T-cell subsets for immunologic monitoring and treatment in recipients of renal allografts. N Engl J Med 1981;305:308-14.	631	606
78 (79)	Auger J, et al. Decline in semen quality among fertile men in Paris during the past 20 years. N Engl J Med 1995;332:281-5.	626	454
79 (56)	Rajfer J, et al. Nitric oxide as a mediator of relaxation of the corpus cavernosum in response to nonadrenergic, noncholinergic neurotransmission. N Engl J Med 1992;326:90-4.	625	523
80 (84)	Carani C, et al. Effect of testosterone and estradiol in a man with aromatase deficiency. N Engl J Med 1997;337:91-5.	622	445
81 (*)	Kass EH. Bacteriuria and the diagnosis of infections of the urinary tract; with observations on the use of methionine as a urinary antiseptic. Arch Intern Med 1957;100:709-14.	618	
82 (44)	Bookstein R, et al. Suppression of tumorigenicity of human prostate carcinoma cells by replacing a mutated RB gene. Science 1990;247:712-5.	612	587
83 (*)	Milsom I, et al. How widespread are the symptoms of an overactive bladder and how are they managed? A population-based prevalence study. BJU Int 2001;87:760-6.	606	
84 (*)	Motzer RJ, et al. Sunitinib in patients with metastatic renal cell carcinoma. JAMA 2006;295:2516-24.	601	
85 (*)	McConnell JD, et al. The long-term effect of doxazosin, finasteride, and combination therapy on the clinical progression of benign prostatic hyperplasia. N Engl J Med 2003;349:2387-98.	600	
86 (95)	Groth CG, et al. Sirolimus (rapamycin)-based therapy in human renal transplantation: similar efficacy and different toxicity compared with cyclosporine. Transplantation 1999;67:1036-42.	581	422
87 (53)	Cohen AJ, et al. Hereditary renal-cell carcinoma associated with a chromosomal translocation. N Engl J Med 1979;301:592-5.	579	551
88 (*)	Kahan BD. Efficacy of sirolimus compared with azathioprine for reduction of acute renal allograft rejection: a randomised multicentre study. Lancet 2000;356:194-202.	579	
89 (64)	Thomas TM, et al. Prevalence of urinary incontinence. Br Med J 1980;281:1243-5.	576	499
90 (80)	Dong JT, et al. KAI1, a metastasis suppressor gene for prostate cancer on human chromosome 11p11.2. Science 1995;268:884-6.	561	453
91 (94)	Walsh PC, et al. Radical prostatectomy with preservation of sexual function: anatomical and pathological considerations. Prostate 1983;4:473-85.	556	422
92 (63)	Almond PS, et al. Risk factors for chronic rejection in renal allograft recipients. Transplantation 1993;55:752-6	552	502
93 (66)	Cooner WH, et al. Prostate cancer detection in a clinical urological practice by ultrasonography, digital rectal examination and prostate specific antigen. J Urol 1990;143:1146-52	551	487
94 (85)	Esrig D, et al. Accumulation of nuclear p53 and tumor progression in bladder cancer. N Engl J Med 1994;331:1259-64.	548	442
95 (89)	Chillón M, et al. Mutations in the cystic fibrosis gene in patients with congenital absence of the vas deferens. N Engl J Med 1995;332:1475-80.	546	431
96 (97)	Vincenti F, et al. Interleukin-2-receptor blockade with daclizumab to prevent acute rejection in renal transplantation. N Engl J Med 1998;338:161-5.	540	420
97 (76)	Smith JR, et al. Major susceptibility locus for prostate cancer on chromosome 1 suggested by a genome-wide search. Science 1996;274:1371-4.	536	459
98 (87)	Lapides J, et al. Clean, intermittent self-catheterization in the treatment of urinary tract disease. J Urol 1972;107:458-61.	533	436
99 (65)	Neal DE, et al. Epidermal growth factor receptors in human bladder cancer: comparison of invasive and superficial tumors. Lancet 1985;1:366-8	529	498
100 (69)	Stamey TA, et al. Prostate specific antigen in the diagnosis and treatment of adenocarcinoma of the prostate. II. Radical prostatectomy treated patients. J Urol 1989;141:1076-83.	518	479

*New articles, not included in the top 100 in 2007.

Table 2. List of omitted articles from updated top 100.

Ranking (2007)	Article
40	Hricik DE, et al. Captopril induced functional renal insufficiency in patients with bilateral renal artery stenoses or renal artery stenosis in a solitary kidney. N Engl J Med 1983;308:373-6.
60	Chajek T, et al. Behcets disease: a report of 41 cases and a review of the literature. Medicine 1975;54:179-86.
68	Legha SS, et al. Reduction of doxorubicin cardiotoxicity by prolonged continuous intravenous infusion. Ann Intern Med 1982;96:133-9.
71	Cartwright RA, et al. Role of N-acetyltransferase phenotypes in bladder carcinogenesis: a pharmacogenetic epidemiological approach to bladder cancer. Lancet 1982;2:842-6.
73	Christensson A, et al. Serum prostate specific antigen complexed to alpha 10antichymotrypsin as an indicator of prostate cancer. J Urol 1993;150:100-5.
77	Willett WC, et al. Prediagnostic serum selenium and risk of cancer. Lancet 1983;2:130-4.
78	Oesterling JE, et al. Prostate specific antigen in the preoperative and postoperative evaluation of localized prostatic cancer in treated patients with radical prostatectomy. J Urol 1988;139:766-72.
81	Corey L, et al. Genital herpes simplex virus infections: clinical manifestations, course, and complications. Ann Intern Med 1983;98:958-72.
82	McNeal JE, et al. Patterns of progression in prostate cancer. Lancet 1986;1:60-3.
83	Partin AW, et al. Serum PSA after anatomic radical prostatectomy: the Johns Hopkins experience after 10years. Urol Clin North Am 1993;20:713-25.
86	Stamey TA, et al. Localization and treatment of urinary tract infections: role of bactericidal urine levels as opposed to serum levels. Medicine 1965;44:1-36.
88	Roos NP, et al. Mortality and reoperation after open and transurethral resection of the prostate for benign prostatic hyperplasia. N Engl J Med 1989;320:1120-4.
90	Fleming C, Wasson JH, Albertsen PC, et al. A decision analysis of alternative treatment strategies for clinically localized prostate cancer. JAMA 1993;269:2650-8
91	Partin AW, et al. Prostate specific antigen in the staging of localized prostate cancer: influence of tumor differentiation, tumor volume and benign hyperplasia. J Urol 1990;143:747-52.
92	Chaussy C, et al. First clinical experience with extracoporeally induced destruction of kidney stones by shock waves. J Urol 1982;127:417-20.
93	Drach GW, et al. Report of United States cooperative study of extracorporeal shock wave lithotripsy. J Urol 1986;135:1127-33.
96	Balfour HH, et al. A randomized, placebo controlled trial of oral acyclovir for the prevention of cytomegalo virus disease in recipients of renal allografts. N Engl J Med 1989;320:1381-7.
98	Krane RJ, et al. Impotence. N Engl J Med 1989;321:1648-59
99	Garraway WM, et al. High prevalence of benign prostatic hyperplasia in the community. Lancet 1991;338:469-71.

performed this search on October 5, 2012. This database includes publications from the 55-year period 1956 to 2011. We searched each of the 132 journals and included every article with greater than 100 citations in a comprehensive ranked list. The top 100 cited articles made up our final list (Table 1). We accessed and reviewed the articles online using MEDLINE. When relevant articles were not available online, we received articles in print format via the Royal College of Surgeons in Ireland library. We analyzed the articles and tabulated the data according to the number of citations, country and institute of origin, journal, impact factor, authorship and subspecialty.

Results

The mean number of citations for the top 100 articles was 892 (range: 529- 2088). The top 100 articles were published between 1957 and 2009 (Table 1). The oldest article was published in 1957 (Kass et al, *Archives of Internal Medicine*) and the most recent in 2009 (Andriole et al, *New England Journal of Medicine*). Of the 2007 top 100 list, 19 articles were not included in the 2012 update (Table 2).

The top 100 articles came from 10 countries, with 77% from the United States (Table 3). Sixteen institutions published 2 or more of the top 100 cited articles, with only 1 of these institutions from outside the United States (Institute Gustave Roussy, Villejuif, France). Nine investigators were first authors of 2 or more of the top 100 cited articles, originating from 8 institutions (Table 4).

Despite the fact that we searched 122 journals, the top 100 articles were published in 16 (13.1%) journals: 7 urology, 7 general medicine and 2 transplantation journals (Table 5). Oncology (54) and transplantation (22) were the most commonly represented subspecialties (Table 6). Eighty-one articles were included in the top 100 cited articles published in 2009. There was a 21% increase in the lowest number of

Table 3. Countries of origin of the top 100 cited articles in urology

Country	No. Articles
United States of America	77
United Kingdom	6
France	4
Canada	4
Sweden	3
Spain	2
Denmark	1
Italy	1
Japan	1
Belgium	1

Table 4. Institutions of origin with 2 or more top-cited articles in urology

Rank	Institution	No. articles
1	Johns Hopkins University	12
2	Harvard University	5
3	Memorial Sloan Kettering Cancer Centre	5
4	Washington University	5
5	National Institute of Health	4
6	University of Texas	4
7	Stanford University	3
8	University of California, San Francisco	3
9	University of California, Los Angeles	3
10	Boston University	2
11	Mayo Clinic	2
12	University of Chicago	2
13	University of Medicine and Dentistry of New Jersey	2
14	University of Massachusetts	2
15	University of Michigan	2
16	Institute Gustave Roussy, Villejuif, France	2

citations received to be included in the top 100 from 418 to 518. One new country of origin (Japan) has been included with 2 falling out of the top 100 cited articles (Australia and Germany). Three of the top 5 institutions remain the same (Johns Hopkins University Hospital, Harvard University and Washington University).

Discussion

We have identified the top 100 articles in urology from 122 recognized peer-reviewed journals. Citation analysis was chosen as the determinant of selection. Although there is no direct correlation between citation frequency and study quality, it does offer an insight to the degree of peer analysis, the readership of the manuscript and a measure of recognition. A high citation frequency also demonstrates that other authors have formulated opinions on the topic and that it has generated discussion and debate. Citation analysis, although debatable, has been used widely as a standard of quality across medical specialities.[5-10] Furthermore, these top 100 articles were published in 16 peer-reviewed journals of high quality demonstrated by their impact factor (mean 13.99, range: 1.005-53.298). The impact factor of a journal is generally accepted as a representation of the scientific quality of a publication.[8]

Publications and research have become key components in trainees' development. In many specialities, publications are one of the main discriminants between individuals. A list of the top 100 most cited articles demonstrates key papers

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

Rank	Journal	No. articles	Impact factor (2011)
1	New England Journal of Medicine	36	53.298
2	Journal of Urology	16	3.746
3	Lancet	12	38.278
4	Journal of the American Medical Association	11	30.026
5	Transplantation	6	4.003
6	Science	5	31.201
7	Annals of Internal Medicine	3	16.733
8	British Medical Journal	2	14.093
9	Kidney International	2	6.606
10	Archives of Internal Medicine	1	11.462
11	British Journal of Urology International	1	2.844
12	International Journal Impotence Research	1	1.712
13	Neurology and Urodynamics	1	2.958
14	Prostate	1	3.485
15	Transplantation Proceedings	1	1.005
16	Urology	1	2.428

Table 6. Most common subspecialties represented in the top 100 cited articles in urology

Subspecialty	No. articles
Oncology	54
Transplantation	22
Sexual function/infertility	13
Voiding dysfunction	7
Infection	3
Congenital abnormality	1

Table 7. Most common first authors of the top 100 cited articles in urology

Author	No. articles
Motzer RJ	4
Catalona WJ	3
Escudier B	2
Oesterling JE	2
Partin AW	2
Rosen RC	2
Stamey TA	2
Thompson IM	2
Walsh PC	2

selected on citations in peer-reviewed journals. Although a flawed rank of quality, it does highlight an acceptance of their importance in the field. An awareness of these articles, mainly in high impact journals, can be an education to trainees regarding research methodology and ethical considerations.

There have been some changes to our updated list compared to the list published by Hennessey and colleagues in 2009.[13] The topics of discussion have largely remained the same; oncology, transplantation and sexual function are the most common topics. There has been a 19% change in the composition of the top 100 articles, as well as a 21% increase in the number of citations necessary to enter the top 100. Most (77%) high impact articles were published from the United States. In 2009, there were only 12 institutes that published more than 2 articles in the top 100 compared to 16 in our 2012 list. The top producing institute remained John Hopkins University. Only 1 institute from outside the United States produced more than 1 article in the top 100 list (Institut Gustave Roussy, France).

It is not possible to analyze the entire top 100 list; however, some interesting observations can be made from the top 10 articles. Three of the top 10 articles focus on sexual dysfunction (a topic that was included in the 2009 top 10). Ranked number 1, Feldman and colleagues discussed male impotence and its medical correlates. Ranked number 4, Laumann and colleagues discussed sexual dysfunction among men and women in the era of pharmacological advances in erectile dysfunction. While at number 7, Rosen and colleagues discussed detecting treatment-related changes in men with erectile dysfunction. Two articles, ranked 3 (Motzer et al.) and 5 (Escudier et al.), discussed the changing chemotherapeutic agents available for the treatment of renal cell carcinoma demonstrating the advances in medical uro-oncology. These papers were published in the past decade, yet have received over 1400 citations, highlighting their importance and obvious effect on clinical practice.

Another paper marks the importance of medical oncology in the field of urology; ranked 8, the paper by Tannock and colleagues focused on the oncological management of prostate cancer. The remaining 4 articles in the top 10 include: at 10, Stamey and colleagues present a classic paper of prostate-specific antigen as a serum marker for prostate cancer; number 9, Palermo and colleagues discuss intracytoplasmic injection of spermatozoon; at number 6, Racusen and colleagues examine the Banff classification of renal allograft rejection; and at number 2, Abrams and colleagues review the standardization of terminology for lower urinary tract function (Table 7).

The limitations of this study are in the measure of a paper's quality. There is no unique way to assess the quality of an article. Citation analysis ignores the fact of a citation being positive or negative, as well as the phenomenon of self-citation, which holds inherent bias. Furthermore, although not a unique research topic, it was prudent to highlight the dynamic process of a top 100 list. As time passes "landmark articles" are cemented in practice or disproved. New publications and developments in research and practice are forging their way into the top 100. Without doubt, there is a time lag for promising papers to accumulate the number of citations to warrant inclusion in the top 100. For this reason, we feel it necessary to update the top 100 most cited articles in urology on an ongoing basis (as is evident by the 19% variation in the top 100 compilation).

Conclusion

This updated top 100 list highlights key papers in the field of urology. The top 100 articles were produced from some of the most reputable institutions across the world by world renowned urologists, clinicians and researchers. It is important for trainees to be aware of these key papers, which ultimately design the evidence-based clinical practice of urology.

Ranking the top 100 articles by their citation index underlines the attention these "classics" have received in the peer review process and the depth of discussion that has been created as a result of these studies. Knowledge of key papers is paramount to any surgical speciality and this update in urology highlights the changes in urological research.

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