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Review Article

Journal impact factor in the era of expanding literature

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The Journal Citation Reports (JCR) of the Science Citation Index (SCI), published by the Institute of Scientific Information (ISI), provides a comprehensive database for analysis of journals. Recent use of JCR's journal impact factor for evaluation of journals and authors has provoked strongly mixed reactions among investigators. This paper examines the effects of the rapidly expanding literature on the impact factor over the past decade and examines the limitations of journal impact factor for evaluating individual author's contributions. The JCR analyzed 6088 journals in 2005, a 32% increase in new listings since 1995. During the same period, there was a 39% increase in new journal listings in the infectious diseases category. The phenomenon of journal proliferation has had a profound effect on the journal impact factor. During the past decade an increased impact factor was observed in 92% of the top ranking major journals, especially in young and rapidly expanding research fields. Certain highly cited new journals published primarily review articles — not original contributions. There was no increase in impact factor among some of the best known journals, such as Journal of Experimental Medicine, Proceedings of the National Academy of Sciences (USA), and Journal of Infectious Diseases. Clearly, journal impact factor is an imperfect tool for measuring the quality of articles, and its use in evaluating authors has inherent risks. In spite of its limitations, journal impact factor can be used as a rough indicator of scientific quality in specific subject categories and for serious reading and learning.

Key words: Abstracting and indexing, bibliographic, bibliometrics, biomedical research, communicable diseases, databases

Introduction

With the proliferation of scientific medical journals, the tasks of selecting significant literature and keeping up with the literature have become significant challenges for physicians, scientists, teachers and students. Reading is not a homogenous activity, and it is essential to define individual needs and choose appropriate and relevant journals and articles for critical reading. Science Citation Index (SCI) was originally introduced in 1961 as a tool for bibliographical retrieval [1,2]. Over the past two decades, journal *impact factor* as presented in the Journal Citation Reports (JCR) of the SCI has been increasingly used as a quantitative tool for evaluation of journal quality and a rough guide for readers [3-5]. And no doubt it is associated with achievement: for example, over 95% of recent discoveries in infectious diseases have been reported in the top 2% of bioscience journals as indicated by impact factor [4]. The term "impact factor" has evolved to include both journal and author impact, and has provoked strong but mixed reactions among researchers, editors, administrators, librarians, and grant-awarding committees. While Garfield and others have pointed out that the use of journal impact factor in evaluating individuals has its inherent dangers [2,6,7], authors and committees alike have continued to use it as a quantitative basis for targeting journals for submission of manuscripts, supporting research, justifying academic promotions, and evaluating institutions.

Since its introduction, many questions have been raised regarding the validity of journal impact factor [6-8]. New information has emerged regarding its usefulness and limitations. Using the infectious disease literature as an example, this paper reviews the effects of the rapidly changing literature on the journal impact factor over the past decade, and suggests proper usage and interpretation of the impact factor.

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Definitions

The JCR, published by the Institute of Scientific Information (ISI), is the only resource for comprehensive citation data for evaluation of journal quality [9,10]. Each year, JCR analyzes a vast collection of journals (6088 in 2005) identified by the SCI and indexes them according to number of citations, impact factor, immediacy index and half-life [9,10].

The *number of citations* is the number of times a journal's articles are cited as references in other articles, and partly reflects the journal's size and publication frequency. The *impact factor* measures the frequency with which the "average article" in a journal has been cited in a particular year, giving a sense of the overall quality and significance of a given journal's contents and correcting for journal size and frequency of publication. The *immediacy index* measures how often within a year after publication the particular journal's "average article" is cited, and may indicate the article's newsworthiness or the pace of research in a particular field. The *half-life* describes the longevity or age of its cited articles, and is an indicator of a journal's historical impact and regard [5,9,10].

In examining the influence of the rapidly increasing medical literature on the journal impact factor, we have focused our analysis on the changing field of infectious diseases. We examined two types of journals that publish infectious disease-related articles: the infectious disease journals as categorized by the JCR [9,10] and selected top-ranking multidisciplinary clinical medicine journals (e.g., New England Journal of Medicine, Lancet, JAMA) and non-infectious disease subspecialty journals (e.g., Circulation, Blood, Gastroenterology).

Emerging Pathogens in Infectious Diseases

At least 37 new infectious disease agents (or toxins) were identified from 1973 to 2006 (Table 1) [4,11-13]. The journals that published these important discoveries include: Lancet (10), Science (6), Journal of Clinical Microbiology (4), Journal of Infectious Diseases (3), New England Journal of Medicine (2), Proceedings of the National Academy of Sciences "PNAS" (2), Virology (2), International Journal of Systematic Bacteriology (2), and one each in British Medical Journal, Journal of Virology, Gastroenterology, Nature Medicine, Biochemical and Biophysical Research Communications, and WHO's Weekly Epidemiologic Record.

Common features of these journals are that they are well established, well recognized worldwide, and publish original research articles. With the exception of Weekly Epidemiological Record (which recorded *Vibrio cholerae* O139 in 1993), these publications, according to the SCI's JCR, are highly cited and have a high journal impact factor [10]. In 2005, the mean impact factor for these 13 journals was 14.2, as compared with the 3.0 achieved by the 46 infectious disease journals listed in Table 2 [10].

Table 1. Recent identification of selected new etiologic agents in infectious diseases

Year	Agent	Reference[a]
1973	Rotavirus	Bishop et al. Virus particles in epithelial cells of duodenal mucosa from children with acute non-bacterial gastroenteritis. Lancet 1973;2:1281.
1975	Parvovirus B19	Cossart et al. Parvovirus-like particles in human sera. Lancet 1975;1:72.
1976	*Cryptosporidium parvum*	Nime et al. Acute enterocolitis in a human infected with the protozoa. Gastroenterology 1976;70:592.
1977	Ebola virus	John et al. Isolation and partial characterization of a new virus causing acute haemorrhagic fever in Zaire. Lancet 1977;1:569.
1977	*Legionella pneumophila*	McDade et al. Legionnaires' disease. 2: Isolation of a bacterium and demonstration of its role in other respiratory disease. N Engl J Med 1977;297:1197.
1977	Hantaan virus	Lee et al. Isolation of the etiologic agent of Korean hemorrhagic fever. J Infect Dis 1978;137:298.
1977	*Campylobacter* sp.	Skirow. Campylobacter enteritis: a "new" disease. BMJ 1977;2:9.
1980	Human T-cell lymphotropic virus type 1 (HLTV-1)	Poiesz et al. Detection and isolation of type C retrovirus particles from fresh and cultured lymphocytes of a patient with cutaneous T-cell lymphoma. Proc Natl Acad Sci 1980;77:7415.
1981	*Staphylococcus* toxin	Schlievert et al. Identification and characterization of an exotoxin from *Staphylococcus aureus* associated with toxic shock syndrome. J Infect Dis 1981;143:509.
1981	*Escherichia coli* O157:H7	Riley et al. Hemorrhagic colitis associated with a rare *Escherichia coli* serotype. N Engl J Med 1983;308:681.
1982	HTLV II	Kalyanaramen et al. Immunological properties of a type C retrovirus isolated from cultured human T-lymphoma cells and comparison to other mammalian retroviruses. J Virol 1981;38:906.
1982	*Borrelia burgdorferi*	Burgdorfer et al. Lyme disease – a tick-borne spirochetosis? Science 1982;216:1317.

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1983	Human immunodeficiency virus	Barre-Sinoussi et al. Isolation of a T-lymphotropic retrovirus from a patient at risk for acquired immune deficiency syndrome. Science 1983;220:868.
1983	*Helicobacter pylori*	Warren and Marshall. Unidentified curved bacilli on a gastric epithelium in active chronic gastritis. Lancet 1983;1:1273.
1988	Human herpesvirus-6	Yamanishi et al. Identification of human herpersvirus-6 as a causal agent for exanthema subitum. Lancet 1988;1:1065.
1989	*Ehrlichia chaffeensis*	Dawson et al. Isolation and characterization of a *Ehrlichia* sp. from a patient diagnosed with human ehrlichiosis. J Clin Microbiol 1991;29:2741.
1989	Hepatitis C	Choo et al. Isolation of a cDNA clone derived from a blood-borne non-A, non-B viral hepatitis genome. Science 1989;244:359.
1991	Human herpesvirus-7	Frenkel et al. Isolation of a new herpesvirus from human CD4+ T cells. Proc Natl Acad Sci 1990;87:748.
1991	Cuanarito fever	Salas et al. Venezuelan hemorrhagic fever. Lancet 1991;338:1033.
1992	*Vibrio cholerae* O139	World Health Organization. Epidemic diarrhea due to *Vibrio cholerae* non-O1. Wkly Epidemiol Rec 1993;68:141.
1992	*Bartonella* (*Rochalimaea henselae)*	Regenery et al. Characterization of a novel *Rochalimaea* species, *R. henselae* sp. nov., isolated from blood of a febrile, human immunodeficiency virus-positive patient. J Clin Microbiol 1992;30:265. Welch et al. *Rochalimaea henselae* sp. nov., a cause of septicemia, bacillary angiomatosis, and parenchymal bacillary peliosis. J Clin Microbiol 1992;30:275.
1993	Hantavirus	Nichol et al. Genetic identification of a hantavirus associated with an outbreak of acute respiratory illness. Science 1993;262:914.
1994	Sabia virus	Lisieux et al. New arenavirus isolated in Brasil. Lancet 1994;343:391.
1994	Human herpesvirus-8	Chang et al. Identification of herpesvirus-like DNA sequences in AIDS-associated Kaposi sarcoma. Science 1994;266:1865.
1996	Hepatitis G	Linnen et al. Molecular cloning and disease association of hepatitis G virus: a transfusion-transmissible agent. Science 1996;27:505.
1996	Andes virus	Lopez et al. Genetic identification of a new hantavirus causing severe pulmonary syndrome in Argentina. Virology 1996;220:223.
1996	*Mycobacterium lentiflavum*	Springer et al. Isolation and characterization of a unique group of slowly growing mycobacteria: description of *Mycobacterium lentiflavum* sp. nov. J Clin Microbiol 1996;34:1100.
1996	*Mycobacterium triplex*	Floyd et al. Characterization of an SAV organism and proposal of *Mycobacterium triplex* sp. nov. J Clin Microbiol 1996;34:2963.
1997	Avian influenza H5N1	Yuen et al. Clinical features and rapid viral diagnosis of human disease associated with avian influenza A H5N1 virus. Lancet 1998;351:467.
1997	Transfusion-transmitted virus (TTV)	Nishizawa et al. A novel DNA virus (TTV) associated with elevated transaminase levels in posttransfusion hepatitis of unknown etiology. Biochem Biophys Res Commun 1997;241:92.
1999	Nipah virus	Chua et al. Fatal encephalitis due to Nipah virus among pig-farmers in Malaysia. Lancet 1999; 354:1257.
1998	VZV-MSP	Santos et al. Antigenic variation of varicella zoster virus Fc receptor IgE: loss of a major B cell epitope in the ectodomain. Virology 1998;249:21.
1999	*Mycobacterium goodii* *Mycobacterium wolinskyi*	Brown et al. *Mycobacterium wolinskyi* sp. nov. and *Mycobacterium goodii* sp. nov., two new rapidly growing species related to *Mycobacterium smegmatis* and associated with human wound infections: a cooperative study from the International Working Group on Mycobacterial Taxonomy. Int J Syst Bacteriol 1999;49:1493.
2000	SEN virus	Tanaka et al. Genomic and molecular evolutionary analysis of a newly identified infectious agent (SEN virus) and its relationship to the TT virus family. J Infect Dis 2001;183:359.
2001	Human metapneumovirus	van den Hoogen et al. A newly discovered human pneumovirus isolated from young children with respiratory tract disease. Nat Med 2001;7:719.
2003	SARS-CoV	Peiris et al. Coronavirus as a possible cause of severe acute respiratory syndrome. Lancet 2003;361:1319.
2006	PARV4 (Parvovirus 4)	Fryer et al. Novel parvovirus and related variant in human plasma. Emerg Infect Dis 2006;12:151.

Abbreviations: VZV-MSP = varicella-zoster virus glycoprotein E mutant; SARS-CoV = severe acute respiratory syndrome-associated coronavirus
[a]References are cited in abbreviated format, using first author and initial page number only.

Table 2. Infectious disease journals ranked by 2005 impact factor — data from 1995 and 2005 Science Citation Index Journal Citation Reports

Journal	Impact factor	
	1995	2005
Lancet Infectious Diseases	NA	10.5
Clinical Microbiology Reviews	8.9	10.4[a]
Clinical Infectious Diseases	2.9	6.5[b]
AIDS	4.9	5.8
Emerging Infectious Diseases	NA	5.3
Antiviral Therapy	NA	5.3
Journal of Infectious Diseases	4.9	5.0
Antimicrobial Agents and Chemotherapy	3.3	4.8[a]
Current Opinion in Infectious Diseases	0.7	4.3[b]
Infection and Immunity	3.7	3.9
Journal of Antimicrobial Chemotherapy	2.1	3.9[a]
Journal of Acquired Immune Deficiency Syndromes	3.5	3.9
Journal of Clinical Microbiology	3.9	3.5
Pediatric Infectious Disease Journal	1.8	3.0[a]
Current HIV Research	NA	3.0
Diagnostic Microbiology and Infectious Disease	0.9	2.7[a]
Sexually Transmitted Diseases	1.8	2.7
Clinical Microbiology and Infection	NA	2.7
Sexually Transmitted Infections	NA	2.7
Journal of Viral Hepatitis	NA	2.6
AIDS Research and Human Retroviruses	3.1	2.5
International Journal of Antimicrobial Agents	NA	2.4
Infection Control and Hospital Epidemiology	1.9	2.4
FEMS Immunology and Medical Microbiology	NA	2.4
American Journal of Infection Control	0.9	2.3[a]
Journal of Medical Microbiology	1.8	2.3
Infectious Disease Clinics of North America	1.3	2.3[a]
Journal of Hospital Infections	1.3	2.2
Microbial Drug Resistance-Mechanisms, Epidemiology and Disease	NA	2.1
European Journal of Clinical Microbiology and Infectious Diseases	1.6	2.1
Clinical and Diagnostic Laboratory Immunology	0.7	2.1[a]
BMC Infectious Diseases	NA	2.0
AIDS Patient Care and STDS	NA	1.9
Journal of Infection	1.2	1.9
Infection	1.0	1.9
Epidemiology and Infection	1.5	1.7
Journal of Antibiotics	1.4	1.5
International Journal of Tuberculosis and Lung Disease	NA	1.5
International Journal of Hygiene and Environmental Health	NA	1.4
Scandinavian Journal of Infectious Diseases	1.1	1.3
International Journal of STD and AIDS	0.6	1.2
Enfermedades Infecciosas y Microbiologia Clinica	NA	0.9
Leprosy Review	NA	0.8
Japanese Journal of Infectious Diseases	NA	0.8
Infections in Medicine	NA	0.3
Medicine et Maladie Infectieuses	0.2	0.2

Abbreviation: NA = not available
[a]Modest increase (1.0-2.9) in impact factor.
[b]Notable increase (3 or more) in impact factor.

Table 3. Comparative data on selected clinical infectious disease journals[a]

Journal	Established	Year	Total cited	Impact factor	Immediacy index	Articles	Cited half-life
Journal of Infectious Diseases	1904	1995	23,090	4.9	0.758	565	5.5
		2005	34,045	5.0	1.547	561	6.6
Clinical Infectious Diseases	1979	1995	4539	2.9	0.253	636	2.7
		2005	28,701	6.5	1.750	564	4.7
Pediatric Infectious Disease Journal	1982	1995	4041	1.8	0.294	289	4.7
		2005	8219	3.0	0.510	247	6.1
Emerging Infectious Diseases	1995	1995	-	-	-	-	-
		2005	8882	5.3	0.840	338	3.4
Lancet Infectious Diseases	2001	1995	-	-	-	-	-
		2005	2443	10.5	1.576	59	2.9

[a]The *total cited* (number of citations) is the number of times a journal's articles are cited as references in other articles, and partly reflects the journal's size and publication frequency. The *impact factor* measures the frequency with which the "average article" in a journal has been cited in a particular year. This measure gives a sense of the overall quality and significance of a given journal's contents and corrects for journal size and frequency of publication. The *immediacy index* measures how soon after publication the "average article" in a particular journal is cited, and may indicate the article's newsworthiness or the pace of research in a particular field. The *half-life* describes the longevity or age of its cited articles, and is an indicator of a journal's historical impact and regard [5,9,10].

Proliferation of Journals and Evolving Impact Factor

There has been significant proliferation of science journals during the past decade. The JCR cited 4625 journals in 1995 and 6088 in 2005, an increase of 32% [9,10]. Among the 46 infectious disease journals ranked by impact factor in 2005, 18 (39%) were new or not listed in JCR's 1995 report (Table 2). Three of the top ten ranking infectious disease journals in 2005 were not available in the 1995 listing (i.e., Lancet Infectious Diseases, Emerging Infectious Diseases, and Antiviral Therapy), and the top two journals concentrated on review articles (i.e., Lancet Infectious Diseases and Clinical Microbiology Reviews). The impact factor in the traditional journals (such as Journal of Infectious Diseases, and Infection and Immunity) has remained steady, whereas the journals in clinical and emerging infectious diseases (such as Clinical Infectious Diseases, and AIDS) have shown notable increases in impact factor. Among 28 infectious diseases journals with data available for 1995 and for 2005, 10 (36%) showed an increase in impact factor, with a mean impact factor of 2.2 in 1995 and 3.1 in 2005.

Significant transformation has occurred among infectious disease journals over the past decade. Table 3 lists the comparative data for five well-known infectious disease journals for the four JCR measures: number of citations, impact factor, immediacy index and half-life. In 2005, the Journal of Infectious Diseases, the oldest and best known journal in the field, remained the leader in total number of citations (34,034), but ranked only fourth for impact factor (5.0). In contrast, Lancet Infectious Diseases, the youngest journal, published only 59 articles — mostly reviews, opinions and news — and had the fewest citations (2443), but nevertheless ranked first in impact factor (10.5).

Clinical Infectious Diseases, a popular journal among clinical infectious disease specialists, has shown a substantial gain in total citations (4539 to 28,701), impact factor (2.9 to 6.5), immediacy index (0.25 to 1.75), and cited half-life (2.7 to 4.7). Likewise, Pediatric Infectious Disease Journal, a well-accepted journal among pediatric infectious disease specialists and pediatricians, has also gained in total citations (4041 to 8219), impact factor (1.8 to 3.0), and cited half-life (4.7 to 6.1). Emerging Infectious Diseases, a new journal focusing on rapidly changing infectious pathogens, has gained acceptance among the infectious disease and microbiology community. It carries a respectable impact factor of 5.3.

Ranking of Major Journals

Table 4 shows 26 selected major journals that occasionally publish infectious disease articles. The list represents the top ranking journals by impact factor in broad basic science (i.e., Nature, Science, PNAS), general clinical science (i.e., New England Journal of Medicine, Lancet, JAMA), and various clinical subspecialties. There is an increase in impact factor in 24 of these 26 (92%) with means of 8.4 and 12.3 in 1995 and 2005, respectively.

Table 4. Selected major journals that include infectious diseases articles: ranked by impact factor (data from 1995 and 2005 Science Citation Index Journal Citation Reports)[a]

Impact factor 1995	2005	Journal
27.1	29.3[b]	Nature
22.4	44.0[c]	New England Journal of Medicine
21.9	31.0[c]	Science
17.5	23.4[c]	Lancet
15.1	14.0	Journal of Experimental Medicine
10.5	10.2	Proceedings of the National Academy of Sciences (USA)
9.9	13.3[c]	Annals of Internal Medicine
8.8	11.6[b]	Circulation
8.8	15.1[c]	Journal of Clinical Investigation
8.6	10.1[b]	Blood
8.2	12.4[c]	Gastroenterology
7.7	23.3[c]	JAMA
7.2	7.4	Arthritis and Rheumatism
5.8	9.2[c]	Journal of the American College of Cardiology
4.5	9.1[c]	British Medical Journal
4.4	6.3[b]	Annals of Surgery
4.2	8.0[c]	Archives of Internal Medicine
3.7	8.7[c]	American Journal of Respiratory Critical Care
3.5	7.7[c]	Journal of Allergy and Clinical Immunology
2.9	4.8[b]	Cancer
2.9	3.8[b]	Journal of Pediatrics
2.7	4.3[b]	Pediatrics
2.5	3.6[b]	Clinical and Experimental Allergy
2.5	3.1[b]	American Journal of Obstetrics and Gynecology
2.2	4.2[b]	Obstetrics and Gynecology
2.1	2.6	Surgery

[a]This is not a complete list, but rather a brief review of major general and subspecialty journals that also address infectious disease topics as they relate to the particular clinical discipline. Additional sources can be found in the Journal Citation Reports.
[b]Modest increase (1.0-2.9) in impact factor.
[c]Notable increase (3 or more) in impact factor.

An increase in impact factor of 3 or more was reported in 12 of the 26 (46%). Notable exceptions are the Journal of Experimental Medicine and PNAS, which showed no increase in impact factor. A major difference in impact factor is observed among the top ranking subspecialty journals. For example, 2005 data show the highest impact factors in medicine (Annals Internal Medicine), surgery (Annals of Surgery) and pediatrics (Pediatrics) were 13.3, 6.3 and 4.3, respectively.

Impact Factor Trends

The most recent trends for impact factor of five selected journals from 2000 to 2005 are shown in Table 5. The New England Journal of Medicine, one of the top ranking clinical journals, had a raw increase in impact factor of 14.5 (29.5 in 1995 vs 44 in 2005). In contrast, Clinical Infectious Diseases rose only 3.5, Pediatric Infectious Disease Journal increased 0.9, while Emerging Infectious Diseases and Journal of Infectious Diseases remained unchanged.

Discussion

It has been suggested that the most noteworthy original contributions in medicine are being reported in a relatively small number of journals [1,3]. Journals with a high impact factor (mean 14.2) have attracted the submission of new discoveries of emerging pathogens in infectious disease over the past three decades (Tables 1, 2 and 4). Our earlier review found that over 95% of new discoveries of major etiologic agents in infectious disease were published in the top 2% of bioscience journals, as ranked by the JCR impact factor [4].

The highly cited journals listed by the JCR have remained relatively highly cited over the four decades since the inception of SCI [2]. However, many new

Table 5. Trends in impact factor in five selected journals for the years 2000 to 2005

Journal	2000	2001	2002	2003	2004	2005
New England Journal of Medicine	29.512	29.065	31.736	34.833	38.570	44.016
Journal of Infectious Diseases	4.988	4.910	4.857	4.481	4.943	4.953
Clinical Infectious Diseases	2.972	3.545	4.750	5.393	5.594	6.510
Pediatric Infectious Disease Journal	2.190	2.289	2.376	2.262	2.735	3.047
Emerging Infectious Diseases	4.907	5.968	4.757	5.340	5.643	5.308

journals have emerged recently, and some of the highly cited new journals publish primarily review articles. It is doubtful that citations of review articles and citations of fundamental research articles mean the same thing.

The highly cited articles that attract the attention of the medical community are found in a small group of journals (Table 4). The majority of these journals had notable increases in impact factor over the past decade. However, for some highly regarded major journals, such as Journal of Experimental Medicine, and PNAS, the impact factor remained essentially unchanged. It is of interest that in 2005, PNAS, one of the world's most prestigious research journals, published 3200 articles and received 357,239 citations, yielding an impact factor of 10.2, which was essentially identical to the 10.5 received by Lancet Infectious Diseases, which was only four years old and published only 59 pieces — most of them reviews — that garnered a total of only 2443 citations [10].

It is noteworthy that impact factor varies greatly among subspecialty journals. For example, the top ranking pediatrics journal (Pediatrics) had an impact factor only one-third as high as that of the top ranking medicine journal (Annals of Internal Medicine) [4.3 vs 13.3]. Apparently, the "importance," "significance," or "influence" of a journal in its own field are not clearly reflected in rankings based on raw impact factor. Impact factor is valid only within categories of journals, not between categories.

Journals in young and rapidly expanding research fields tend to have high impact factors. For example, articles in biochemistry and molecular biology were cited about five times as often as articles in pharmacy [6]. It is not unexpected that Journal of Infectious Diseases, for decades a leading journal in the field, collected a lower impact factor in 2005 than the new expanding journals, such as Antiviral Therapy, AIDS, Emerging Infectious Diseases, and Clinical Infectious Diseases.

Reports of clinical trials and papers that are published in high impact factor journals in the new expanding fields often become obsolete within a few years [6,14]. A review of 49 highly cited original clinical research articles found that only 44% of them were replicated in subsequent studies, and 46% were not confirmed [14]. In these top-cited clinical trials, contradiction or weaker effects upon attempted replication were encountered in five of six non-randomized studies and over one-third of the randomized studies [14]. Therefore, high citation does not necessarily translate into clinical or scientific validity.

Although journal impact factor can be used as a rough indicator, it has many limitations. In a detailed analysis, Seglen found that there was a poor correlation between journal impact factor and actual citation rates of articles from individual scientists or research groups, and he argued that journal impact factor should not be used for evaluating research [6]. In a review of citation patterns of journals with high impact factor, it was noted that the top 50% of article citations account for 90% of the journal citations (i.e., journal impact factor) and that even the uncited articles are given full credit for the impact of the few highly cited articles [6,7]. Given this highly significant skewing of the citation rates, the quality of the individual articles or the individual authors' accomplishments cannot be evaluated by the journal impact factor. Critical appraisal of individual articles is always needed.

It is well known that journals with high impact factors are often associated with greater resources and higher rejection rates, and that impact factor has had an important influence on perceptions of journals and their published articles. It is also important to know that journals with low impact factor and those not listed by the JCR will continue to play significant roles in education and in transmitting useful and practical information. Furthermore, many high quality, and well written articles in foreign journals with primary emphasis on dissemination of knowledge, sometimes published in the native language, are excluded from the indices [5].

Conclusion

Journal impact factor is presumably a marker for the "importance", "significance", or "influence" of a journal, yet it is greatly influenced by the type of articles (review vs original research), subject specialty, novelty of the research field, and the fact that the literature on the whole is expanding. Thus, the value or relevance of impact factor is controversial and subject to myriad interpretations. In spite of its limitations, journal impact factor can be used as a rough indicator for scientific quality in specific subject categories and for serious reading and learning, but its use in evaluating individual authors' or papers' impact is inherently risky.

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