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Impact factors of forensic science and toxicology journals: what do the numbers really mean?

A.W. Jones*

Department of Forensic Toxicology, University Hospital, 581 85 Linköping, Sweden

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Abstract

This article presents review and opinion about the use and abuse of journal impact factors for judging the importance and prestige of scientific journals in the field of forensic science and toxicology. The application of impact factors for evaluating the published work of individual scientists is also discussed. The impact factor of a particular journal is calculated by dividing the number of current year citations to a journal's articles that were published in the previous 2 years by the total number of citable items (articles and reviews) published in the same 2-year period. Journal impact factors differ from discipline to discipline and range from 0 for a journal whose articles are not cited in the previous 2 years to 46 for a journal where the average recent article is cited 46 times per year. The impact factor reflects the citation rate of the average article in a journal and not a specific article. Many parameters influence the citation rate of a particular journal's articles and, therefore, its impact factor. These include the visibility and size of the circulation of the journal including availability of electronic formats and options for on-line search and retrieval. Other things to consider are editorial standards especially rapid and effective peer-reviewing and a short time lag between acceptance and appearance in print. The number of self-citations and citation density (the ratio of references to articles) and also the inclusion of many review articles containing hundreds of references to recently published articles will boost the impact factor. Judging the importance of a scientist's work based on the average or median impact factor of the journals used to publish articles is not recommended. Instead an article-by-article citation count should be done, but this involves much more time and effort. Moreover, some weighting factor is necessary to allow for the number of co-authors on each article and the relative positioning of the individual names should also be considered. Authors should submit their research results and manuscripts to journals that are easily available and are read by their peers (the most interested audience) and pay less attention to journal impact factors. To assess the true usefulness of a person's contributions to forensic science and toxicology one needs to look beyond impact factor and citation counts. For example, one might consider whether the articles contained new ideas or innovations that proved useful in routine forensic casework or are widely relied upon in courts of law as proof source.

Keywords: Authorship; Bibliometrics; Forensic science; Impact factor; Journals; Toxicology

1. Introduction

Spreading information to colleagues working in other laboratories or countries and sharing new knowledge by timely publication of research findings or providing details of new method development is fundamental for the advancement and practice of science [1]. Some have said that science does not exist until it is published [2]. The first scientific journal appeared in 1665 (*The Philosophical Transactions*) and the refereeing of manuscript began in 1752, when the Royal Society of London took over responsibility for this publication [3,4]. Thousands of scientific journals are now available and many of these have wide circulation and a solid reputation for scholarly excellence. Indeed, a large proportion of manuscripts submitted to these premier journals are rejected because of shortage of space despite receiving favorable peer-review reports from the referees [5,6]. By contrast, other periodicals have relatively small circulation numbers and some have gained a dubious

* Tel.: +46-13-252-114; fax: +46-13-104-875.
E-mail address: wayne.jones@rmv.se (A.W. Jones).

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reputation and seemingly publish every article submitted to them. Those persistent enough will eventually get their work published.

Besides the prestigious multidisciplinary weekly journals (*Science* and *Nature*), where only a select few manage to get their articles published, there are hundreds of specialized journals covering all branches of the pure, applied and biomedical sciences as well as the social sciences. Some journals are controlled, edited and published by scientific or professional societies and the membership is encouraged to submit their work for peer-review evaluation and possibly publication [1,2]. With such a wide selection of journals available for submitting a manuscript, does it really matter where a paper eventually gets published?

The prestige and standing of a particular scientific journal depends on many factors including the reputation of the editor and the editorial standards, the speed of handling manuscripts, the timeliness of publication, the size of the circulation, the potential for on-line search and retrieval, and not least the rigor of the peer-review process [6]. More recently, the journal impact factor (IF) has emerged as an alternative index of quality and prestige and IFs are being used increasingly for ranking and evaluating journals and also as surrogates for judging academic performance and the quality and importance of an individual researcher's publications [7–12]. As impact factors are numbers reported with three decimal digits this gives them a mark of quantitative importance and prestige and they are being increasingly used by funding agencies and university search committees to evaluate individual scientists or entire departments [13,14]. Getting articles published in journals with high impact factor is a major goal for many scientists and the way a journal's IF fluctuates is closely monitored by publishers, editors, administrators and also by those who submit articles for publication [15]. When evaluating the productivity and scientific output of a university department, when allocating funding for research or when judging candidates for academic promotion, journal impact factors are being increasingly scrutinized [14–17].

Detailed lists of journal citations and impact factors are produced and made available by the Institute for Scientific Information (ISI), which has its head offices in Philadelphia, PA. A listing of all the impact factors is included in Journal Citation Reports (JCR) and, since 1997, this product has been searchable on-line and this was the source of the data used to prepare the present review.

The impact factor of a scientific journal in a particular year is the ratio of the number of current year citations to articles published in the journal in the two preceding years divided by the number of citable items (articles and reviews) published in the same 2 years [18,19]. For example, the 2001 impact factor for *Forensic Science International* (*FSI*) is the number of citations received by this journal in 2001 to articles published in *FSI* in 2000 and 1999 divided by the number of articles published in these same 2 years. Impact factors are, therefore, derived from a breakdown of the reference lists attached to the end of each article. This entails counting the number of times a particular target journal's articles are cited as a function of the year these articles appeared in print.

One important underlying assumption of citation analysis is that citing a particular author's work establishes a scholarly link or influence on one's own research work [18,19]. Journal impact factors range from 0 for the least cited journal to over 40 for some of the most highly cited journals. The median impact factor for all science journals in the ISI database for the year 2001 was about 0.80. In a relatively small discipline such as forensic and legal medicine, the impact factors of the journals are generally lower compared with broader subject categories, such as life sciences, clinical medicine and much lower than hot research topics like genetics and molecular biology [18,19].

The aim of this article is to review and comment upon the impact factors for certain forensic science, legal medicine and toxicology journals. Many of the variables that influence the calculation of journal impact factors are discussed and some problems and pitfalls are highlighted when impact factors are used to judge the importance of the work of individual scientists.

2. Trends in impact factors of forensic science and toxicology journals

Table 1 shows the year-by-year changes (1997–2001) in journal impact factors for selected forensic science, legal medicine and toxicology journals. On the whole, impact factors of these specialist forensic science and toxicology journals changed very little over this time period [20]. The toxicology journals seemed to achieve higher impact factors than the forensic and legal medicine journals. Compared with other disciplines covered by ISI, the impact factors shown in Table 1 are relatively low and some are below the average for all journals in the database (median 0.80).

Table 1
Changes in journal impact factor over time (1997–2001) for some selected forensic, legal medicine and toxicology journals

Journal abbreviation	1997	1998	1999	2000	2001
J. Anal. Toxicol.	2.16	1.83	2.22	1.59	1.41
Ther. Drug Monit.	1.83	1.54	1.38	1.73	2.04
J. Tox. Clin. Toxicol.	0.93	1.17	1.73	1.30	1.36
Hum. Exp. Toxicol.	0.71	0.95	1.06	0.82	1.30
Int. J. Legal Med.	1.95	1.81	1.63	1.50	1.13
J. Forensic Sci.	1.40	0.77	0.99	0.94	0.88
Forensic Sci. Int.	1.32	0.82	1.39	0.83	1.05
Sci. Just.	1.10	0.71	1.07	0.91	0.56
Am. J. Forensic Med. Pathol.	0.39	0.60	0.37	0.60	0.41
Med. Sci. Law	0.39	0.29	0.41	0.47	0.40

Note that the journal abbreviations are those used by ISI in their Journal Citation Reports for 2001 [55].

There does not appear to be one pre-eminent journal in the field of forensic science and legal medicine [21].

Another feature of the numbers in Table 1 is the occurrence of peaks and troughs in impact factor between 1997 and 2000 for *Forensic Science International* in particular. The journal with the highest IF in 2001 was *Therapeutic Drug Monitoring* (IF = 2.04), which means that the average article published in this journal was cited twice per annum in the 2-year window after the year of publication. The distribution of citations to a particular journal is not a simple Gaussian curve. Instead, citation rates tend to be skewed to the right with a mode occurring after 2–4 years and then a long tail, the slope of which depends on the cited half-life of the journal, which is also a statistic published by ISI and available in the Journal Citation Reports. A journal's immediacy index (e.g. for 2001) is defined as the ratio of current year citations to the number of articles appearing in print that same year.

3. Subject categories

The Journal Citation Reports is subdivided into different subject categories. The forensic science journals are found within the subcategory "medicine, legal" and make-up a small group of only eight journals (median IF 0.96, in 2001). Moreover, some of the titles included in the list are seemingly not of any direct interest or relevance to mainstream forensic scientists, e.g. *Regulatory Toxicology Pharmacology* and *Expert Opinion Therapeutic Patents*. However, one journal that should have been included is *Medicine, Science and the Law*, which for some reason was placed in the pathology category in 2001 but in legal medicine in 2000. A relatively new journal that warrants inclusion in the legal medicine category, but has not yet been selected by ISI, is *Journal of Clinical Forensic Medicine*, which is now in its 9th year of publication by Churchill Livingston, a well respected publishing house, recently acquired by Elsevier Science.

The toxicology subject category contained 78 journals according to the 2001 version of JCR with mean and median impact factors of 1.8 and 1.3, respectively. The toxicology journals were rank ordered according to their impact factors and this distribution is shown in Fig. 1. Topping the list of journals was *Annual Reviews of Pharmacology and Toxicology* (IF = 20.79), which actually is a book that appears once a year and contained just 33 articles in 2001. The second most cited journal was entitled *Critical Reviews in Toxicology*, which had an impact factor of 6.64 and contained 35 citable items in 2001. *Journal of Analytical Toxicology* [22] ranked 36th with an IF of 1.41 and contained 111 citable items. The lowest ranked journal in the subject category toxicology was *Japanese Journal of Toxicology & Environmental Health* with an IF of 0.186. Occasionally, the journal with lowest impact factor in one category might exceed that of the top ranked journal in another, which highlights the dangers of comparing IFs of journals from different subject categories.

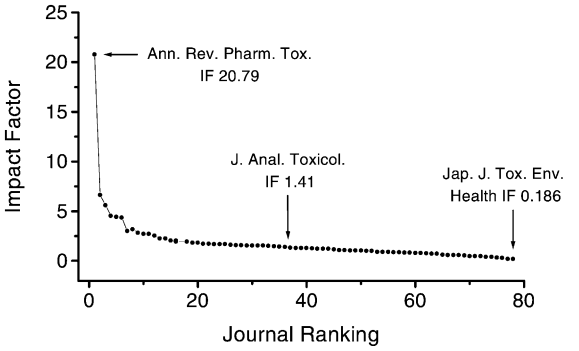

Fig. 1. Rank ordering of impact factors (IF) of journals within the subject category toxicology ($N = 78$, median IF 1.3) according to the 2001 edition of ISI's Journal Citation Reports [55].

4. Citing and cited journal pages

The starting point for compiling journal citation reports and calculating impact factors is the reference lists or bibliographies that appear at the end of each published article in the thousands of journals covered by ISI. For example, reference lists from every article and review paper published in *Forensic Science International* in 2001 are scrutinized and used to find the total number of references cited. The average citation density is derived by dividing the number of references by the number of articles appearing in 2001. The list of references contained in each article is checked in detail to find the names of the journals that published the cited article along with the year of the publication and its chronological distribution. This gives the information necessary to create the citing journal page for *FSI*.

Table 2 shows the first part of this page for year 2001 and presents the number of times *FSI* articles cited articles from the other journals listed. All the journals cited by *FSI* are then rank ordered according to total number of citations they received regardless of the year the articles were published to give the all years column. Thereafter, the total number of citations in the all years column is broken down chronologically into separate columns depending on the publication year of the particular article cited.

Table 3 gives part of another listing from *JCR*, namely the 2001 cited journal page which shows the number of times that journals in the database (citing journals) cited articles that were published in *FSI*. Here, *FSI* is the cited journal and as is always the case *FSI* cites its own articles frequently and these are called self-citations ($N = 571$). The information in Table 3 is necessary to calculate journal impact factor, immediacy index and the cited half-life of *Forensic Science International*. Note that the number of self-cites (Table 2) and self-citings (Table 3) for *FSI* are identical.

The 2001 column in Table 3 contains the number of citations ($N = 52$) received by *FSI* for all articles appearing in the journal in 2001 ($N = 348$). The ratio (cites/articles, in

Table 2
Forensic Science International (*FSI*) as the "citing journal" showing a breakdown of the top five cited journals and the number of citations from *FSI* articles in 2001 is found in the all years (column) and the all journals (row)

Cited journal	All years	2001 articles	2000 articles	1999 articles	1998 articles	1997 articles
All journals	6415	56	310	429	486	520
Forensic Sci. Int.	571	20	62	56	65	85
J. Forensic Sci.	536	5	24	39	47	42
Int. J. Leg. Med.	241	2	11	27	40	71
J. Anal. Toxicol.	128	0	10	18	14	9
Am. J. Hum. Genet.	88	0	20	11	14	9

Table 3
Forensic Science International (*FSI*) as the "cited journal" showing the top five citing journals and the number of citations given to *FSI* articles

Citing journal	All years	2001 articles	2000 articles	1999 articles	1998 articles	1997 articles
All journals	1787	52	205	198	209	201
Forensic Sci. Int.	571	20	62	56	65	85
J. Forensic Sci.	137	1	2	13	14	13
Anal. Chem.	72	2	35	29	5	0
J. Anal. Toxicol.	66	3	7	5	9	10
Int. J. Legal Med.	56	3	7	7	17	6

The total number of citations received by *FSI* in 2001 is given under the all years (column) and in all the journals (row).

2001) is known as the immediacy index, which is, therefore, 0.149 for *FSI*. The impact factor is derived from information in the all journals row (Table 3) and the number of citations received for the 2000 and 1999 articles, namely 205 and 198 counts, respectively. The sum of these two numbers ($N = 403$) is then divided by the number of citable items in 2000 and 1999, which was 383 to give *FSI*'s impact factor for year 2001 of 1.05. Yet another citation statistic available from JCR is the cited half-life, which is the age range of 50% of the journal's cited articles. For citations received in 2001, the cited half-life for *FSI* was reported as 5.2 years. This number comes from a breakdown of citations to *FSI* by the cumulative percent of 2001 cites to all articles published in previous years. The cited half-life tells something about the longevity of articles appearing in a particular journal or the rate at which a journal's papers become obsolete. The cited half-life for *FSI* (5.2 year) indicates that half the citations received by this journal in 2001 were attributed to articles published during the previous 5.2 years.

5. Adjusting for self-citations

Research workers who publish regularly often cite their own previously published work and also articles by their colleagues who are active in similar branches of research. This is only natural considering scientists tend to build or expand on their earlier research work covering a particular area of interest. An article by one or more authors containing a bibliographic reference to earlier articles by one or more of the same authors is called a self-citation. Such self-citations usually represent a considerable fraction of the total number of citations an author accumulates during a lifetime. It has been claimed that citation circles exist whereby friends and colleagues preferentially cite each other's work with the intent of boosting their personal citation records, which must be considered a dubious practice. Some consider that self-citations should be subtracted when a person's citation record or academic performance is being assessed.

When a journal article references articles from the same journal this is also called self-citation and tends to increase the impact factor. Indeed, most journals predominantly cite their own articles and this practice is encouraged by some journal editors but frowned upon by others. The frequency of self-citations for a particular journal can be gleaned by looking at the cited journal and citing journal pages (e.g. Tables 2 and 3 for *FSI*). If required, impact factors can be recalculated to adjust for the number of self-citations. The results of this exercise are shown in Table 4 for selected forensic, legal medicine and toxicology journals. The total cites received in 2001 are shown (1787 for *FSI*) along with the number of self-cites (571) and the percentage of self-cites (32%). The impact factors for 2001 were then recalculated after allowing for self-citations and the "clean" impact factor of *FSI* dropped to 0.74 compared with 1.05 when self-cites were included. Clearly, the impact factors of all the journals in Table 4 are now lower after adjusting for self-citations and rank ordering also changes slightly with *FSI* moving from seventh to fifth spot.

Table 4
Selected forensic, legal medicine and toxicology journals showing the 2001 impact factor before and after adjusting for the number of self-citations[a]

Journal abbreviation	Impact factor	All cites	Self-cites[a]	New impact factor
J. Anal. Toxicol.	1.41 (2)	1648	425 (26%)	1.01 (4)
Ther. Drug Monit.	2.04 (1)	2073	197 (10%)	1.73 (1)
J. Tox. Clin. Toxicol.	1.36 (3)	1019	91 (9%)	1.25 (2)
Hum. Exp. Toxicol.	1.30 (5)	1112	76 (7%)	1.12 (3)
Int. J. Legal Med.	1.13 (6)	993	180 (18%)	0.74 (5)
J. Forensic Sci.	0.88 (8)	2710	589 (22%)	0.66 (7)
Forensic Sci. Int.	1.05 (7)	1787	571 (32%)	0.74 (5)
Sci. Just.	0.56 (9)	126	31 (24%)	0.46 (8)
Am. J. Forensic Med. Pathol.	0.41 (10)	611	106 (17%)	0.29 (10)
Med. Sci. Law	0.40 (11)	40	6 (15%)	0.34 (9)

[a] The ranking is shown in brackets. Self-citations are defined as references in 2001 citing articles in the same journal.

6. Long-term versus short-term impact

Some of the critics of journal impact factors maintain that a major flaw is the way that ISI makes the calculations, namely by only considering the citations to articles published in the two previous years. This method is thought to be unfair to slower moving disciplines such as Forensic Science and Toxicology as well as others. However, it is fairly easy to calculate 5- or even 10-year impact factors if considered necessary. The 5-year IF is derived by looking at all current year citations (e.g. 2001) to articles published in a target journal over the previous 5-years and dividing by the number of citable items in these same 5 years.

Table 5 compares conventional 2- with 5-year impact factors for selected forensic, legal medicine and toxicology journals. This alternative way of computing impact factors gives an advantage to journals that reach their citation peak later although the resulting change in IF is only marginal and hardly alters the rank ordering of the journals considered. Garfield [23,24] came to similar conclusions in a survey of many more journal titles covered by ISI.

Table 5
Selected forensic, legal medicine and toxicology journals comparing the conventional 2-year impact factor for 2001 with a 5-year impact factor

Journal abbreviation	Impact factor (2-year)	Impact factor (5-year)[a]
J. Anal. Toxicol.	1.41 (2)	1.54 (2)
Ther. Drug Monit.	2.04 (1)	1.81 (1)
J. Tox. Clin. Toxicol.	1.36 (3)	1.43 (4)
Hum. Exp. Toxicol.	1.30 (4)	1.27 (5)
Int. J. Legal Med.	1.13 (5)	1.61 (3)
J. Forensic Sci.	0.88 (7)	0.99 (7)
Forensic Sci. Int.	1.05 (6)	1.07 (6)
Sci. Just.	0.56 (8)	0.58 (9)
Am. J. Forensic Med. Pathol.	0.41 (9)	0.67 (8)
Med. Sci. Law	0.40 (10)	0.42 (10)

The ranking is shown in brackets.

[a] Defined as number of citations in 2001 to articles published 2000 + 1999 + 1998 + 1997 + 1996 divided by the number of articles published in these same 5 years.

7. Citation density and inclusion of review articles

Other things that are considered to influence journal impact factor and complicate comparisons between journals are the citation density and the number of review articles published each year. Citation density is the ratio of total number of references in all the articles published in a particular journal divided by the number of articles. Not many journals set limits on the number of reference items (citations) an author is permitted to include in the manuscript submitted for publication. However, the actual number differs widely from discipline to discipline with biomedical journals having many more references per article than social science or physics journals. But even closely related journals within the same subject category differ in citation density ranging from 12.3 to 27.7 (Table 6). As expected, journals with the largest citation density also tended to have larger impact factors.

Review articles usually contain many more literature references compared with research articles and reviews also tend to become highly cited, which at least in part accounts for the high impact factor of the two leading toxicology journals shown in Fig. 1. These two journals had citation densities of 142 and 83, respectively, in 2001. The higher citation rate enjoyed by review articles has prompted some journal editors to include one or more comprehensive reviews in each issue of the journal, presumably in the hope that these will become highly cited within 2 years of publication and thereby increase the impact factor. Some comprehensive review articles might contain several hundred references to recent articles from closely related

Table 6
Selected forensic, legal medicine and toxicology journals showing 2001 impact factor, number of articles and reviews published and the corresponding citation density

Journal abbreviation	Impact factor	Articles	Reviews	Reference items	Citation density[a]
J. Anal. Toxicol.	1.41	111	0	2221	20.0
Ther. Drug Monit.	2.04	100	5	2868	27.3
J. Tox. Clin. Toxicol.	1.36	60	4	1586	24.8
Hum. Exp. Toxicol.	1.30	77	2	2187	27.7
Int. J. Legal Med.	1.13	45	2	1034	22.0
J. Forensic Sci.	0.88	238	1	3922	16.4
Forensic Sci. Int.	1.05	345	3	6312	18.1
Sci. Just.	0.56	37	1	466	12.3
Am. J. Forensic Med. Pathol.	0.41	83	1	1563	18.6
Med. Sci. Law	0.40	53	2	788	14.3

[a] Ratio between total number of reference items in 2001 and the total number of non-review and review articles appearing in print that year.

specialist journals. Long articles with many references help to increase the numerator (citations) and decrease the denominator (citable items) in the calculation of impact factor.

8. Concluding remarks

For some people journal impact factors have become the Holy Grail of scientific publishing [25,26], whereas, others consider them highly contentious with many artifacts including strong national biases [27–30]. This criticism is especially justified when IFs are used to evaluate and compare the productivity and importance of the work of individual scientists [31–34]. There is a low correlation between the impact factor of a journal where an article is published and the number of future citations to that article [34]. Indeed, the inventor of journal citation reports and impact factors (Eugene Garfield) continuously warns about the misuse of journal impact factors and calls for caution when they are used for evaluating the published work of individual scientists [7,18,19].

It is important to realize that the IF of a journal represents the citation frequency of the average published article and not a specific article [28,34]. Accordingly, even if an article appears in *Nature* or *Science*, which are journals with high impact factors, this does not necessarily mean the article in question is later highly cited. In short, the articles determine the journal's citation rate and not vice versa [34].

Impact factors are ratios of citations to citable items, so any change in the numerator (citations) or denominator (citable items) alters the impact factor calculation. Both original articles and reviews are considered as citable items, whereas, Letters to the Editor, Editorial commentary, and Opinion pieces attract citations [7,8,18]. When these latter items become highly cited, this tends to increase the numerator without changing the denominator and, thus increasing the journal impact factor. Journals with a high citation density or high ratio of references to articles, particularly if many papers <2-year-old are included, is another way to boost the journal IF. Delays in completing peer-review of manuscripts and a lengthy lag-time from acceptance to appearance in print have negative influences on impact factor calculations. Unusually long delays in reviewing, copy-editing and publishing means that many items in the reference lists are no longer current (more than 2-year-old) and, therefore, do not count in ISI's calculation of impact factor. Many journals now handle all submitted material online including the peer-review of manuscripts and checking of galley proofs. This innovation has shortened considerably the time between submission and appearance in print, which for some journals is now <6 months.

Great care should be taken in preparing the reference list for a manuscript, which is the most important part of a paper as far as impact factor calculations and citation analysis is concerned [35,36]. More thought is needed before a particular author's work is cited in preference to another and not simply because a copy of the article just happened to be on your desk! Errors in copying references from one article to another, such as use of an incorrect journal name or abbreviation or the wrong year of publication are problematic and tend to skew the IF calculations [37]. The name and abbreviation of some journals are similar and can easily become confused while working through various drafts of a manuscript. The wrong spelling of an author's surname or dropping one of his or her initials, e.g. citing W. Jones instead of A.W. Jones deprives him of a citation (so please be careful). The accuracy of reference lists in published articles often leaves much to be desired [35–37].

The impact factors of journals are being increasingly used when scientists compete for research funding or promotion to higher academic positions [38,39]. This practice has been much debated and is highly controversial but there is no escaping the fact that the competition in getting an article published in journals with the highest impact factor is tough. The crème de la crème of scientific journals have rejection rates for unsolicited papers often exceeding 90% [5]. Another dilemma when evaluating a person's publication list is how to deal with multi-author papers [38].

This becomes a thorny issue when academic appointments, grant applications and promotion is concerned and when trying to attribute credit to individuals who might have many common articles in their bibliographies [40–44]. For example, should each author be given equal credit for producing the article or should some weighting factor be applied in proportion to the number of co-authors and the relative positioning of the names on the paper?

The prestige positions are first and last names in the line-up although it is widely accepted that the first author is the one who made the greatest contribution to the work reported and the last author is usually the laboratory director or senior scientist in the group [45,46]. Those who work in teams and write in teams can accomplish more studies and produce more scientific articles compared with an investigator who works alone or together with a technician or graduate student [47]. Being a solo-author of an article leaves no doubt to whom both responsibility and credit belong. Some have said that only the first, second and the last author on the paper should receive any credit for the work contained in the article [47]. When comparing applicants for grants or academic appointments much more emphasis should be given to the number of first author articles and the number of times they are cited [38,39]. It seems, however, that more and more people are including the impact factors of the journals where they published their articles in their personal bibliographies.

It is important to remember that journal impact factors are not static but change over time. The journal *Clinical Chemistry* is a good example of this: in 1991, this journal had an impact factor of 1.88 compared with 4.37, in 2001 [48]. Accordingly, should an article that appeared in *Clinical Chemistry* in 1991 be credited with the impact factor for the current year (2001) when a person submits his list of publications for evaluation? Notwithstanding all these issues, there is no escaping the fact that journal impact factors are being closely scrutinized during funding decisions and faculty appointments and whether you like them or not they are here to stay [49,50].

The creation of the Science Citation Index (SCI) and the spin-off product Journal Citation Reports (JCR) has fostered the subject of bibliometrics, a word coined by Pritchard [51]. Bibliometrics deals with quantitative analysis of groups of publications, books and scientific journals and the references contained in them. Indeed, a specialized periodical exists called *Scientometrics* the first issue of which appeared in 1978 and has now reached its 50th volume (2001 impact factor 0.676).

Eugene Garfield (Ph.D.), who founded the Institute for Scientific Information (Philadelphia, PA) is the undisputed guru of citation analysis and impact factors. Garfield is a prolific author and has produced hundreds of articles for peer-review journals as well as writing thousands of essays on information science and bibliometrics. His entire output of papers, articles, books and selected correspondence is now freely available through his comprehensive website (http://www.garfield.library.upenn.edu), which constitutes a treasure trove for those interested in bibliometrics and citation analysis. To pay tribute to Garfield's life-long achievements and contributions to information science some of his colleagues and admirers recently produced a festschrift to mark the occasion of his 75th birthday [52]. This book contains much useful information about citation analysis and its applications with major focus on Eugene Garfield seminal contributions.

In conclusion, journal impact factors and citation analysis has attracted unprecedented interest among academic scientists and research administrators [52]. Everybody likes to see their name in print and it is always flattering when you notice that your articles get cited. Nobody would object if their next toxicology paper was accepted for publication in *Lancet* or *New England Journal of Medicine* and, indeed, some manage to achieve this feat [53,54]. Finally, it is worth remembering the aphorism "don't judge a book by its cover" because this can also be applied to scientific articles. So, don't judge them by the impact factor of the journal where they are published. Instead, read the paper carefully and if you like what you read cite the article in your own next publication. However, make sure you do this quickly and at least within 2-years of the article being published otherwise you won't help the journal impact factor.

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