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LEAD ARTICLE

The Journal "Impact Factor": A Misnamed, Misleading, Misused Measure

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ABSTRACT: *The Institute for Scientific Information (ISI), a database publishing company that publishes* Current Contents *and* Science Citation Index, *has devised and promulgated what it terms the journal "impact factor." ISI describes this factor as a "measure of the frequency with which the 'average article' in a journal has been cited in a particular year." The factor is a ratio between citations and recent citable published items calculated by dividing the number of all current citations of items published in a journal during the preceding 2 years by the number of articles published in those 2 years by that journal. What, if anything, is wrong with the "impact factor"? There is absolutely nothing incorrect with the calculation of the ratio itself. However, the "impact factor" is misnamed and misleading. Being misnamed and misleading, the "impact factor" has been misused. It is being held out as a measure of the importance of a specific journal article and the journal in which the article appeared. By extension, the "impact factor" is also being misused to gauge the relative importance of individual researchers, research programs, and even the institution hosting the research. We recommend that the term "impact factor" be abolished and that this measure be renamed in keeping with its actual role, that merely of a time-specific "citation rate index" and nothing more. What is currently called the "impact factor" should not be misused to evaluate journals or to validate the scientific relevance of a particular researcher or research program, especially in decisions regarding employment, funding, and tenure.*

INTRODUCTION

The Institute for Scientific Information (ISI) "has for almost forty years, responded to the needs of the global research community," according to its site on the Internet (the address for which is http://www.isinet.com). To be precise, ISI was founded in 1958. The purpose was, ISI states, " . . . to provide researchers with access to current research information of the highest quality."

No mention is made of monetary motivations. However, ISI is a commercial company and so would presumably not be adverse to a profit on the bottom line. To our knowledge, all of the products and services developed and delivered by ISI are based upon ISI's own database. ISI says that its database "covers over 16,000 international journals, books, and proceedings in the sciences, social sciences and humanities, including complete bibliographic data, cited references, and author abstracts for every item it includes." ISI purports to have "the most comprehensive, multidisciplinary, bibliographic database of research information in the world."

Among the ISI publications, perhaps the best known are *Scientific Citation Index* and *Current Contents*. As is common practice with many journals, *Cancer Genetics and Cytogenetics* proclaims in print that it is "cited in Biological Abstracts, CABS (Current Awareness in Biological Sciences), Current Contents (Life Sciences), . . ." and so forth. This statement comes twice per issue: right after the listing of the contents of the issue and then at the bottom of the back cover. A scientific journal could hardly hope to succeed these days were it omitted from the contents of *Current Contents*.

ISI has gone from developing its bibliographic database of research references to doing its own research on that same database. This type of research has obviously become feasible by the extensive use of computers capable of analyzing the enormous amount of information residing in the ISI database. As a result of this research, ISI now markets a number of "Research Services Products." These ISI products, all available for a price, include: (1) High Impact Papers (1981–1995), (2) Hot Papers, (3) Institutional Cita-

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tion Report, (4) Journal Analysis, (5) Personal Citation Reports, and (6) Journal Citation Reports [1]. The last product, Journal Citation Reports (JCR), is published annually and is available in either Fiche or CD-Rom format. JCR includes journal rankings, subject category listings, journal immediacy index, journal cited half-life, and journal impact factor.

THE "IMPACT FACTOR"

We wish here to consider the "JCR impact factor." ISI modestly mentions that, in addition to the impact factor, there are "other ways of calculating journal impact." These other ways were described in a 1972 paper by E. Garfield [2], the founder of ISI. However, according to ISI, the "impact factor" has emerged as the most prominent "tool in journal evaluation." If this is true, it is unquestionably thanks to the evangelical efforts expended by ISI on behalf of its offspring, "the impact factor."

ISI formally defines the "impact factor" as "A measure of the frequency with which the 'average article' in a journal has been cited in a particular year." In other words, the "impact factor" is ". . . basically a ratio between citations and recent citable items published."

The "impact factor," like any ratio, has a numerator and a denominator. The numerator in this case is the number of all current citations in the literature to articles published in a given journal over a set period of time (the preceding 2 years). The denominator is the number of articles that were published in that journal during that 2-year period [3]. Obviously, the greater the number of citations for a specific number of articles, the higher the number and the larger the "impact factor" will be. These "impact factors" can then be arrayed in sequence.

THE "HIGHEST-IMPACT" JOURNALS

An example of the utilization of the "JCR impact factor" is given in Table 1, which lists what ISI ranks as the 25 "highest-impact journals." This pantheon of publications can be likened to the periodic poll of the top 25 football and basketball teams in the United States or to the old "hit parade" of top tunes. It is a neat numerical ranking. Everything is reduced to numbers, and these numbers are then ranked in descending order. That is all there is to it.

When one examines this table of "highest-impact journals" more closely, several aspects become apparent. It is not surprising that a number of the elite publications made it into the top 25. However, note that these primary research journals are indiscriminately intermingled with review periodicals. In fact, the majority (at least 15 of 25, or 60%) of the supposed "highest-impact journals" do not report fresh research results. They contain a compilation of reviews and summaries of research past.

MIXING RESEARCH REPORTS AND REVIEWS

Granted that reviews have their own undeniable utility and the writing of a review can be just as challenging (or more) as producing a research paper. Still, reviews simply cannot have the same immediacy and influence as an innovative research paper, and volumes of reviews clearly have no business being included in the same select list as *Nature Genetics* and *Science*.

Why might review periodicals tend to rank highly among the "highest impact" journals? In short, why are review articles so often cited? The citability of reviews may be due to their inclusivity. In referencing the introduction and discussion sections of a research article, it saves authors considerable time and space if they cite a recent review on the topic rather than all of the original articles referenced in the review. By necessity, a review article is more comprehensive and covers more ground than a research article. If we select the arbitrary number of 10 times more information, on that basis alone, the average review would tend to be cited more often (10-fold) than the average research article.

Whatever the reasons, review periodicals receive numerous citations. The result is to elevate the relative standing of review publications in the "impact-factor" ratings and, commensurately, to drop research journals down in the ranking.

THE "IMPACT FACTOR" MISUSED FOR MARKETING

What are the current uses and misuses of the "impact factor?" Are editors and publishers of journals making policy decisions on the basis of the "impact factor" that ISI so coyly calculates and then calculatingly propagates? The answer seems to be "yes," especially as evidenced in the advertising arena. For example, the front page of a flier distributed in 1996 by the publishers of the journal *Genes*

Table 1 The 25 "highest-impact journals"

1	Clin Res
2	**Annu Rev Biochem**
3	**Annu Rev Immunol**
4	Cell
5	**Annu Rev Cell Biol**
6	Nature
7	New Engl J Med
8	Nat Genet
9	**Pharmacol Rev**
10	Science
11	**Immunol Today**
12	**Microbiol Rev**
13	**Trends Neurosci**
14	Neuron
15	**Annu Rev Neurosci**
16	Genes Dev
17	Lancet
18	**Endocr Rev**
19	**Trends Pharmacol Sci**
20	**Trends Biochem Sci**
21	**Physiol Rev**
22	**Adv Immunol**
23	FASEB J
24	**Annu Rev Plant Phys**
25	**Rev Mod Phys**

Review publications are in bold-face type.

& Development (G & D) carries the statement that "After a decade of *rising impact factors* and growing circulation, G & D is now more than important. It's essential, and it belongs in your library." In addition, the entire third page of the brochure is dedicated to the question, "What's the impact factor?" A table demonstrated that *Genes & Development* with an impact factor of 17.334 was in spot no. 7 of the "Top 10 Primary Research Journals," just above *Lancet* in spot no. 8 with a score of 17.332.

Now *Genes & Development* is published not by hucksters but by an august academic house, the Cold Spring Harbor Laboratory Press, "in association with" that respected scientific body, the Genetical Society of Great Britain. It would seem that at least the Cold Spring Harbor Laboratory Press and its transatlantically associated Genetical Society of Great Britain do pay close attention to the "impact factor" of their journal. The Cold Spring Harbor Laboratory Press is far from alone in exploiting the "impact factor" for commercial purposes. This week, for example, we received a flier from Stockton Press on behalf of the journal *Gene Therapy*. The very first words on the flier are "Announcing its first ever impact factor of 8.063!"

The "impact factor" has clearly become a key marketing tool in biomedical publishing, and a high "impact factor" is desirable because it can be used to promote a particular journal. Changes may be made in editorial policy in an attempt to increase that journal's "impact factor" but these changes may or may not result in improving the overall quality of the journal. For example, the review process, which most journals use for the evaluation of the quality and publishability of an article, varies greatly from journal to journal. It may even vary within the same journal, depending on the specific topic with which an article is dealing, and some articles may not be exposed to the full rigors of the review process (e.g., invited reviews, letters, correspondence). Perhaps a journal needs to review its own review process. We are not questioning editorial changes that improve the quality of scientific publications. But we are concerned that an excellent article published in a journal with a so-so "impact factor" is demeaned vis-à-vis an average article appearing in a journal with a lofty "impact factor." We are also concerned that editorial decisions will come to be based not on scientific merit, but on financial merit. The traditional separation of science from the biomedical publishing business may be disrupted. Editorial policies once determined by scientist-editors may increasingly be dictated by executives and accountants.

THE DIASPORA OF PUBLISHED SCIENCE

The number of scientific journals continues to increase dramatically. To gain some measure of the number of journals now carrying biomedical information of a specific type, we did a MEDLINE standard search in June 1997 for the term "cancer chromosome." We specified that "cancer chromosome" be in the title of the article, required that the article have a summary, and restricted the search to 1996–97.

In all, 69 articles were recovered. These articles appeared in 27 journals. The journals are listed alphabetically in Table 2. As might be expected, there was a broad range (1–14) in the number of articles in a given journal (data not shown). The mean was 2.56 articles per journal, indicating that the average journal carried 3.71% of the total number of articles.

When the British mathematician G. H. Hardy set out the fundamental theorem of population genetics in 1908, he considered publishing his contribution in the eminent journal *Nature* in Great Britain. Instead, thinking that his work would be viewed as too trivial by his confreres in mathematics, Hardy opted to publish it instead in the United States in a fledging journal by the name of *Science*. Today Hardy would have to consider many more than these two journals in deciding where to submit his description of what is now known as the Hardy-Weinberg law.

The word "diaspora" (Greek, "dispersion") is applied to the settling of the Jewish people outside Palestine and, more generally, to the breaking up and scattering of peoples far from their ancestral homelands. We would suggest that the term "diaspora" can also be aptly applied to the dispersion of biomedical knowledge today. There are now so many journals—and more with each passing year—that knowledge in any area is being more and more dispersed. No individual can possibly afford to subscribe to all relevant journals, nor can many research groups and, now, even some libraries. Publishers are aware of this and design advertisements ensuring that the maximum number of readers purchase subscriptions to their journals. Hence we are seeing the increased use of the "impact factor" as a way to promote specific scientific journals over the competition.

A PROCRUSTEAN BED FOR ALL PERIODICALS

In a place between Athens and Sparta where a traveler might wish to stop for the night, according to Greek legend there lived the giant Procrustes, a giant robber with a strong sense for the fitness of things. He offered each guest a bed of iron. If the man were too short to fill the bed, Procrustes stretched him to fit; if the man were too long, Pro-

Table 2 Journals with articles recovered by a MEDLINE standard search in June 1997 for "cancer chromosome" in title of article with a summary published in 1996–1997

Am J Clin Pathol
Am J Pathol
Anticancer Res
Br J Cancer
Cancer
Cancer Genet Cytogenet
Cancer Res
Cell
Genes Chromosom Cancer
Genome Res
Genomics
Gynecol Oncol
Hum Genet
Hum Mol Genet
Hum Pathol
Int J Cancer
Int J Gynecol Pathol
J Med Assoc Thai
J Pathol
J Urol
Mutat Res
Nat Genet
Nat Med
Nipon Ika Daigaku Zasshi
Oncogene
Proc Natl Acad Sci USA
Science

Journals are given in their abbreviated format.

crustes simply lopped off any excess. The word procrustean has therefore come to mean an effort to fit any and all things into a preconceived framework.

When ISI assigns an "impact factor" to an article, has anyone at ISI read that article to gauge its quality? ISI only uses two types of information. One is information identical with that in a journal's table of contents (which is in ISI's *Current Contents*), and the other is how many times an article is subsequently cited. These two types of information are then used to calculate the "impact factor." To rank a journal based on its "impact factor" is to make a determination based on Procrustean standards.

Elite general journals (e.g., *The New England Journal of Medicine* and *Science*) can be relatively selective in the articles that they publish, because they are in no way restricted to a specific area within medicine or science but cover these fields as a whole. Hence, it is not surprising that the elite general journals tend to carry articles of generally high quality.

Specialty journals, on the other hand, deal with a specific field and are committed to covering a wide range of accomplishments in that field. They are also committed to publishing articles that may be of a confirmatory nature, backing up the original "breakthrough." Articles of this sort usually do not result in press conferences and may be dismissed as mere corroboration, but all scientists know that it is important to publish this additional data, whether confirmatory or conflicting. Furthermore, the specialty journals often accept articles from smaller research groups or from less well known research programs, perhaps from non-English speaking countries, giving this research perhaps a greater profile than if it were published in a non-English journal with a more limited readership. For a number of reasons, articles in specialty journals may be more variable in quality and immediacy than those typically found in the elite general journals. It is totally inappropriate for ISI to put general journals, specialty journals, and review periodicals into one procrustean bed.

INDEPENDENT CRITICISM OF THE "IMPACT FACTOR"

We are not alone in calling for rejection of the impact factor as a guide to journal quality. Hansson [4] also feels that the impact factor (IF) is a misleading tool in the evaluation of medical journals. The calculation of the IF is based on a 2-year period, but there are inherent "differences between research areas with respect to citation habits during these 2 years." He states that "speedy references in a journal means that the journal could be expected to display a high IF." He concludes that the "IF is predicted by field-associated habits to cite articles published within 2 years, favouring research areas that generate many short-term studies. IF creates a tendency to treat clinical journals as less important. Quality plays a small part in determining IF." We agree with his observations about field-associated habits. For example, there are big differences among the dynamics of gene mapping, the collection of data in clinical trials, and the description of rare disorders.

The relation between article citedness and journal impact has been investigated by Seglen [5]. He compared the citedness of an individual journal article (measured as the mean annual number of citations in years 02–04) with the journal impact (mean article citedness of each corresponding journal recorded during years 01–02) by using complete publication lists provided by 16 senior authors (project leaders) from a biomedical research institute. When he divided the authors into two groups, the highly cited and the less cited, he observed a "twofold ratio in citedness between the two groups throughout the journal impact range." Seglen felt that ". . . this difference could not be accounted for by journal choice, and did not diminish with increasing journal impact." He concluded that the "citedness of journal articles thus does not seem to be detectably influenced by the status of the journal in which they are published." Seglen added, "Use of journal impact as an evaluation parameter may yield highly misleading results" and ". . . that article citedness is unaffected by journal prestige and that certain journals have a high impact simply because they publish high-impact articles."

THE IMPACT OF THE "IMPACT FACTOR" IN WESTERN EUROPE AND THE UNITED STATES

It is not easy to determine the impact of the "impact factor" in the United States; that is, to know when and under what situations it is being employed other than in journal advertising. But it is clear that the "impact factor" has made a considerable impact in Western Europe. The exact reasons for this are not readily apparent, but they may reside in the past history in Europe in regard to academic appointments, promotions, and the allocation of research funds—all of which, we would suggest, have had a history of favoritism, nepotism, and social-rank privileges behind them.

The explosion in the number of well-trained scientists and physicians in Europe after World War II and the democratization of that part of the world necessitated an alternative system of review with a significant objective component. The "impact" factor seems to have been incorporated into this review formula. In situations of employment or funding, the use of "objective" numbers obviates charges of bias or prejudice. Given the litigious nature of the U. S. population, one can predict that these "objective numbers" may well in the future form the basis for discrimination lawsuits.

Not surprisingly, the utilization of the "impact factor" is not confined to the biomedical sciences and those other areas of human endeavor overseen by the ISI. An analogous "factor" is all the rage in the field of law and a new discipline called "citology" has developed. Citology is the study of legal footnotes, historically a major component of legal writings. There are now lists of the most-cited law review articles based on the frequency of footnote citation. Apparently " . . . serious law reviews are devoting attention to citology . . . [and there is] . . . dawning recognition of citation analysis as a legitimate area of scholarship" [6]. Some law schools are even using citation counts in hiring professors. Enthusiasts maintain that footnote tallies reveal a lot about which ideas or schools-of-thought are currently the most important and influential.

Clearly, any fundamental failings that beset the 'impact factor" also apply to law citology and all comparable attempts that reduce the relative importance of an article or an author to a purportedly precise number. Whether in science or law, this type of analysis has become feasible only because of computers. Ironically, computers will probably again change the process itself. As the costs of paper publishing and the volume of published science increases, in the future, if not already, a biomedical scientist will be able to gain full access to information only by electronic means. Paper journals will reverse roles with their electronic counterparts and e-journals will be the standard. The only paper journals will be in university and national libraries, if even there. The same computer technology that has made possible the calculation of the "impact factor" will make possible the substitution of online journals for their classic counterparts.

One reason that the "impact factor" has gained such prominence is the intense competition among an ever-increasing number of journals. The electronic library of the future will, we hope, render the "impact factor" obsolete because journals as we know them today, may be obsolete. In the meantime, as Seglen has commented, "Science deserves to be judged by its contents, not by its wrappings" [5].

CONCLUSIONS AND RECOMMENDATIONS FOR THE FUTURE

We conclude that the "impact factor" is not a measure of true impact. Granted, the "impact factor" is very appealing because it is a simple quantitative measure. The trouble is that it is a quantitative measure of a quality that cannot be quantified. We recommend that the term "impact factor" be abolished. We suggest that this measure be renamed in keeping with its actual role, that of a "citation rate index." As such, this index should not be used to sell journals or to validate the scientific relevance of a particular researcher or research program, especially in decisions regarding funding, employment, and tenure.

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REFERENCES

1. Science Citation Index Journal Citation Reports (1994).
2. Garfield E (1972): Citation analysis as a tool in journal evaluation. Science 178:47–79.
3. Garfield E (1993): SCI Journal Citation Reports: A Bibliometric Analysis of Science Journals in the ISI Data Base. Institute for Scientific Information, Philadelphia.
4. Hansson S (1995): Impact factor as a misleading tool in evaluation of medical journals. Lancet 346:906.
5. Seglen PO (1994): Causal relationship between article citedness and journal impact. J Am Soc Inf Sci 46:1–11.
6. Barrett PM (1997): "Citology," the study of footnotes, sweeps the law schools. The Wall Street Journal, Wednesday, January 22.