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Impact factors in nuclear medicine journals.

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ABSTRACT

The annual Journal Citation Reports include a number of statistics and figures, the key figure being the journal impact factor. A journal’s impact factor, despite being widely used, is not well understood. This article aims to provide a broader understanding of the impact factor and the implications thereof.

Key words: impact factor, IF, journal quality, nuclear medicine, academic
Introduction
The journal impact factor (IF) was introduced to replace the science citation index (SCI) because the SCI was biased towards journals with a large number of published articles (1). The IF allowed indexation of smaller but influential journals (1). Certainly nuclear medicine journals published quarterly would not have been included in the SCI but which rank strongly with IF.

Thomson Scientific, or the Institute of Scientific Information (ISI) in a previous iteration, publishes Journal Citation reports (JCR) annually. While the JCR includes a number of statistics and figures, the key figure published is the journal IF. A journals IF, despite being widely used, is not well understood.

What is the Impact Factor?
A journal's impact factor is a measure of the ratio of recent citations to recent articles in the journal. The ISI JCR provides the most comprehensive citation data for the evaluation of quality (2), although it should be interpreted with caution. The 2005 JCR indexed 6088 journals which is a 32% increase over 10 years (2).

The ISI JCR may be used for promotion, recruitment or grant decisions. Identifying a candidates publication record against the respective IF of journals is not an attempt to determine the quality of the journal but more an attempt to gauge the quality of the individual publication. Generally, however, only a small number of articles contribute to the overall IF of a journal while the majority of articles are either not or infrequently cited. This may be referred to as the 80/20 phenomenon where 80% of citations are attributed to 20% of articles (1). The journal IF alone, therefore, provides little indication to the ‘impact’ or ‘quality’ of a given article.

The journal IF should be interpreted with great care and with the acknowledgement that it represents only a rudimentary guide to journal quality.
Even journals ranking amongst the highest IFs maintain a degree of skepticism regarding their usefulness. IFs are not easily transferable or comparable across ISI categories. A high impact factor simply reflects the rate of citations to recent articles, it does not imply any degree of quality. A poorly written or methodologically flawed article is likely to attract numerous citations and contribute in a significant way to the journals IF.

In short, the IF is the number of times the ‘average’ article in a journal over the preceding two years was cited in journals in the subsequent year. That is, the 2005 IF is based on the number of citations in all ISI listed journals in 2005 of articles published in the specific journal in 2003 and 2004.

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\text{IF (2005)} = \frac{\text{cites in 2005 to articles from 2003 and 2004}}{\text{number of articles in 2003 and 2004}}
\]

**Shortcomings of Impact Factors**

ISI purport that the JCR, including the IF, are an indicator of the frequency with which current researchers use a particular journal (3). A poor indicator one might imagine given:

- The reports are based on citations over a two year cycle.
- Publications in any one year may have been undertaken early in the two year cycle and, thus, initial analysis of existing literature may predate the two year cycle. That is, published work with an immediate ‘impact’ on clinical practice or other researchers may have a less than indicative contribution to IF calculations.
- Cutting edge or innovative research may require a longer cycle before even those with rapid adoption generate publications citing the original work.
- The IF does not measure the longer citation life and prolonged high impact of seminal works.
• Lack of citation does not indicate a lack of impact on either the research or clinical practice of others.
• The JCR cycle is biased towards industries with rapidly evolving technology and techniques (e.g. information technology) while being biased against those industries with less dynamic evolution (e.g. mathematics).

Indeed, the very nature of health based research handicaps health based journals where the research cycle, including the relevant ethics approvals, radiation safety approvals, patient recruitment and the long sampling interval required for a measurable outcome, is significantly longer than laboratory based or field observational studies typical of many of the high IF science journals.

None the less, the IF might reflect a journals visibility or profile within a discipline. It has been suggested that the IF is biased towards North American journals and against non-English language journals (4). Mueller et al. (5), however, on investigating this proposition only found evidence of a language bias with no differences in IF noted between English language journals originating in the USA versus other countries. The language bias is not entirely surprising given the predominance of English language journals in the ISI database and the inclination of individuals to rely more heavily on articles not requiring translation. Despite this, the German language nuclear medicine journal, *Nuklearmed*, has consistently performed strongly in the annual JCR; perhaps a reflection of an active German based nuclear medicine research community supporting a local journal and demonstrating a micro level language bias.

Interpreting trends in the IF needs careful consideration. One suspects that, across many discipline areas, that emergence of new technology and innovation comes in waves. The cycle might resemble rapid adoption after release, a hiatus in advances as capabilities are fully realized, a lag phase as shortcomings are addressed and a spike as solutions and advances are released. The journal IF
might reflect this cycle. Interestingly, these cycles may be inter-related across discipline areas. For example, the emergence of PET/CT may have boosted the IF of nuclear medicine journals but as the technology has become more broadly adopted clinically, the influence of PET/CT may extend to oncology journals; although one suspects that PET/CT articles in oncology journals might widely cite nuclear medicine journal articles and, thus, boosting the nuclear medicine IF.

The Impact Factor Game
Publishing ones research work plays an important role in completing the project but also in disseminating the results to a target audience. Unfortunately, the role of IFs in employment, promotion and the like has seen a trend emerge where the highest IF journals are targeted for publication even when an alternative journal might provide broader dissemination to the target audience. This may perpetuate a downward cycle for those journals with low or no IF as less authors seek to publish articles in these journals and/or article quality decreases, reducing citations and reducing the IF. The converse argument might be that publication in the broadest valid audience might result in greater citations. The Journal of Nuclear Medicine Technology (JNMT) provides a good example of the ideal outlet for dissemination of technically based research but the JNMT does not have an ISI listing. The absence of an ISI IF may be reflected in a change in popularity in the JNMT as an outlet for research. In the four year period 2003 to 2006 the average number of published articles in the JNMT was 23.75 annually. In the four year period 1997 to 2000, a period prior to the IF emphasis, the average number of published articles in the JNMT was 38.5 annually. Does this decline reflect a change in popularity, a change in editorial policy or an emergence of IF driven journal selection?

The role of the IF does not serve as a guide to decision making with regard to either quality or impact of individual articles. Since the central goal of publication is to disseminate findings to as broad a valid audience as possible,
the number of times a journal article is actually read might provide a better indication of impact; although a little more difficult to reliably measure. From an educator’s perspective, what greater impact does a journal article have than if it is used to teach the future practitioners in that discipline?

One of the potential problems with IFs is the difficulties in comparing small and large disciplines. The argument might suggest that high impact factors can not be achieved in categories that do not have a large number of researchers because the number of citations would be lower. That argument might be true if the same number of journals existed in each category. In reality, smaller disciplines or those with less research invariably have fewer journals and fewer active researchers. None the less, the impact factor should not be used to directly compare disciplines or specialties.

In 2005, Ultrasonic imaging had an IF of 0.938, similar to that of Clin Physiol & Funct Im (0.973). The former was based on just published 9 articles for the sampling period while the latter was 57. The variations outside discipline groups is more dramatic. In 2005, the highest ranked IF was that of Ca Cancer J Clin (49.794) based on just 20 published articles over 2 years. The J Nucl Med (JNM), which is arguably the most influential journal in nuclear medicine, had an IF of just 4.684 based on 294 articles. The IF is valid only within ISI categories, not between them (2).

**Strategies to Boost Impact Factors**

A contributor to variations in the IF between journals that might otherwise be of similar quality is often identified as the referencing policy. The JNM, for example, limits the number of references per manuscript to 40. A limit of 30 references is typical of many other journals. A large proportion of journals, including nuclear medicine journals like Nuclear Medicine Communications, do not set reference capping. While increasing the number of references per article will contribute significantly to boosting the collective IF of a given discipline
like nuclear medicine, removing reference capping may not change the referencing practice of the average author. In 2005 the mean number of references per article for the *JNM* was 31.4 (3) which is well short of the limit of 40. Moreover, *Nuclear Medicine Communications* had an average number of references per article of 22.5 for 2005, despite having no capping. Perhaps removal of reference capping will only encourage those with the inclination to engage in gratuitous self citation.

Self citation is the practice of referencing one's own previously published work in a manuscript and, when excessive, may bring into question the validity or quality of the manuscript. Self citation may not always be limited by a reference capping policy. For example, Clasen and Kulicke (6) contains 29 references of which 23 (80%) are self references. Expanding the reference capping for the *JNM* beyond 40 might contribute to boosting the IF of the journal and of the collective category on the ISI JCR. While self citation might then be encouraged, it is not always inappropriate or indulgent. Indeed, it may be the only means for references to cutting edge research or innovation within the ISI JCR sampling period. Germano et al. (7) offers an example where new innovations in quantitation of gated myocardial perfusion SPECT may otherwise be disproportionately represented in IF calculations. Germano et al. (7) employ 30 references of which 18 (60%) refer to work previously published by one of the authors. Self citation may simply reflect the expertise of a group of authors in a particular domain, as is the case with Germano et al. (7). None the less, self citation is also a means by which individuals can boost their own citation index. Eugene Garfield is credited with the introduction of the SCI and IF, and his recent brief communication (1) on the history of the IF contained 33.3% self references. Removing referencing capping by one or more nuclear medicine journals may offer a strategy to increase the IF of the ‘radiology, nuclear medicine and medical imaging’ category compared to other categories but also to increase the IF of nuclear medicine journals relatively within the category.
Review articles generally attract a greater number of references than other types of articles, boosting the disciplines collective IF. Review articles also tend to attract more citations than original research articles. Thus, a journal based entirely on review articles, like *Seminars in Nuclear Medicine*, might attract an IF that, relative to a competing research journal like the *JNM*, does not reflect either the quality or visibility. In the JCR year of 2005, the *JNM* included 289 articles but only 5 reviews (3); although our own classification of a ‘review’ article might be much higher. Increasing the number of reviews might boost the *JNM* impact factor relative to other nuclear medicine journals and to those in other categories.

There has been a proliferation of ‘open access’ journals in recent years. A typical Medline query will retrieve any number of ‘free full text’ articles. Open access is a strategy being used to boost IF with some success because online availability of full text articles increases a journal visibility (8). Many journals, like the *JNM*, rely on subscriptions making an open access strategy difficult to justify. Several journals offer open access to articles several years old while keeping the current volume closed to non subscribers. Clearly this does not help improve IF because the open access falls outside the JCR two year cycle.

Perhaps a more astute approach might be to offer selective open access to the current volume. The status and profile of the *JNM* is based in a large part on the quality and cutting edge nature of the research published. The continuing education articles and reviews not only represent a small proportion of published work but also fall outside the core competitive advantage of the *JNM*. *Seminars in Nuclear Medicine*, on the other hand, centres on review articles. Review articles do, however, attract more frequent citations in other journal articles and, thus, have a greater contribution to the journal IF. The *JNM* might boost its IF without losing subscriptions by providing all review articles as open access online while maintaining subscription only access to other articles.
There are a number of other strategies that have been used with some success to improve a journal’s IF:

- Publication in multiple languages, particularly when the native language is not English, expands the readership and potential for citation.
- A selective editorial policy where articles are rejected or accepted with some consideration to the likelihood that they will be cited. An important factor to consider is that a controversial issue that is likely to divide a community may attract a considerable number of citations.
- Astute choice of themes for journals, particular with respect to review articles, may contribute to an increased impact factor.

While the *JNM* has dominated the IF rankings for nuclear medicine journals fairly consistently over the last 8 years, a number of other nuclear medicine journals have occupied the IF ‘roller coaster’. *Seminars in Nuclear Medicine* offers the best case study with a fairly consistent ranking of third for nuclear medicine journals over 8 years. In 2003, *Seminars in Nuclear Medicine* had an IF of 3.431 which rose to 5.800 in 2004 and then fell back to 3.000 in 2005. The rise probably reflects research interest of industry in emerging techniques with ‘fresh’ themes of PET, lung scanning including CT, peptides and FDG. The demise probably reflects a lack of research interest due to a narrow and ongoing theme of PET.

**The Journal of Nuclear Medicine Technology**

Despite the 7500 scholarly journals included in the ISI JCR, there are a number of omissions, most notably the *JNMT*. It is crucial to recognize that low IF journals and those, like the *JNMT*, without an ISI listing will continue to play an important role in dissemination of new knowledge. Had the *JNMT* been listed with ISI, the 2005 IF would have been 0.350 with 44 articles over the 2
year period. This corresponds to a rank of 82/85 in the category and 5458/6088 overall.

**Conclusion**
The ISI JCR needs to be interpreted with caution. The IF provides a good rudimentary tool for illuminating trends in journal quality within discipline groups. The IF itself should be used as a guide rather than a tool for definitive decision making and is best interpreted in conjunction with the entire contents of the JCR. A number of strategies can be employed to boost a journal's IF but, ironically, while boosting IF a decrease in ‘actual’ journal quality may result. In the absence of a single instrument to measure the actual impact of a journal (or its contents) on policy and practice, the JCR IF provides rankings reflective of the visibility of nuclear medicine journals.
REFERENCES


