In 2004 the impact factor (IF) of *REVISTA ESPAÑOLA DE CARDIOLOGÍA* reached 1.802. This figure for the popular bibliometric indicator was nearly double our previous IF, and represented a significant achievement not only for our journal, but for all medical journals in Spanish. We editors thus feel that this is a magnificent opportunity to review the underlying foundations, implications and limitations of the bibliometric indicators that are now used most widely, and to offer some reflections on our editorial procedures and policies.

**Calculating Bibliometric Indicators**

The challenge of performing a balanced assessment of the merits of research remains unresolved. Methods presumed to be objective, e.g., citation rates and the IF, have been proposed to evaluate the quality of research in biomedical journals. Data for citations are obtained from a database maintained by the Institute for Scientific Information (ISI) which now forms part of a private institution (Thomson Scientific) with its headquarters in Philadelphia. The ISI continuously computes and classifies all citations in the reference sections of articles published in an extensive list of science journals from around the world. These references are processed in their databases to determine how many times a given article has been cited during a specific period, and by whom. Since 1963 these data have been compiled in the Science Citation Index (SCI), and more recently in SCI-Expanded. Lists of publications by different authors make it possible to calculate how many citations a researcher has garnered in a given year, whereas citation rates for science journals can be measured as the IF, which calculates the mean percentage of citations received, divided by the total number of articles published in a given journal. Since 1975 journal IFs published annually in the SCI’s Journal Citation Reports (JCR) have provided a widely accepted way to objectively compare the scientific quality of journals. In principle the IF was developed by ISI simply as an internal indicator of the relative quality of scientific publications to help them decide which journals to include in their database. Later the popularity of the indicator spread because of its simplicity, and was subsequently consolidated when it was shown that the IF correlated to an acceptable degree with several parameters of quality in biomedical journals. As we discuss below, although the IF is currently considered one of the most widely accepted indicators of a publication’s visibility and prestige, it is not without important limitations.

The ISI indexes almost 8500 journals in 20 different knowledge areas. In the area of biomedicine, 16 of the indexed journals are in Spanish, and 11 of them are published in Spain. Although it was Gross et al. in 1927 who first suggested the usefulness of counting references in science articles, the IF itself was “invented” 50 years ago by Eugene Garfield, founder of ISI, as a simple method to compare different journals regardless of their size. This was an attempt to correct for the increase in citations to a journal simply as a result of the journal publishing more articles. The journal’s IF for a given year is calculated as the number of citations published in that year (in other journals indexed by ISI) to articles published by the target journal during the 2 preceding years (numerator), divided by the total number of citable articles published in the target journal during the 2 preceding years (denominator). As noted, the ISI is an independent organism and it is frequently hard to establish accurately how many items are considered citable (substantive articles, source items, citable items). Moreover, the IF tells us only how frequently articles in a given journal are cited in the short term.

Another interesting bibliometric indicator provided by the ISI is the cited half-life. This indicator reflects the number of years (counting backward in time) that comprise 50% of the citations received by the journal during a given year. In practical terms, this indicator expresses the time during which articles published in the journal are cited and are assumed to be useful to
the scientific literature.1-4 A similar indicator—the inverse of citation half-life, in a sense—is the half-life of articles that are cited by the journal of interest (the citing half-life).

The immediacy index, a measure of citations received during 1 year by articles published in that year divided by the total number of citable articles in that year, provides an approximate idea of the journal’s editorial dynamics, i.e., how current the journal’s coverage of the discipline is.

Another parameter is the absolute citation count. This is the total number of citations a journal receives in a given year for any article published previously. This approach partly counteracts the problems arising from the short-term view typical of the IF, although it has its own limitations in that it favors older journals and journals that publish larger numbers of articles.5

### TABLE 1. Problems and Limitations of the Impact Factor for Science Journals*

<table>
<thead>
<tr>
<th>Problem/Limitation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Journal impact factors are not statistically representative of individual journal articles</td>
<td>Impact factors can be skewed by the size and impact of individual articles.</td>
</tr>
<tr>
<td>2. Journal impact factors correlate poorly with actual citations of individual articles</td>
<td>When citations are influenced by factors such as author prestige or article length.</td>
</tr>
<tr>
<td>3. Authors use many criteria other than impact when submitting journals</td>
<td>Selection of journals is based on various factors, not just impact.</td>
</tr>
<tr>
<td>4. Citations to “noncitable” items are erroneously included in the database</td>
<td>Items that are not considered citable by others may be cited by the journal’s authors.</td>
</tr>
<tr>
<td>5. Self citations are not corrected for</td>
<td>Self-citation rates are not adjusted, leading to inflated impact factors.</td>
</tr>
<tr>
<td>6. Review articles are heavily cited and inflate the impact factor of journals</td>
<td>Articles that summarize or summarize and critique other works can receive high citation counts.</td>
</tr>
<tr>
<td>7. Long articles collect many citations and give high journal impact factors</td>
<td>Journals that publish longer articles are at an advantage.</td>
</tr>
<tr>
<td>8. Short publication lag allows many short-term journal self citations and gives a high journal impact factor</td>
<td>Journals with shorter publication cycles can benefit from recent citations.</td>
</tr>
<tr>
<td>9. Citations in the national language of the journal are preferred by the journal’s authors</td>
<td>Journals in the target language receive more citations.</td>
</tr>
<tr>
<td>10. Selection journal self-citation: articles tend to preferentially cite other articles in the same journal</td>
<td>Citation patterns can vary by journal.</td>
</tr>
<tr>
<td>11. Coverage of the database is not complete</td>
<td>The database may not include all journals relevant to the research field.</td>
</tr>
<tr>
<td>12. Journals in English language bias</td>
<td>Journals published in English tend to be cited more frequently.</td>
</tr>
<tr>
<td>13. Database is dominated by American publications</td>
<td>Impact factors are skewed by the dominance of publications from the USA.</td>
</tr>
<tr>
<td>14. Journal set in database may vary from year to year</td>
<td>Database composition can change due to the entry or exit of journals.</td>
</tr>
<tr>
<td>15. Impact factor is a function of the number of references per article in the research field</td>
<td>Impact is influenced by the number of articles published.</td>
</tr>
<tr>
<td>16. Research fields with literature that rapidly becomes obsolete are favored</td>
<td>Journals that publish rapidly growing fields tend to receive higher impact factors.</td>
</tr>
<tr>
<td>17. Impact factor depends on dynamics (expansion or contraction) of the research field</td>
<td>Impact is affected by the growth dynamics of the research field.</td>
</tr>
<tr>
<td>18. Small research fields tend to lack journals with high impact</td>
<td>Journals in smaller fields are at a disadvantage due to the scarcity of high-impact articles.</td>
</tr>
<tr>
<td>19. Relations between fields (clinical versus basic research, for example) strongly determine the journal impact factor</td>
<td>Impact is influenced by the relationship between different research disciplines.</td>
</tr>
<tr>
<td>20. Citation rate of article determines journal impact, but not vice versa</td>
<td>Impact is determined by citation rates, but vice versa is not considered.</td>
</tr>
</tbody>
</table>

*IF indicates impact factor. Adapted from Seglen.7

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**Limitations and Abuses of Bibliometric Indicators**

The main problems that arise from the use of bibliometric indicators can be classified into 3 groups: 1) limitations intrinsic to the indicators; 2) inappropriate use of the indicators; and 3) editorial implications. Per O. Seglen1 provided an excellent summary of the fundamental problems that result from the use of the IF of biomedical journals to evaluate scientific research (Table 1).

### Limitations Inherent to Bibliometric Indicators

**Citations received.** The citations received by a journal depend critically on the number of journals in a given subject category that are included in the ISI database.7,12-13 This is the case because only citations from this select club of journals are counted. The fact that this database includes a relatively small number of journals whose language of publication is not English accounts for the bias that clearly favors English-language publications.5,10-14,16

Indeed, there have been proposals to calculate a modified IF for journals that are published in languages other than English, so as to consider citations from journals not included in the ISI database but that are published in the same language as the target journal.2-15 The tendency toward self-citation among researchers in the USA has also been noted—a tendency that further increases the number of citations these scientists receive.7,20-23

Basic science journals usually receive large numbers of citations.5,10 These publications are centered on recent original research, are often present in large numbers in the ISI database, and are cited not only in basic research articles but also in practitioner-oriented articles. It is important to realize that citation habits differ between areas of knowledge, and that in some disciplines the rate of growth and development of knowledge is such that long citation half-lives are the norm. Other fields where growth is more dynamic and the literature quickly becomes obsolete benefit clearly from bibliometric indicators like the IF, which reward short-term citations.3,10 In response to these differences in growth dynamics, proposals have been made to calculate the IF for periods of 5 or even 10 years rather than 2 years.16

Moreover, it is readily seen that clinicians might read important articles in practice-oriented journals that lead them to significantly change their daily practice, but that they will never cite in new publications. In comparison to specialty journals, general medical journals also tend to benefit from the IF.7,10 Aside from the advantages of their wide field of influence, these publications can change tack to better cover topics that currently attract the most interest.
Review journals are also highly favored by the IF, as they compile large numbers of citations and their articles are frequently cited as a single, global source of information on a topic.3,12 For these reasons is has been suggested that it may be worthwhile to correct the IF within subject areas so that comparisons can be made across disciplines.25,26

Journals that publish more articles have more chances of being cited, and in this sense the IF is useful since it “standardizes” the factor across journals of different sizes.3,14 However, it has also been shown that long articles, those with many authors, items on interdisciplinary topics and collaborative studies involving authors from different centers are also highly cited.3,15 Publishing 2 articles on the same topic in the same issue of the journal also increases the chances that they will be cited.3 Some journals produce spotlight or monographic issues on highly timely aspects that attract more citations than regular issues.2,5

Self-citation of articles published in the same journal as the citing article can also raise specific problems, as this factor is not taken into account (i.e., self-citations are treated the same way as citations to items that appeared in other journals) when the IF is calculated.3,10 The trend toward higher self-citation rates can be considered justifiable under certain circumstances, as in the case of national journals—especially those not published in English—and in the case of journals that deal with very narrow topics or areas that few other publications cover.3,20 Garfield15 suggested calculating a corrected IF that omits self-citations from the numerator.10,22,25

A final consideration is that journals that are more widely disseminated receive more citations.3,10 To avoid this problem, some researchers have suggested calculating a corrected IF that omits self-citations from the numerator.20,22,25

It should be recalled that the IF applies only to journals, and that articles and authors are not said to have a certain IF but to have received a certain number of citations. On the assumption that the journal is representative of its articles, one proposal has been to estimate an author’s scientific achievements by adding the IF of all journals in which he or she has published.36-40 Because some institutions use the IF of the journals in which scientific articles are published to reward research (especially in Europe),39,40 many authors have made efforts to publish in journals with the highest IFs. This completes the vicious circle that rewards journals with higher IFs by attracting more researchers, and punishes journals with a lower IF despite their broad dissemination and excellent acceptance by readers.

However, it has been shown that publishing an article in a journal with a high IF does not guarantee that the article will be highly cited.3 Because the distribution of article IFs is neither homogeneous nor gaussian and the numbers vary widely, a journal’s IF is not representative of the IFs of all its articles: the most cited 15% of the articles yield 50% of all citations received.3 Although researchers recognize that the distribution of citations is asymmetrical, citations are still evaluated not count as citable items in the denominator of the IF; however, both citations to these documents and the articles they cite are considered valid references for the IF. Keeping a journal “dynamic” by publishing frequent editorials and devoting substantial space to correspondence has direct benefits not only on the immediacy index, but also on the IF.16,17 Paradoxically, research letters can have the opposite effect: they count as citable items in the denominator, but because they are short and relatively uninteresting, they tend to generate few citations. In fact, this is what seems to have caused a decline in the IF of The Lancet18,19; nevertheless, the editors stood by the editorial policy they had implemented to foment this type of correspondence. To avoid these problems, Garfield20 proposed a somewhat more complex method (Journal Performance Indicators) which made it possible to track and evaluate all citations to “citable” articles over time. This information can be now obtained on the Internet by subscribing to the ISI’s Web of Knowledge.21

Reducing the total number of manuscripts that are published (i.e., reducing the denominator) is another—obviously risky—way to increase or sustain the publication’s IF. One interesting study showed that in the 5 most prestigious medical journals, the IF correlated inversely with the number of articles published.3 This is why some editors pay heed to the advice not to publish too much, and to chose what they publish wisely.

Inappropriate use of Bibliometric Indicators

It should be recalled that the IF applies only to journals, and that articles and authors are not said to have a certain IF but to have received a certain number of citations. On the assumption that the journal is representative of its articles, one proposal has been to estimate an author’s scientific achievements by adding the IF of all journals in which he or she has published.36-40 Because some institutions use the IF of the journals in which scientific articles are published to reward research (especially in Europe),39,40 many authors have made efforts to publish in journals with the highest IFs. This completes the vicious circle that rewards journals with higher IFs by attracting more researchers, and punishes journals with a lower IF despite their broad dissemination and excellent acceptance by readers.
on the basis of estimates of the mean (such as the IF) instead of the median.2,14

The number of citations a research article receives does not necessarily indicate its importance in intellec-
tual terms. Of the 25 journals with the highest IF 60% of them publish only reviews.8,9 Why then is their im-
 pact so high if they do not publish novel research?10 Many original contributions are quickly incorporated
by the scientific community into the stable body of knowledge, and the original reference may lose inte-
rest before it has been heavily cited. However, merely technical or methodological contributions within
a specific area may become obligatory references and remain so for many years.7 Meanwhile other truly pio-
 neering studies may take years to be accepted by the international scientific community, and may need to
 “ripen” before they attain the recognition they deserve. It is only in the long term that such studies are judged
appropriately by bibliometric indicators. Unfortunate-
l y, all the corrections proposed thus far to offset the
limitations of the IF undermine its simplicity and have
not taken hold within the scientific community.13,25,26

We should recall that the ultimate goal of medical
research is to improve the health of the populations we
serve. Although the bibliometric indicators described
above are useful to evaluate the quality of scientific
study, they can not estimate the impact it will have on
health.42 Therefore a number of countries41,43 are look-
ing into the development of new indicators that would
shed light on the so-called “social impact” of research
and determine the actual benefits of research for
health. The limitations noted above should reassure re-
searchers and provide further arguments they can use
to defend their work before those who, in our
kaufmesque world,12 prefer to count rather than read
the articles they judge.8,45,46 What really matters is
an article’s scientific content—its original contribu-
tion to knowledge—and nothing can replace reading and
assessment, ideally by a panel of experts.8,39,41,46 How-
ever, both authors and institutions are now frequently
judged and evaluated (not only for the purpose of
awarding research grants) on the basis of their publica-
tions in high-IF journals.

Bibliometric Indicators: Editorial Implications

From a publisher’s point of view the IF can be con-
sidered a suitable currency for comparing the scientific
quality of different journals11,14 and a useful aid to both
librarians and publishers.44 Although the IF is not a
perfect instrument there is currently no better alterna-
tive, and despite its important limitations as mentioned
above, the IF is widely accepted by the scientific com-
munity. In fact, most of the problems arise from its
misuse rather than from defects inherent in this para-
meter. Since a publication’s international success is
closely linked to its IF (which can be considered the
journal’s calling card), it would seem desirable to try
to optimize this bibliometric indicator with reasonable
editorial measures. Otherwise many worthy national
journals might be condemned to ostracism despite their
critical importance to readers in intellectual
terms. Moreover, the IF can be used by editors as a
means rather than as an end in itself, since attracting
high-quality articles can help improve their journal’s
scientific status.

The best ways to increase a journal’s IF are to im-
prove the scientific quality of the articles and facilitate
the journal’s dissemination.35,45 Proactive decisions
aimed at broadening the journal area of interest and
influence can also capture a wider audience, and even-
tually lead to improvements in the IF.46 Reducing the
time needed for peer review and the lag between ac-
ceptance and publication, encouraging review articles
or items covering recent methodological advances, and
favoring self-citation are additional tools the editor can
use to enhance the journal’s IF.2,5,9 However, editorial
maneuvers aimed at raising the IF at any price are not
in the least justifiable.29,32

When the IF improves, editors editorialize (this arti-
cle is in fact an excellent example), whereas when the
IF declines, they generally remain silent.29 Interes-
tingly, it is easy to find examples of editorials that con-
tain substantial numbers of references to articles pub-
lished recently in the editor’s own journal.3,13,45,46 In
fact, this extensive Editor’s Page article with its 5
appropriate self-citations might raise our IF for the
year 2005 by as much as 0.02, assuming that the num-
ber of citable articles remains stable.

Citations Versus Reading Biomedical
Journals

Trying to determine whether journal articles are ac-
tually read is a challenge. This issue can be ap-
 proached by analyzing the number of visits or full arti-
cle downloads (in html or pdf format) from the
journal’s website (www.revespcardiol.org) via search
engines and databases, or via PubMed.2 Facilitating
electronic connectivity is a key measure for improving
knowledge dissemination, and the Web Impact Fac-
tor9 has been defined for this purpose as the number
of links that provide access to the journal’s website.
Moreover, the exponential increase in electronic publi-
cations means that we will soon be able to measure
and compare data for visits to e-journal websites, and
this in turn will soon make it possible to create access
factors for individual articles as well as for journals.8
Paradoxically, we may be surprised to find that many
widely cited articles are not read as often as their cita-
tion rates would suggest, and that a whole mythology
has sprung up around authors able to cite much more
than they read. It has been shown that availability on
the Internet of the full contents of the journal online increases dissemination and eventually increases the
IF.\textsuperscript{51} Nevertheless, an interesting development is that
electronic search tools are acting as levelers in terms of
the journals that are being located, and that re-
searchers currently obtain the articles they are most in-
terested in directly from the Internet, regardless of
whether they were published in high-IF journals or
elsewhere.\textsuperscript{12}

Other researchers have found that studying down-
load rates for specific articles can be considered equi-
vallent to the interest factor,\textsuperscript{6} a number which makes it
possible to identify immediately which articles the
readers are most interested in. However, it should be
recalled that these documents are often downloaded
simply on the basis of their title, the authors’ names, or
the key words, before the abstract has been read.\textsuperscript{49}
Moreover, this approach does not take into account
readers of the printed version of the journal. Another
possibility is that readers may not find the downloaded
and saved document of interest; conversely, it is hard
to imagine that a document that was not felt to be in-
teresting or at least controversial would be used as a
reference. It has even been suggested that authors
might fraudulently access their own articles many
times so that they appear to attract many visits. Des-
pite these limitations, it is clear that this new form of
bibliometrics (webometrics) is here to stay; in this
connection it is interesting to see once again that re-
view articles and articles in special issues are consult-
ed most frequently.\textsuperscript{6} An immediate analysis of the
original articles that have attracted the most interest
might help editors to orient their journal toward those
topics which their readers find most attractive. Indeed,
many journals already point their readers toward their
own “best sellers.”

Where Does REVISTA ESPAÑOLA DE CARDIOLOGÍA
Stand?

The IF achieved for the year 2004 consolidates Re-
VISTA ESPAÑOLA DE CARDIOLOGÍA\textsuperscript{1} as a high-quality in-
ternational science journal. In 2004 we received a total
of 997 citations, of which 427 were recent citations
(2002-2003). Currently, REVISTA ESPAÑOLA DE CAR-
DIOLOGÍA has the highest IF of all medical journals in
Spanish. Moreover, our journal is ranked 28th by IF
among the 71 prestigious journals included by the ISI
in the cardiovascular subject category of the JCR. It is
also significant that this notable improvement occurred
while the percentage of self-citations remained con-
stant in comparison to previous years. This confirms
that the number of citations REVISTA ESPAÑOLA DE CAR-
DIOLOGÍA receives from other publications contin-
ues to grow. In the future we should aim to maintain
the favorable trend in our IF, the slight (“sawtooth”)\nyearly variations notwithstanding\textsuperscript{5,14} but despite edi-
torial strategies intended to enhance the quality and
visibility of our publication.

Although the 570 other citations received during
2004 were older and did not boost our IF, they are un-
doubtedly a valuable indication that articles published in
REVISTA ESPAÑOLA DE CARDIOLOGÍA continue to be
considered useful, and thus continue to be cited in the
longer term.

As noted above, the immediacy index provides a
window on the journal’s citation dynamics. This para-
metric has also improved clearly (1.023, with 88 cita-
tions), and our journal now ranks an impressive sixth
in the immediacy index ranking among the 71 journals
in the ISI’s cardiovascular subject category.

Table 2 lists the editorial strategies that have been
implemented in our publication over the years, and
which have undoubtedly been key factors in our cur-
rent achievements.\textsuperscript{7,4-6,45-57}

Issues Related to Editorial Policies

We are proud of the way the IF of REVISTA ESPAÑO-
LA DE CARDIOLOGÍA has climbed steadily to its current
level of international competitiveness. Our journal
is apparently not only widely valued and read, but is
clearly also cited increasingly often.\textsuperscript{2,14,44-46,55}
However, a journal’s fundamental mission should not consist solely of serv-
ing as an efficient means of communication among
researchers in a specific area (which is something the
IF measures well), but should also comprise the goal
of providing accurate, high-quality information that
clinicians find of interest for their daily practice. Al-
though some studies have shown that the quality of a
publication as perceived by researchers and clinicians
correlates clearly with the IF, the correlation is much
better from the researcher’s standpoint.\textsuperscript{53} In addition,
other studies have emphasized that the IF is poor at
accurately identifying articles that will eventually be
included as references in evidence-based clinical prac-
tice guidelines.\textsuperscript{55,57} Accordingly, and although we are
pleased that we can offer our authors and researchers
an attractive IF, it is clear that the quality and prestige
attained by REVISTA ESPAÑOLA DE CARDIOLOGÍA do not
depend upon a mere number. Thus our editorial poli-
cies will not be aimed at achieving this objective. We
are convinced that the substantial increase in our IF
will not cause impactitis, but that it will—like a gently
applied therapy (impactotherapy)—allow us to open
new doors and further improve the scientific content
of our journal. Our mission as editors will continue to be
to foment the overall development of our publication
to achieve a harmonious balance between its attrac-

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TABLE 2. Editorial Strategies Used by REVISTA ESPAÑOLA DE CARDIOLOGÍA∗

1. Continuing implementation of the highest standards of quality for science journals
2. Adoption of the recommendations of the ICMJE on technical and ethical matters
3. Continuing enhancement and frequent updating of the journal’s website
4. Increased dissemination through national, international and electronic media. Inclusion in the most prestigious international databases
5. Cover-to-cover translation into English for the on-line English edition
6. Open access to all articles in the electronic editions in Spanish and English. In html and pdf format
7. Careful manuscript selection process (systematic use of peer review and methodological-statistical reviews). Help with improving the final quality of the articles
8. The most relevant articles are highlighted (editorials; dissemination to authors, researchers and the editorial board; press releases; fast-track publication and on-line publication ahead of print publication)
9. Prizes awarded by the SEC for the best articles
10. Scope broadened to cover all aspects of cardiovascular disease
11. Turnaround time for peer review optimized and fully electronic manuscript management system developed
12. Publication of clinical practice guidelines developed by SEC, and more recently by ESC

∗ICMJE indicates International Committee of Medical Journal Editors; SEC, Spanish Society of Cardiology; ESC, European Society of Cardiology. From Alfonso et al.25,26 and Bosch et al.27

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