Available online at www.sciencedirect.com
ScienceDirect
Forensic Science International 165 (2007) 115–128
Forensic Science International
www.elsevier.com/locate/forsciint

The distribution of forensic journals, reflections on authorship practices, peer-review and role of the impact factor

Alan Wayne Jones *

Department of Forensic Chemistry and Genetics, National Board of Forensic Medicine, Artillerigatan 12, SE-581 33 Linköping and University Hospital, SE-581 85 Linköping, Sweden

Received 26 April 2006; accepted 10 May 2006
Available online 19 June 2006

Abstract

This article presents information about journals specializing in the forensic sciences and legal medicine, their development and distribution and their current status as reflected in the journal impact factor. The first scientific journal devoted to spreading information and reporting new developments in social and legal medicine seemingly originated in Germany about 150 years ago. The official journal of the American Academy of Forensic Sciences (*Journal of Forensic Sciences*, JFS) was founded in 1956 and has enjoyed 50 years of scholarly publishing. The two leading European journals specializing in forensics are *Forensic Science International* (FSI) and *International Journal of Legal Medicine* (IJLM). Besides the size of the circulation, the readership numbers, the quality of the editorial staff and the peer-reviewers, the number of submitted and accepted manuscripts, considerable interest has focused on the journal's impact factor as a measure of prestige. The 2006 impact factor of a certain journal is derived by counting the number of citations in 2006 to all material published in the journal in the previous 2 years (2004 and 2005) and dividing this total by the number of citable items (articles and reviews) published in the same 2 years. Impact factors for several thousand scientific journals are compiled and published by a company called Thomson Institute for Scientific Information (Thomson ISI) and are available on-line via the database Journal Citation Reports. Forensic journals are grouped within the subject category Medicine, Legal, which currently comprises nine journals a few of which are seemingly unrelated to mainstream forensics. The top-ranked forensic journal in terms of its impact factor was IJLM with a score of just over 2.0 in 2004. This means that the average article published in 2003 and 2002 was cited twice per year in the 2-year window after publication. Impact factors of forensic journals are fairly low in comparison with many other disciplines, probably because of the small size of the field, fewer active researchers and less pressure to publish. The relatively low impact factors of forensic journals should be less of a concern than ensuring that manuscripts receive a rigorous and preferably an open peer-review prior to acceptance for publication. The information, conclusions and opinions published in forensic science journals might one day be proffered as evidence in criminal or civil litigation.

Keywords: Authorship; Bibliometrics; Forensic science journals; Impact factors; Peer-review

1. Introduction

Scientific, technical and medical publishing has grown enormously over the past few decades and new journals and periodicals continue to emerge worldwide [1–4]. The weekly scientific journal *Nature* (founded in 1869) has now been joined by a long string of sister journals from the Nature Publishing Group that focus on basic research, clinical practice and comprehensive reviews. The well-known medical journal the *Lancet*, which first appeared in 1823, has followed this lead by establishing specialist journals such as *The Lancet Oncology*, *The Lancet Neurology*, and *The Lancet Infectious Diseases*. These highly acclaimed journals operate a rigorous peer-review of submitted manuscripts and the selection process is meticulous leading to high rejection rates.

Publication is an integral part of the research and development process and in academia the old adage ''publish or perish'' still rings true when it comes to career advancement, promotion, and successful applications for research funding and attracting graduate and postdoctoral students [2–5]. Scientists publish their work to spread new information and communicate with their colleagues and network of peers working in other laboratories or in different countries and also to lay the foundation for future research advances. It has often

* Tel.: +46 13 252114; fax: +46 13 104875.
E-mail address: wayne.jones@RMV.SE.

0379-0738/$ – see front matter © 2006 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.forsciint.2006.05.013

been said that ''research does not exist until it gets published'' and ''inaccessible research may as well not have been conducted at all'' [2,3].

Contributing to the scientific literature by frequently submitting articles for publication enhances the reputation of the senior author and draws attention to the laboratory where the work was done [2]. However, the question of attributing credit to the growing number of co-authors on published articles is a dilemma for which there is seemingly no simple solution and this problem continues to be debated [6–9]. At forensic science and legal medicine departments closely affiliated with a university or teaching hospital, the writing of papers for publication is done in parallel with teaching, casework and providing expert testimony. In some countries, evaluating publications in terms of their quantity, quality and relevance has become an essential element of the research assessment process when government funding is allocated to university departments [10–13].

Many forensic science laboratories are not affiliated with universities and instead are closely related to and often considered as ''police laboratories''. The scientific staff working at these places is under less pressure to publish scientific articles and put new information into the public domain. At many government-run police laboratories promotion is seemingly more dependent on management and people-skills rather than on talent in science and dedication to research and scholarship. Many of the staff working at government laboratories, although well qualified in science and technology and sometimes holding an advanced degree (PhD), seem more inclined to spend their time in business and strategy meetings or making vain attempts to rationalise and reorganise, which often spells disaster for those more interested in research and publication.

There is a climate in some countries for offering privately-run forensic science services where the customer and the balance sheet (income, profit and loss) tend to dominate at the expense of scholarship, academic freedom and publication. Notwithstanding these changes in the forensic science market, there will always be a need to keep abreast of developments in the field by reading scientific journals even if the urge to publish has been extinguished for many of the people employed at these new organizations. A classic example of this is the privatization of the forensic science services in UK and especially the closure and abandonment of the Home Office Central Research Establishment at Aldermaston [14,15].

This article gives a review and opinion about international scientific journals that specialize in forensic science and legal medicine and also includes a consideration of authorship practices, peer-review and the omnipotent journal impact factor.

2. Growth of forensic journals

The word forensic comes from the Latin *forensis*, which means before the forum [16]. In ancient Rome, the forum was where trials and debates took place and accordingly served also as the courtroom. Today, the word forensic serves as an adjective to qualify words like evidence, science, medicine, investigation, odontology, toxicology, etc. In US parlance, forensic science is synonymous with criminalistics and a forensic laboratory is generally known as a crime laboratory, which specializes in the analysis of crime-scene evidence [17–19]. Forensic science and criminalistics involve the application of a broad spectrum of chemical, physical, and natural sciences as well as technology for collection, analysis and interpretation of evidence to answer questions of legal interest.

Early fictional characters, particularly Sherlock Holmes, brought attention to the usefulness of chemical tests to help solve crimes as popularized in the books by Sir Arthur Conan Doyle. In Britain, the term forensic science was apparently coined in the 1930s to embrace the various crime-related investigations performed on behalf of the police authorities, e.g. identification of fingerprints, blood groups, ballistics, fibres and glass fragments with the help of physical, chemical, chromatographic and spectroscopic methods [19]. The gathering of information from a crime scene and the subsequent analysis and classification of physical and biological trace evidence is paramount for successful prosecution in today's criminal justice system [17–19].

The first scientific journals with a major emphasis on social and legal medicine probably arose in Germany about 150 years ago, as exemplified by the forerunners of periodicals such as *Deutsche Zeitschrift für die gesamte gerichtliche medizin* (*Comprehensive Judicial Medicine*) and *Zeitschrift für Rechtsmedizin* (*Journal of Legal Medicine*) [20,21]. In older days, legal medicine was referred to as medical jurisprudence, although today forensic medicine is the term more widely used. Before the advent of scientific journals, knowledge about forensic and legal medicine came from reading books or monographs written by some recognized authority in a particular discipline. For example, most forensic toxicologists are well aware of but probably have never read the treatise on poisoning written by MJB Orfila (1787–1853), which was first published in 1814 [22].

JFS, which is the official journal of the American Academy of Forensic Sciences (AAFS) has a current membership of over 5000 and began publishing in 1956 [23]. JFS publishes papers on all aspects of forensic science including criminalistics, questioned documents, pathology, biology, psychiatry, toxicology, etc. The 2005 edition of JFS ran into 1571 pages of text and published over 200 articles and notes. The corresponding periodical from UK was originally called *Journal of the Forensic Science Society*, which was launched in 1960 and became renamed in 1995 to *Science & Justice*.

Many learned and professional societies are concerned with forensic and legal medicine and many of these organizations have established their own scientific journals to disseminate information to the membership. Both Canada (*Canadian Society of Forensic Science Journal*, vol. 39 in 2006) and Australia (*Australian Journal of Forensic Sciences*, vol. 37 in 2006) have their own forensic journals including local editorial boards and peer-review committees. Although many useful articles are published in these journals, this information source is not easy to locate unless one subscribes to them. Neither the Canadian nor the Australian journal is abstracted or covered by

Table 1
Brief description of forensic science sub-specialities, which often have their own scientific journals

Forensic sub-speciality	Brief description
Forensic odontology	This entails the study of the characteristics of teeth and dentition mainly for purposes of identification
Forensic toxicology	Toxicology is the science of poisons especially the analysis of drugs and poisons in body fluids and the effects these substances have on the human body
Forensic engineering	This topic deals with the cause or causes of failure of buildings, vehicles, devices and structures
Forensic pathology	This medical speciality has to do with establishing the manner and cause of death by means of a post-mortem examination – autopsy – means to see for oneself
Forensic psychology and psychiatry	These subjects deal with legal aspects of human behaviour and mental health
Forensic anthropology	This subject focuses on the recovery and identification of bones and skeletonized human remains
Forensic entomology	This forensic subject deals with examination of insects and maggots that invaded human remains to help establish the time of death

the major on-line database (e.g. PUBMED), which is produced by the National Library of Medicine in Washington DC nor by Thomson ISI the company that calculates journal impact factors [24].

Examples of smaller circulation forensic and legal medicine journals include the official publication of the Romanian Society of Legal Medicine, which publishes articles in English. There is also a journal emanating from the Nordic countries entitled *Scandinavian Journal of Forensic Science* (earlier entitled *Nordisk Rettsmedisin*) as well as a journal sponsored by the Council of Forensic Medicine of the Republic of Turkey. A periodical from France entitled *Journal de Médicine Légal Droit Médical* is devoted to medicine, science and law and has a long publishing history and includes an occasional article written in English [25].

The larger nations like Japan, India and Russia probably publish scientific journals devoted to forensic and legal medicine but the present status is not easy to verify because none are seemingly abstracted by PUBMED or covered by ISI. More recently, a number of internet journals have appeared with a major interest in forensic science and toxicology although the peer-review of the material posted on the internet is often difficult to ascertain. Many university libraries are ending their subscription to the traditional hard-copy format journals and instead provide links to electronic versions of the major periodicals. Indeed, publishers of scientific journals are busy scanning in the backlog of volumes and everything will eventually be available in portable document format (PDF) for on-line search, retrieval and printing.

Although some journals include the words ''legal medicine'' in their title, the contents bear little resemblance to forensic medicine or pathology. Instead, these journals focus on medical malpractice, human health issues and aspects of civil litigation as exemplified by *Journal of Legal Medicine* (published by Taylor & Francis), which has now reached vol. 27 in 2006.

Table 1 gives a brief survey of the broad spectrum of forensic science disciplines, many of which operate under the auspices of professional bodies and publish their own journals.

Examples of more specialized journals dealing with various aspects of the forensic sciences are listed below although the present status of some titles is difficult to ascertain:

- *Journal of the American Academy of Psychiatry Law*
- *Journal of Analytical Toxicology*
- *Journal of Forensic Odontostomatology*
- *Journal of Forensic Identification*
- *American Journal of Forensic Psychiatry*
- *Journal of Forensic Psychiatry & Psychology*
- *British Journal of Forensic Practice*
- *Forensic Linguistics*
- *Environmental Forensics*
- *International Journal of Forensic Document Examiners*

Table 2 gives information about the most recently launched forensic science journals, two of which are indexed by PUBMED including all back issues from the first volume. Indeed, PUBMED, which is produced by the US National Library of Medicine in Washington DC, has become virtually indispensable as a tool for keeping abreast of developments in the sciences. However, none of these latest forensic journals are covered by Thomson ISI's databases and accordingly they cannot be given an impact factor [24].

The most widely acclaimed European journals specializing in forensic science and legal medicine are *Forensic Science International* (FSI), original entitled *Forensic Science* and *International Journal of Legal Medicine* (originally called

Table 2
Information about the three most recently launched journals that specialize in forensic sciences and legal medicine

Journal	Publisher	Editor-in-chief	First appeared	PUBMED coverage	ISI coverage
Legal Med.	Elsevier	H. Takizawa	1999	Yes	No
J. Clin. Forensic Med.	Elsevier	J.J. Payne-James	1992	Yes	No
Forensic Sci. Med. Pathol.	Humana Press	G.N. Rutty	2005	No	No

Zeitschrift für Rechtsmedizin) [26–29]. In 1990, when the *Zeitschrift für Rechtsmedizin* changed name and began publishing only in the English language, it was replaced by a German language journal called *Rechtsmedizin* (vol. 16 in 2006). This periodical now serves as the official organ of the *Deutschen Gesellschaft für Rechtsmedizin* [21].

In terms of annual number of printed pages and published articles, *Journal of Forensic Sciences* (published by Blackwell since 2006) and *Forensic Science International* (published by Elsevier) are remarkably similar. These two journals are also comparable in terms of annual number of articles and printed pages as well as the impact factor and citations per article.

Another useful reference source for forensic scientists is entitled *Forensic Science Review* (edited by Ray H. Liu), which is now in its 18th year of continuous publication and appears twice annually. According to the editor, the objective and scope of *Forensic Science Review* is to bridge the gap between research-oriented journals and reference books devoted to forensic science and legal medicine.

Two major reference works devoted to forensic science and legal medicine were recently published [30,31]. The first was entitled *Encyclopedia of Forensic Sciences* (Academic Press, 2000), which comprised three volumes and 1440 pages of text and also contained a very useful glossary [30]. The other compilation was called *Encyclopedia of Forensic and Legal Medicine* (Elsevier/Academic press 2005), which comprised four volumes and 2563 pages of text [31].

The mainly German-language journal *Blutalkohol* (Blood-alcohol) published by Steintor–Verlag (Lübeck, Germany) was launched in 1961/1962 and is still going strong [32]. Most of the articles appearing in *Blutalkohol* deal with forensic alcohol research such as the determination of ethanol in body fluids, effects of ethanol on performance and behaviour and especially the role played by drunk and drugged drivers in traffic crashes.

The Chemical Abstract Service, which is a division of the American Chemical Society, produces a biweekly listing of abstracts, books and patents deemed relevant to forensic scientists (CA Selects Plus—Forensic Chemistry). This CA selects product also abstracts many non-English language journals devoted to the forensic sciences and legal medicine and such information is otherwise not easy to locate. The Elsevier empire also market a product called Forensic Science Abstracts (six issues per year), which is intended to provide readers with a current awareness service in the multi-disciplinary field of the forensic sciences. Another useful resource is a multidisciplinary forensic bibliographic database called FORS, which is produced and marketed by the Forensic Science Service in UK. This database is created by scanning a core list of about 250 scientific journals published worldwide. This compilation started in 1976 and from 1996 onwards each record includes an abstract of the cited work. This information product is available in a monthly printed format as well as on CD-ROM (Silver Platter International) and more recently has been made available on-line over the internet for an annual subscription cost.

Table 3
Impact factors of the five leading forensic science and legal medicine journals included in the subject category ''medicine, legal'' according to the Institute for Scientific Information (ISI) Journal Citation Reports

Journal	2004 impact factor	Impact 2000–2004	Impact 1981–2004
Int. J. Legal Med.	2.11	3.71	7.96
Forensic Sci. Int.	1.39	2.70	5.37
J. Forensic Sci.	0.88	2.11	5.92
Am. J. Forensic Med. Pathol.	0.60	1.22	3.69
Med. Sci. Law	0.25	0.67	3.34

3. Journal impact factors

Scientific journals are increasingly being ranked and graded in terms of their impact factor, which is a measure of the frequency by which the average journal article is cited within the first 2 years after publication [33–37]. By citing another person's work is a way to acknowledge that it proved of interest and relevance in preparing your own article. Accordingly, citations are generally considered a mark of distinction and influence in science and technology [38].

Table 3 compares the impact factors of the main forensic science journals over three different time periods. Besides the most recent 2004 impact factors, citation impacts have been included for both 5-year and 24-year periods. This information was obtained from Journal Performance Indicators, which is another database produced by Thomson ISI. By dividing total citations to a journal's published papers over a given time period by the total number of papers over the same period gives a score for citation impact.

International Journal of Legal Medicine (IJLM) has consistently ranked highest both in terms of the conventional 2-year impact factor and also when long-term impact is considered. The 2004 impact factors of *Journal of Forensic Sciences* (JFS) and *Forensic Science International* (FSI) measured over longer periods were remarkably similar. The relationship between number of papers, which gives an idea of the size of the journal and number of citations over a 10-year period is shown in Table 4 where close agreement between JFS and FSI is obvious.

The idea of creating a journal impact factor was first mentioned by Eugene Garfield (PhD) in 1955 to help select the best scientific journals for indexing [36]. Since then, much has been written and discussed about journal impact factors, not only for comparing and contrasting scientific journals but also

Table 4
Comparison of the citation impact of articles published in the four leading forensic science and legal medicine journals over a 10-year period, 1995–2005

Journal	Papers	Citations	Cites/paper
Int. J. Legal Med.	874	6453	7.38
Forensic Sci. Int.	2419	11203	4.63
J. Forensic Sci.	2452	10248	4.18
Med. Sci. Law	596	1117	1.87

for evaluating the published work of individual scientists, university departments and entire nations [26–29]. Too much reliance on journal impact factors has become controversial especially when used in connection with making faculty appointments and during assessment of research performance for purposes of awarding grants and scholarships [43–45]. In some countries, government authorities and research councils are scrutinizing the impact factors of journals where scientists publish as a proxy for reading the articles concerned [11–13,48]. A better approach would be to count the number of citations received by individual articles although it usually takes a few years before a paper starts to become highly cited.

The impact factor is a numerical ratio between citations to a journal's articles and recent citable items published in the journal [33–35]. In short, the impact factor measures the frequency with which the ''average article'' in a journal is cited over a specific time period, usually the first 2 years after the year of publication. Although a person might be lucky or talented enough to get an article published in a high impact journal, this does not necessarily mean the article in question attracts lots of citations [43]. The value of a paper to a field can only be evaluated by carefully reading the article concerned [44]. To paraphrase Per Seglen, who has been one of the strongest critics of impact factor for evaluating the performance of individual scientists ''science deserves to be judged by its contents, not by its wrapping'' [43–45].

The journal impact factor for 2005 is calculated as follows:

$$\text{Impact factor for 2005} = \frac{\text{Citations in 2005 to all material published 2003 and 2004}}{\text{Citable items published 2003 and 2004}}$$

The numerator of the impact factor ratio includes citations to all kinds of material published in the journal, whereas the denominator (citable items) or source material only refers to the number of research articles, reviews and scientific notes. All other published items in the journal that might attract citations, such as editorials, news commentaries, letters-to-the-editor, are not counted as citable items [49]. Even scientific notes have a somewhat dubious position as source material as recently demonstrated for the many so-called technical briefs appearing in *Clinical Chemistry* [50]. These technical briefs report original research and often occupy several pages of journal space but for some reason they are not classified by ISI as citable items. This kind of source material attracts citations and includes references to previously published work from the same journal, so called self-citations. This mismatch between citations and citable items tends to skew the impact factor calculation [51,52]. Those responsible for producing Journal Citation Reports need to make it perfectly clear how they define a scientific note and whether case reports, technical briefs, short or rapid communications are included as citable items in the denominator of the impact factor calculation.

Because impact factors are based on citations to recent articles, that is, those published in the previous 2 years, if a paper starts to become highly cited several years after it appeared in print, this has no influence on the impact factor of the journal [53,54]. However, it is possible to compute 5-year or even 10-year impact factors. When this was done for the forensic science and toxicology journals it did not seem to make much of a difference compared with the traditional 2-year count [27]. The immediacy index is another of ISI's indicators of citation frequency and is calculated as the ratio of recent citations to recent articles, that is citations in 2005 to articles published in 2005. Obviously, articles appearing late in the year have little chance of being cited in articles published that same year. However, the recent trend by many publishers of posting accepted articles on the internet before publication and also uploading them to PUBMED makes early citation possible. This strategy should help to boost the immediacy index of the journals.

Table 5
Scientific journals with the highest citation impact according to ISI's Journal Performance Indicators for all subject categories over the period 1995–2005

Journal	Impact factor 2004	No. papers 1995–2005	Citations/paper
Cell	28.38	3890	161.2
N. Engl. J. Med.	38.57	3925	122.5
Science	31.85	10264	113.4
Nat. Med.	31.23	1740	112.0
Nature	32.18	10693	109.6
Chem. Rev.	20.23	1315	105.9
Nat. Gen.	24.69	2050	104.5
Immunity	15.44	1547	84.1
Genes Dev.	16.38	2884	83.8
J. Exp. Med.	14.58	4098	70.7

The top-ranking science journals covered by ISI are listed in Table 5 along with their 2004 impact factors, the number of papers published and the average number of cites per article between 1995 and 2005. If these figures are compared with the forensic science journals listed in Tables 3 and 4, the differences are breathtaking, which underscores the danger

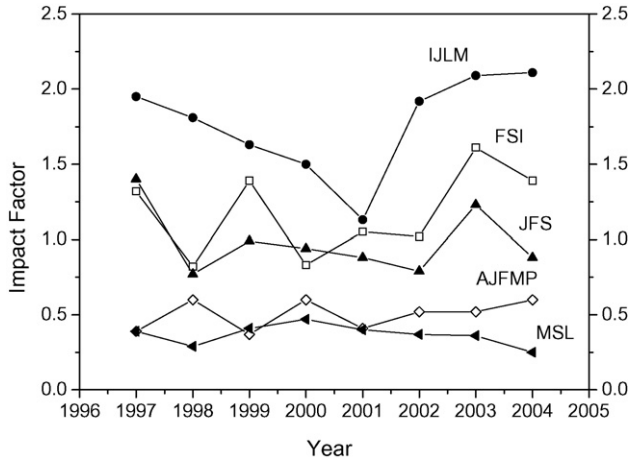

Fig. 1. Trends (1997–2004) in impact factors of the five leading forensic science and legal medicine journals, namely *International Journal of Legal Medicine* (IJLM), *Forensic Science International* (FSI), *Journal of Forensic Sciences* (JFS), *Medicine, Science and the Law* (MSL) and *American Journal of Forensic Medicine and Pathology* (AJFMP).

Table 6
The most highly cited articles in the five leading forensic science and legal medical journals according to ISI's Web of Science database up to January 2006

Rank	First author	Title of highly cited article	Journal (year)	Citations
1	K. Kasai	Amplification of a variable number of tandem repeats (VNTR) locus (pMCT118) by the polymerase chain reaction (PCR) and its applications in forensic science	*J. Forensic Sci.* (1990)	295
2	M. Kayser	Evaluation of Y-chromosomal STRs: a multicenter study	*Int. J. Legal Med.* (1997)	292
3	P. Lincoln	Publication of population data of human polymorphisms	*Forensic. Sci. Int.* (2000)	144
4	R. Sarvesvaran	Sudden natural deaths associated with commercial air-travel	*Med. Sci. Law* (1986)	80
5	J.I. Coe	Post-mortem chemistry update—emphasis on forensic applications	*Am. J. Forensic Med. Pathol.* (1993)	61

of comparing impact factors for scientific journals that belong to different subject categories.

Fig. 1 shows time-trends and fluctuation in impact factors of the five leading forensic science and legal medicine journals between 1997 and 2004. The impact factors for *Med. Sci. Law* (MSL) and *Am. J. Forensic Med. Pathol.* (AJFMP) remained fairly constant over the 8-year period, averaging about 0.5. The two journals of comparable size, namely *Forensic Sci. Int.* (FSI) and *J. Forensic Sci.* (JFS) were consistently on a higher level averaging between 1.0 and 1.5. Over the past few years, the impact factor of FSI has tended to surpass that of JFS. The journal with the highest impact factor scoring consistently higher than the others was IJLM, which was awarded an impact factor of 2.1 in 2004, which means that the average paper in this journal was cited twice per year in the first 2 years after publication.

4. Citation classics

Articles that attract an unusually large number of citations are commonly referred to as citation classics [55]. The number of citations required to reach this status differs from journal to journal and also from subject category to subject category. Gene Garfield (PhD), the founder of ISI and the guru of citation analysis, has identified and categorized hundreds of citation classics and made these available for browsing and printing from his own website (www.garfield.library.upenn.edu). The corresponding authors of the highly cited articles were also given the opportunity to write a personal account of the work published. Many of these commentaries make fascinating reading and give a unique ''behind the scenes'' look at the genesis of the highly cited work including serendipity and not least the various personalities involved.

Table 6 presents information about the most cited articles published in the leading forensic science and legal medicine journals making it evident that studies on forensic genetics and identification by DNA techniques dominate [29]. For comparison, Table 7 lists the five most highly cited articles of all time according to the ISI database Web of Science up to July 2005 [55]. Clearly, new methods of analysis and novel techniques with wide-ranging applications in basic biochemical research are destined to attract many citations [56].

5. What makes a good scientific journal?

The primary means to communicate new scientific ideas, besides the obvious use of e-mail and written correspondence, is to present a paper at a scientific conference and especially by writing and publishing an article in a reputable journal. Scientific articles are a perfect way to share new knowledge, ideas, and discoveries and to disseminate information to colleagues residing in other countries. Publishing an article in a journal gives credit for the work presented and new information enters the public domain often becoming abstracted by major databases and thus available for search and retrieval [2,3]. Besides research articles, a range of other items regularly appear within the pages of a scientific journal as listed in Table 8.

Some scientists might prefer to write a book or monograph as a way to spread new knowledge and information, which often proves to be more lucrative than writing journals articles. However, prolific authorship of scientific papers has long been and still is crucial for career advancement in higher education and research [2,3]. The number of articles published and the prestige of the journals where these appear helps to boost the reputation of the authors and the institutions where the work

Table 7
The top-five most cited articles of all time up until July 2005 according to ISI's database [55]

Rank	First author	Title of highly cited article	Journal (year)	Citations
1	O.H. Lowry	Protein measurement with the Folin phenol reagent	*J. Biol. Chem.* (1951)	293,328
2	U.K. Laemmli	Cleavage of structural proteins during assembly of head of bacteriophage T4	*Nature* (1970)	192,022
3	M.M. Bradford	Rapid and sensitive method for quantitation of microgram quantities of protein utilizing principle of protein-dye binding	*Anal. Biochem.* (1976)	120,179
4	F. Sanger	DNA sequencing with chain-terminating inhibitors	*PNAS* (1977)	63,909
5	P. Chomczynski	Single-step method of RNA isolation by acid guanidinium thiocyanate phenol chloroform extraction	*Anal. Biochem.* (1987)	55,987

Table 8
Examples of different forms of scientific publication

- Journal item
  - Full papers
  - Research letters
  - Review article
  - Short or rapid communications
  - Technical notes or briefs
  - Case reports
  - Letter-to-the-editor
  - Editorial material and news commentary
  - Book reviews
- Books
- Book chapters
- Articles in proceedings of conferences
- Abstracts and poster presentations
- Departmental reports

was done [10–12]. In this connection, most credit is awarded for articles appearing in journals with the highest impact factor [37,39]. Experience has shown that those journals with the highest impact factors also have the highest rejection rates. For example, JAMA, which is an acronym for *Journal of the American Medical Association*, achieved an impact factor of 24.8 in 2004. The acceptance rate for all kinds of material (original papers, reviews, editorials and commentaries) was only 9% [57].

The reputation and prestige afforded a particular scientific journal is rather subjective and not always easy to determine. It takes time for a newly launched journal to become established within the relevant scientific community. Timeliness of appearance in print is paramount for survival. A journal shipped to subscribers 3 months after the date on the cover will not survive in the long term. A short turnaround time from receipt of a manuscript to it being peer-reviewed and either accepted or rejected is also important to potential authors. Most authors would prefer a rejection notice within a week of submission rather than waiting 3-months to learn the fate of their work. Some of the more prestigious journals make a rapid in-house decision on suitability of a submitted manuscript before the work is sent for external peer-review by specialists (e.g. *Lancet*, *Nature*, and BMJ). Unusually long time delays between writing an article, submitting it for publication and its appearance in print means that many items in the list of references are too old to be included in the journal impact factor calculation.

The quality and respect for a scientific journal is directly related to the dedication and commitment of the editor, his or her editorial board and the thoroughness and rigor of the peer-review process [58]. Peer-review has come under close scrutiny in recent years with charges of conflicts of interest, bias, sexism, nepotism and scientific rivalry [59–61]. Peer-review can be considered a form of quality assurance of the work published. However, experience has shown that even the very best and most prestigious journals cannot guarantee validity of the work published and the peer-review process has failed to detect outright data fabrication and fraud [62–67].

The crème de la crème in scientific journals, such as *Nature* and *Science*, might accept less than 10% of all unsolicited articles it receives for evaluation whereas the average forensic science journal will probably accept 50–60% of all the material submitted. Any paper will eventually be accepted provided the authors have the necessary persistence and patience and are prepared to send the work to enough journals, usually of decreasing prestige and impact factor.

The intense competition for grants and research funding in academia has necessitated new ways to assess the merits and accomplishments of individual scientists and also entire university departments [11–13]. Producing large numbers of articles and ensuring these are published in respectable journals carries great weight and has become crucial for success in science. When university administrators allocate funding or when grant applications are evaluated besides using the traditional and time-consuming peer-assessment more and more attention is being given to use of bibliometric indicators, such as the impact factor of the journals where the articles were published and the number of citations [2,3,11–13].

A commercial company called Thomson ISI (Philadelphia, USA) calculates journal impact factors and makes these available in electronic format in a product called Journal Citation Reports. The roughly 6000 journals covered by ISI are grouped into one or more subject categories and these can be searched for individually or by subject category, which comprises from 10–60 individual journals. ISI also produce the science citation index (SCI), which is also on-line and renamed Web of Science and holds about 550 million citations derived from over 16,000 journals as well as books and conference proceedings [68,69]. However, this represents only a small fraction of the world literature in the sciences, social sciences, arts and humanities. Obviously coverage of non-English and third-world journals is limited but there is no escaping the fact that English today is the principal language for scientific communication [70].

The editorial committees and the publisher of newly launched scientific journals are keen to become included in ISI's citation database, which is essential for being awarded a journal impact factor. Many different aspects are considered by ISI when a new journal is selected for coverage [68]. Among other things, the journal's basic publishing standards, its editorial content, diversity of authorship, citation frequency as well as timeliness of publication and the inclusion of abstracts and keywords and most importantly use of peer-review to guarantee overall quality of the work published.

6. Importance of peer-review

Peer-review of manuscripts prior to publication is almost as old as the first scientific journal and began when the Philosophical Transactions was taken over by the Royal Society of London in 1752 [71]. Peer-review represents an organized method by which a manuscript submitted for publication to a scientific journal is scrutinized by recognized experts on the subject, who are given the task of evaluating the correctness, novelty and validity of the results [61]. Peer-review represents a kind of quality control of the work contained in the published article and reviewers have been referred to as the

gatekeepers of science [72,73]. Without a proper and well functioning peer-review process, the information published in a scientific journal is virtually worthless. However, peer-review does not guarantee the work presented is error free or that the experiments described were actually carried out as exemplified by several recent high-profile cases of fraud and fabrication [62–67].

In brief, peer-review begins with the journal editor sending the submitted manuscript to two or more prominent scientists considered ''experts'' in the research area or topic that the article is concerned with [61,74–77]. These individuals serve as the ''reviewers'' or ''referees'' and their task is to read the manuscript and make a critical appraisal of its contents. This is best done in the form of an opening general opinion of the article followed by a numerical list of criticisms and recommendations for improving the quality and presentation of the work in question. This method makes it easier for the authors to respond to or rebut the opinion of the peer-reviewers [74–77]. Specific points of concern should, whenever possible, be linked to page, paragraph and line number in the manuscript. The reviewers are sometimes asked to grade the manuscript and also to recommend whether the work is suitable for publication as is (which is very rare), should be returned for minor or major revisions or rejected outright. The final decision on the fate of a submitted manuscript is, however, in the hands of the editor-in-chief of the journal concerned.

Typically, the authors of the article do not know the names of the referees although the referees know the names and address of the authors [78–80]. There is never any direct contact between reviewers and authors and all correspondence goes through the editorial office of the journal. This lack of transparency has been much criticised with accusations of possible bias and conflicts of interest on the part of some referees for not taking public responsibility for their oft-negative comments about the manuscript being considered for publication [80,81]. In response to this, a few journals notably the *British Medical Journal* began using a completely open peer-review system since 1999 and the reviewers are required to sign their reports [82]. Some journals (e.g. FSI) remove the name and address of the authors of submitted manuscripts before this is sent for peer-review. Because the acknowledgement section might also contain information indicative of the origin of a manuscript, this is also hidden from the referees.

The notion of masking author identity often proves unsuccessful because clues might exist within the text of the manuscript (name of laboratory or county of residence), which discloses where the work was done. Because most scientists tend to cite their own previously published work a quick glance through the list of references in the manuscript can usually divulge the name of the senior author of the work being refereed. Some authors of manuscripts rightly or wrongly attempt to guess the name of the person serving as peer-reviewer with limited success and sometimes undesirable consequences [83]. Some journals (e.g. FSI) invite the authors of manuscripts to recommend the names of qualified reviewers for the work they are submitting for evaluation. However, this seems a strange request because one can never really be sure whether or not the editor followed the recommendation, which tends to cause confusion (and anger) when a highly critical review is received. You do not make friendships by being critical of your colleagues work even if the critique might be fully justified.

The so-called open-access journals [84], which are increasing in number, such as those produced by the Biomedical Central (BMC), e.g. *BMC Clinical Pharmacology*, post on the web the entire pre-publication history of the manuscripts accepted for publication. The date the manuscript was received, the reviewer reports and the names of the reviewers as well as the response from the authors and any re-writes of the manuscript are available on-line for all to read. This completely open system of peer-review obviously makes the reviewers more accountable for what they write because this becomes available for all to read and ponder over.

Publishing an article in a peer-review journal does not make the results gospel and over the years a lot of junk science has seen print, including papers in the forensic science journals. Even if an article appears in a peer-reviewed journal, this says nothing about the quality and rigor of the peer-review process and what changes were made to the first version of the manuscript. The response from authors, their rebuttal and the extent of any changes made to the original submission after peer-review also makes interesting reading. The notion of introducing a completely open system of peer-review might prove especially important in forensic science and legal medicine because information gleaned from a journal article might eventually be used as evidence in legal proceedings. Accordingly, both the defence and prosecution attorney would be anxious to know about and read the comments and critiques of a manuscript during the peer-review stage prior to publication.

The editors of BMJ and other leading medical journals were instrumental in starting a series of International Congresses on peer-review in Biomedical Publication, the most recent of which was held in Chicago in 2005. Papers dealing with all aspects of scientific publishing are presented at these meetings including open versus blind peer-review, conflicts of interest, authorship practise, scientific misconduct, impact factors, citation analysis, the future of open-access journals etc. Moreover, a group of senior medical journal editors have promulgated a document called ''*Uniform requirements for manuscripts submitted to biomedical journals*,'' which contains a wealth of information on ethical questions, editing, peer-review, and authorship of biomedical publications. These requirements as well as other useful information can be found at www.icmje.org.

Most journals publish the date a manuscript was received and also the date the work was finally accepted for publication. The time in between involves editorial handling of the manuscript and the time required to complete the peer-review process. The date of receipt of any revised manuscript is registered at the editorial office and in some journals this is also printed on the final article. Besides regular peer-reviewed articles, some journals publish annual supplements that contain papers presented at conference or the work of discussion or

expert groups. Such material does not normally undergo the same peer-review evaluation as regular journal articles.

Journal editors should always inform the peer-reviewers about a submitted manuscript's fate and also provide the reports from other assessors of the work. These make interesting reading and are useful feedback to learn and improve as a peer-reviewer. Today's on-line submission and peer-review of articles makes this information loop easy to accomplish.

7. Authorship practices

One of the most common lapses in scientific publication today is dubious authorship assignment, which raises the question of what exactly co-authorship is worth [85–89]. The prestige positions among the line-up of names on a paper are first and last and especially the person designated as the corresponding author. The practice of listing authors alphabetically is a thing of the past [87]. The intense pressure to publish in the academic community is a fact of life owing to fierce competition for grant support. This has led to author inflation as evidenced by an ever-increasing number of names appearing on published articles in most scientific journals. The dubious practice of gift and ghost authorship is frowned upon by journal editors and various ways have been devised to remedy this problem [90–93]. Gift authorship occurs when a senior researcher or a colleague is included among the authors although this person made on significant contribution to the experiments or the writing of the manuscript [90]. Ghost authorship on the other hand arises when the name of the person on the manuscript, who is usually a prominent scientist, did not participate in the actual writing process, which is usually done by professional writers. The "ghosts" might contribute by reading and editing the manuscript and approving a final version for publication and also accepting payment for their trouble [75].

To deal with questionable authorship practices, a group of influential journal editors (International Committee of Medical Journal Editors) have deliberated on the qualifications and contributions necessary to be listed as an author. These are available at www.icmje.org. However, these guidelines have not been universally accepted, partly because the requirements are fairly demanding as indicated by the following statement:

> "Authorship credit should be based on: (1) substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content and (3) final approval of the version to be published. Authors should meet conditions 1, 2 and 3."

Fulfilling the above requirements certainly justifies being included as an author if not the sole author or the first and corresponding author. Well-founded authorship of a scientific paper means doing the experiments, analyzing the data, working out the theory, writing the paper, reading the literature and defending the work during peer-review [4,5,8]. These activities enable an author to lecture on the paper in front of a critical audience. It is sometimes amusing to see the name of a department head or chairperson holding the rank of full professor appearing in the middle of a multitude of authors or occupying fifth or sixth position in a line-up of seven names [94,95]. The reason such senior scientists need to have their name among the authors is hard to understand and mention in the acknowledgments section for laboratory space, advice, encouragement and perhaps financial support should suffice [96]. The lure of seeing ones name in print is admittedly hard to resist.

Before considering a manuscript for publication, more and more journals require that each person named as an author sign a statement to that effect, which might take the form:

> "I have participated sufficiently in the conception and design of this work or the analysis and interpretation of the data, as well as the writing of the manuscript, to take public responsibility for it. I believe the manuscript contains valid work."

Some journals ask the authors to spell-out in a footnote exactly what each one contributed to the genesis of the work contained in the manuscript [97]. Co-authorship brings with it both credit and responsibility and this should be remembered if and when published research findings are eventually shown to be fraudulent or plagiarized. High-impact journals, although they operate a rigorous peer-review before a paper is accepted, are not immune to publishing flawed or faked data as documented by several recent high-profile examples [62–67].

If a submitted article is fortunate enough to be selected for serious consideration by the *Lancet*, the editorial office requires the following signed statements from the authors:

- Specify individual author contributions, including use of any professional writers or editors.
- Information about any perceived conflicts of interest (financial or personal) that could lead to bias.
- Written consent from all cited individuals in the acknowledgements.
- Written consent for use of all personal communications.
- Signed permission from author or publisher for use of all copyright-protected material.

Over a career spanning 30 years, a productive forensic scientist might have his or her name on about 100 published articles, which work out to an average of about three articles per year. By contrast, Table 9 shows the extraordinary productivity

Table 9
Top-ten most highly cited scientists 1983–2005 according to ISI's databases

Rank	Name	Country	Field	Papers	Citations
1	B. Vogelstein	USA	Molecular biology/genetics	361	106,401
2	S. Moncada	UK	Pharmacology	541	68,889
3	S.H. Snyder	USA	Pharmacology	625	63,106
4	C.A. Dinarello	USA	Immunology	862	62,365
5	P. Chambon	France	Molecular biology/genetics	686	61,884
6	R.C. Gallo	USA	Immunology	930	61,303
7	D. Baltimore	USA	Molecular biology/genetics	386	59,519
8	T. Kishimoto	Japan	Molecular biology/genetics	1406	58,621
9	A. Ullrich	Germany	Molecular biology/genetics	525	58,395
10	R.M. Evans	USA	Molecular biology/genetics	442	57,630

of the top-10 most cited scientists worldwide between 1983 and 2005 according to information gleaned from ISI's databases. This kind of prolific authorship is hard to believe considering the enormous work effort such an accomplishment entails. As might have been expected, most of the people on the list are from research organizations in USA although a few other countries are also represented, including Britain, France, Germany and Japan. This phenomenal output of scientific papers is only possible for leaders of large research-orientated groups with plenty of financial support and scores of postdoctoral fellows working at the bench and drafting articles for publication. It is also common knowledge that at some prestigious research institutions, the laboratory director puts his or her name on every manuscript submitted for publication by a member of the research group [4,5,89].

The scientific paper is unquestionably the key measure of success and scholarly achievement in academia and prolific authorship brings with it both recognition and prestige. The number of single author articles on a persons CV is decreasing and multi-author works are increasing, which makes it increasingly difficult to attribute credit to individual names on an article. This becomes a problem when scientists compete for new appointments or research grants or become nominated for awards and prizes. One solution is to give most weight and credit to those people who are sole author or listed as first author on the majority of their publications. Alternatively, some kind of factorization might be envisaged so that a paper is divided up among the authors with the highest score being given to the lead author and attributing diminishing credit or points to each person listed thereafter. In addition, a person's overall citation track record, invitations to serve as peer-reviewer and membership of editorial boards, invited lectureships and other forms of peer recognition deserve consideration. In the case of forensic scientists, testimony as an expert witness or arbitrator in high profile cases seems highly relevant, especially if this entails travel to other countries or jurisdictions.

8. Concluding remarks

Science would be hard to imagine without scientific journals. Writing up work for publication is a time-consuming business and talent as an experimenter and researcher at the bench does not always correlate with talent as an organizer or writer. The impact factors of forensic journals will not increase unless those working in this field are given encouragement, opportunity and the time necessary to summarize and write-up their work for publication. The publication output of most forensic scientists is dismal compared with university scientists of comparable age and qualifications.

Writing reports and regularly publishing scientific articles should count for more in the career development of a forensic scientist, which today is clearly not the case considering the trend away from academia into privatization [25]. The scientific staff at forensic laboratories is often overloaded with routine casework, participating in meetings for the sake of meetings, and the never ending paper trail associated with accreditation and process-driven work schemes. This leaves less time and opportunity to focus on experimental work, teaching, reading, writing, and reviewing articles and contributing to the literature.

The editors of a newly launched scientific journal in forensic science, medicine and pathology painted a rather bleak picture for the future of forensic pathology as an academic discipline [98]. A decreasing number of forensic autopsies, difficulties in attracting graduate and post graduate students, problems of research funding for the traditional kind of research projects undertaken in forensic medicine, failure to re-appoint professorships in the discipline and sometimes the negative publicity from alleged miscarriages of justice in certain high-profile cases were among the issues discussed.

Many examples could be given of controversial opinions from expert witnesses, such as the health hazards of silicone breast implants, and the scientific facts underlying the health of Gulf War veterans [99–102]. Expert testimony is often overshadowed by conflicts of interest and prejudices on the part of experts many with vested interests (money or prestige) spurred on by lawyers (barristers) participating in the adversarial system of justice [25,101]. Use of expert testimony came under scrutiny in the case of *Daubert versus Merrill Dow Pharmaceuticals* and the US Supreme Court reacted by issuing guidelines for admission of expert opinions [99,101]. A major focus was given to information gleaned from material that had undergone peer-review and publication.

Trial by jury has been called into question when the jurors are tasked with listening to and judging the merits of conflicting expert opinions related to complex medical and technical evidence [25,101]. The charisma and personality of a star expert witness is likely to exert a big influence on both judge and jury and might overshadow the strength of the evidence being presented [103,104]. To quote Sir Alec Jeffreys [105], the man who introduced DNA fingerprinting into forensic science:

> "I lost my faith in the adversarial system the first time I stood up in court after the realization that it all depends on the chemistry between the witness and the jury."

In the wake of the *Daubert versus Merrill Dow* judgement, much was written about use of expert witnesses in criminal trials and expert testimony in general [106] and an editorial in the journal *Nature* [107] contained the following statement:

> "The so-called expert witness in court may be a hired-gun, willing to testify to anything for a fee, or a crackpot whose unsupportable ideas are masked by an advanced degree (PhD), often from a respectable university."

Sustained interest, drive, ambition, intellectual curiosity and the stimulus from interacting with peers are essential elements for success in any scientific endeavour, including the forensic sciences. Writing and working at home is natural for most university-based scientists who spend a lot of their free-time reading and reviewing journal articles. This kind of work ethic would be hard to accept by government employed forensic scientists unless the writing and reviewing of scientific papers counts for more towards promotion and salary increments

Forensic scientists should not be too concerned about the relatively low impact factors of the journals where they publish

[25–29]. Instead, they should strive to ensure that their work has undergone a proper, detailed and open peer-review. Peer-review reports might one day become discoverable in criminal or civil litigation. Manuscripts benefit tremendously from a careful peer-review, not least in terms of clarity and readability of the finished product [108]. Peer-reviewers assess, among other things, the novelty of the research and the soundness of the methodology used in the experiments reported [77]. Obviously the relevance of the work to the target journal readership also needs to be gauged by both the reviewers and the editor when a decision is made to accept or reject a manuscript.

To save time and effort on the part of unpaid peer-reviewers, the journal editors should not hesitate in returning immediately a manuscript to the authors without the paper being sent for peer-review. This might be motivated, for example, by inappropriate subject matter, flawed structure or unacceptable language style. Authors without English as a mother tongue should seek help from a language editor before the manuscript is finalized and submitted for publication. A badly written and untidy submission and when it is obvious that the journal's instructions to authors has not been read stands little chance of being accepted for publication even if the article contains exciting new observations [108]. Common errors and misuse of statistics in submitted manuscripts has prompted some journals to recruit specialist reviewer whenever advanced statistical methods are a prominent part of the article, e.g. multi-variable factorial designs, Bayesian probability estimates as well as the currently in vogue meta-analysis [109–111].

The attraction to journal impact factor by authors, editors and publishers alike is not so difficult to understand considering that most people like to rate and rank items and compare performance by developing lists and league tables [112,113]. Indeed, impact factors are numbers reported to four decimal places, which tend to given them some false sense of accuracy and precision. However, the journal impact factor should not be used as a surrogate for reading the article concerned [43–45]. Citation practices vary considerably from field to field and even within sub-specialities within the same field. It is inappropriate to think that a forensic science journal with an impact factor of 2.0 is twice as good as another with an impact factor of 1.0, even though articles in the latter journal are cited on average less. Impact factors are only of practical use when journals from the same field or subject category are compared.

Table 10
Some potential problems with citation counting and impact factors as indicators of quality

- How to deal with negative citations?
- How to deal with self-citations?
- How to deal with typographical errors in the bibliographies?
- Should review journals be considered separate from journals reporting original research?
- Methods papers generally attract more citations
- Mismatch between citations and citable items is extreme for some journals
- Articles that might have been retracted (e.g. owing to fraud) continue to be cited
- Citation amnesia—people deliberately failing to cite a relevant work
- Creation of citation circles—citing friends and colleagues preferentially
- National and language biases
- Large variations in the number of references per article in some disciplines
- Classification of journals by ISI into inappropriate subject category

Many factors can bias computation of the impact factor and examples of these are listed in Table 10. With some journals there is often a mismatch between citations and number of citable items, as recently demonstrated for *Clinical Chemistry*, which had an impact factor of 6.5 in 2004. When the many technical briefs in this journal were re-classified as citable items, the impact factor for 2004 dropped to 3.97 [50]. The weekly journals *Nature*, *Science*, BMJ, JAMA and others, contain many news items, letters, editorial material and commentaries and although this kind of material attracts citations it is not counted by ISI as citable items when the impact factor ratios are calculated [49].

Forensic science journals have a fairly limited circulation compared with mainstream biochemical or clinical medicine journals. The smaller size of the forensic discipline, the lack of incentive to conduct research and publish articles has a negative influence on both citations and journal impact factors because people who do not write do not cite. Many university scientists manage to publish 10 or more papers annually and a certain scientific elite – leaders of large research groups – co-author scores of papers annually (Table 9).

Publishing a comprehensive review of the forensic sciences, which might contain a bibliography listing hundreds of references to recently published articles from forensic journals, is one way to increase the numerator in the impact factor calculation. This is exactly what happened with the review by Brettell, Butler and Saferstein (114, 115), which is published every 2 years, in the journal *Analytical Chemistry* (2004 impact factor 5.45). The 2005 version of the review contained 783 items in the bibliography most of which were citations to recent articles (published 2004 and 2003) from the major forensic science journals [114]. By contrast, in 2004, when *Analytical Chemistry* did not contain a review of the forensic sciences, there were only six citations awarded to JFS articles and seven citations to FSI articles published in 2003 and 2002. This means that the impact factor of JFS rises or falls depending on the year that *Analytical Chemistry* contains a review of recent developments in the forensic sciences [115]. Accordingly, the impact factor of both JFS and FSI can be expected to increase appreciably when the 2005 issue of Journal Citation Reports becomes available in June 2006.

The creation of citation indexes and the concept of counting citations for purposes of ranking and comparing articles, journals and scientists was a smart idea [33–36]. Growing interest in bibliometrics and journalology is evidenced by many scientific conferences being devoted to these topics as well as the creation of a specialist scientific journal, exemplified by *Scientometrics* (2004 impact factor 1.12). It is important to remember that neither citation counts nor impact factors should be compared across academic disciplines without some appropriate normalization being made. This might entail adjusting for the size of the field (number of core journals), co-authorship practices, frequency of publication and bibliographic format (citation density) of representative articles in that field [112,113].

One unique feature of citation indexes is the ability to trace developments in a topic forward in time and thus to check progress in a field by examining who has cited a particular work and why. In contrast, the use of keyword or subject-searching only permits looking back in time. The question of who, when and why to cite is subjective and citation habits differ from person to person, laboratory to laboratory and nation to nation. Ways have been suggested to improve the utility of impact factors by adjusting for the scope of the journal coverage and also by establishing topic-based impact factors [116]. The impact factor of journals should not be the most pressing concern of potential authors of scientific articles, who instead should be anxious that their work is read by their peers and that it has undergone a thorough peer-review prior to publication. Likewise, university administrators, policy makers and funding organizations should not depend solely on citations and impact factors when judging the work of individual scientists. Many of the criticisms of counting citations and using journal impact factors for the purpose of ranking and rating individual scientists, research groups and entire universities are given in Table 10.

Scientific publishing has become big business and seems to be dominated by a few large commercial publishing houses with Elsevier accounting for about 30% of all scientific journals [117]. Other well-known publishers, some with a strong interest in forensics, include Taylor & Francis, Blackwell Publishing, John Wiley, Springer, Kluwer and Humana Press. Besides the traditional and costly paper-copy editions of journals, publishing firms now provide searchable electronic versions of their products and some are even venturing into the business of tracking citations (e.g. Elsevier's SCOPUS is putting up a challenge to Thomson ISI's Web of Science).

The existence of GOOGLE scholar seemingly provides another way to count citations to published articles but its utility and accuracy in comparison with ISI's databases has yet to be tested. The notion of open access journals is a hot topic in 21st century publishing and the number of such journals is growing steadily [75,84,117]. Biomedical Central (BMC) was an early mover and shaker in open access publishing although authors of the articles published are required to defray part of the handling and production costs. Many believe that open-access represents the future of scholarly publishing [118].

Forensic science is an exciting multidisciplinary field and employment as a forensic scientist is an attractive vocation for young academics and others. The basic training should include a thorough grounding in core subjects like chemistry, physics, biology, biochemistry and genetics at the university level. In some countries (e.g. UK), there is a proliferation in university courses offering a degree in chemistry and forensic science and hopefully training in analytical skills and other applied science subjects are included. Forensic science and especially forensic pathology continue to enjoy unprecedented media attention from cable TV as evidenced by many popular programs both fictional as well as more interesting documentaries from real-world cases such as those shown on the History and Discovery channels.

The undisputed leader in citation analysis and the man who founded the Institute for Scientific Information (ISI, Philadelphia) is Eugene Garfield PhD, who recently celebrated his 80th birthday [55,119]. Gene Garfield can look back on a remarkable career both as a scholar, entrepreneur and a highly prolific writer, with hundreds of journal articles and reviews to his credit and over 1000 essays of an information scientist.

Acknowledgement

There was no external funding for preparing this article.

References

[1] K. Abbasi, M. Butterfield, J. Connor, T. Delamothe, et al., Four futures for scientific and medical publishing, BMJ 325 (2002) 1472–1481.
[2] P.A. Lawrence, The politics of publication, Nature 422 (2003) 259–261.
[3] R. Wu, Making an impact, Nature 428 (2004) 206–207.
[4] A.H. Jones, F. McLellan (Eds.), Ethical Issues in Biomedical Publication, The Johns Hopkins University Press, Baltimore, 2000.
[5] M. Angell, Publish or perish: a proposal, Ann. Intern. Med. 104 (1986) 261–262.
[6] R. Horton, A fair reward, Lancet 352 (1998) 892.
[7] D. Riesenberg, G.D. Lundberg, The order of authorship. Who's on first, JAMA 264 (1990) 1857.
[8] A.W. Jones, Some thoughts and reflections on authorship, Alcohol Alcohol 31 (1996) 11–15.
[9] A.S. Relman, Responsibilities of authorship—where does the buck stop, N. Engl. J. Med. 310 (1984) 1048–1049.
[10] D. Adam, The counting house, Nature 415 (2002) 726–729.
[11] G. Williams, Misleading, unscientific, and unjust; the United Kingdom's research assessment exercise, BMJ 316 (1998) 1079–1082.
[12] S. Tomlinson, The research assessment exercise and medical research, BMJ 320 (2000) 636–639.
[13] R. Smith, Unscientific practice flourishes in science, BMJ 316 (1998) 1036.
[14] O. Drummer, A.R. Forrest, B. Goldberger, S.B. Karch, et al., Forensic science in the dock, BMJ 329 (2004) 636–637.
[15] Z. Erzinclioglu, British forensic science in the dock, Nature 392 (1998) 859–860.
[16] M.J. Clark, Historical keywords—forensic, Lancet 366 (2005) 1351.
[17] P.R. Deforest, R.E. Gaensslen, H.C. Lee, Forensic Science—An Introduction to Criminalistics, McGraw-Hill Co., New York, 1983.
[18] R. Saferstein, Criminalistics: An Introduction to Forensic Science, 4th ed., Prentice hall, New Jersey, 1977.
[19] S.S. Kind, The Scientific Investigation of Crime, The Forensic Science Society, Harrogate, North Yorkshire, 1987.
[20] K. Püschel, H. Lach, E. Türk, S. Pollak, The centenary of the German Association of legal medicine—from its foundation in 1904 to 21st century legal medicine, organs of publication, Forensic Sci. Int. 144 (2004) 285–288.
[21] W. Keil, A. Berzlanovich, B. Madea, Text books on legal medicine in the German-speaking countries, Forensic Sci. Int. 144 (2004) 289–302.
[22] M.J.B. Orfila, Traité des poisons, Crochard, Paris, 1814.
[23] R.E. Gaensslen, The journal of forensic sciences, in: K.S. Field (Ed.), History of the American Academy of Forensic Sciences: 50 years of progress, 1948–1998, American Society for Testing of Materials (ASTM), Philadelphia, 1998, pp. 117–121.
[24] A.W. Jones, in: J. Payne-James, R.W. Byard, T.S. Corey, C. Henderson (Eds.), Forensic Journals—Bibliometrics and Journal Impact Factors. Encyclopedia of Forensic and Legal Medicine, vol. II, Elsevier, Oxford, 2005, pp. 335–345.
[25] R.H.J. Disney, Fraudulent forensic scientists, J. Med. Leg. Droit. Med. 45 (2002) 225–230.
[26] A.W. Jones, The impact of forensic science journals, Forensic Sci. Int. 62 (1993) 173–178.

[27] A.W. Jones, Impact factors of forensic science and toxicology journals—what do the numbers really mean? Forensic Sci. Int. 133 (2003) 1–8.
[28] A.W. Jones, Which articles and which topics in the forensic sciences are most highly cited, Sci. Justice 45 (2005) 174–180.
[29] A.W. Jones, Crème de la crème in forensic science and legal medicine—the most highly cited articles, authors and journals 1981–2003, Int. J. Legal Med. 119 (2005) 59–65.
[30] J.A. Siegel, P.J. Saukko, G.-C. Knupfer (Eds.), Encyclopedia of Forensic Sciences, vols. I–III, Elsevier, Oxford, 2005, pp. 1–1440.
[31] J. Payne-James, R.W. Byard, T.S. Corey, C. Henderson (Eds.), Encyclopedia of Forensic and Legal Medicine, vols. I–IV, Elsevier, Oxford, 2005, pp. 1–2563.
[32] J. Gerchow, Editorial, Blutalkohol 38 (2001) 127–128.
[33] E. Garfield, Journal impact factor: a brief review, CMAJ 161 (1999) 979–980.
[34] E. Garfield, The history and meaning of the journal impact factor, JAMA 295 (2006) 90–93.
[35] E. Garfield, How can impact factors be improved? BMJ 313 (1996) 411–413.
[36] E. Garfield, Citation indexes to science: a new dimension in documentation, Science 122 (1955) 108–111.
[37] E. Garfield, Citation analysis as a tool in journal evaluation, Science 178 (1972) 471–479.
[38] E. Garfield, When to cite, Lib. Q. 66 (1996) 449–458.
[39] T. Opthof, Sense and nonsense about the impact factor, Cardiovasc. Res. 33 (1997) 1–7.
[40] A.P. Kurmis, Understanding the limitations of the journal impact factor, J. Bone Joint Surg. Am. 85A (2003) 2449–2454.
[41] H.F. Moed, The impact factors debate: the ISI's uses and limits, Nature 415 (2002) 731–732.
[42] C. Jennings, Citation data. The wrong impact, Neuroendocrinol. Lett. 20 (1999) 7–10.
[43] P.O. Seglen, Citation and journal impact factors: questionable indicators of research quality, Allergy 52 (1997) 1050–1056.
[44] P.O. Seglen, Citation and journal impact factors are not suitable for evaluation of research, Acta Orthop. Scand. 69 (1998) 224–229.
[45] P.O. Seglen, Why the impact factor of journals should not be used for evaluating research, BMJ 314 (1997) 498–502.
[46] F. Hecht, B.K. Hecht, A.A. Sandberg, The journal impact factor: a misnamed, misleading, misused measure, Cancer Genet. Cytogenet. 104 (1998) 77–81.
[47] R. Coleman, Impact factors: use and abuse in biomedical research, Anat. Rec. 257 (1999) 54–57.
[48] G. Lundberg, The omnipotent science citation index impact factor, MJA 178 (2003) 253–254.
[49] K.S. Joseph, J. Hoey, CMAJ's impact factor: room for recalculation, CMAJ 161 (1999) 977–978.
[50] A.W. Jones, Mode of classification of source material as citable items skews journal impact factor calculations, Scand. J. Clin. Lab. Invest. 65 (2005) 623–625.
[51] H.F. Moed, T.N. Van Leeuwen, Improving the accuracy of Institute for Scientific Information's journal impact factors, J. Am. Soc. Inform. Sci. 46 (1995) 461–467.
[52] W. Glänzel, H.F. Moed, Journal impact measures in bibliometric research, Scientometrics 53 (2002) 171–193.
[53] S. Bloch, G. Walter, The impact factor: time for change, Aust. N.Z.J. Psychiatry 35 (2001) 563–568.
[54] G. Walter, S. Bloch, G. Hunt, K. Fisher, Counting on citations. A flawed way to measure quality, MJA 178 (2003) 280–281.
[55] K. Hopkin, Most highly cited, The Scientist 20 (2005) 22–23.
[56] N. Kresge, R.D. Simoni, R.L. Hill, The most highly cited paper in publishing history, protein determination by Oliver H. Lowry, J. Biol. Chem. 280 (2005) e26–e28.
[57] C.D. DeAngelis, P.B. Fontanarosa, Thank you, JAMA peer reviewers and authors, JAMA 295 (2006) 1171–1172.
[58] C. Laine, C. Mulrow, Peer review: integral to science and indispensable to Annals, Ann. Intern. Med. 139 (2003) 1038–1040.
[59] J. Giles, Journals submit to scrutiny of their peer-review process, Nature 439 (2006) 252.
[60] C. Wenneras, A. Wold, Nepotism and sexism in peer review, Nature 387 (1997) 341–343.
[61] O.E. Chubin, E.J. Hackett, Peerless Science—Peer Review and US Science Policy, State University of New York Press, New York, 1990.
[62] R.F. Service, Bell labs fires star physicist found guilty of forging data, Science 298 (2002) 30–31.
[63] M.K. Cho, G. McGee, D. Magnus, Lessons from the stem cell scandal, Science 311 (2006) 614–615.
[64] E.Y. Snyder, J.F. Loring, Beyond fraud—stem cell research continues, N. Engl. J. Med. 354 (2006) 321–324.
[65] C. White, Suspected research fraud: difficulties in getting at the truth, BMJ 331 (2005) 281–288.
[66] E. Marris, Doctor admits Lancet study is fiction, Nature 439 (2006) 248–249.
[67] R. Dalton, The stars who fell to earth, Nature 420 (2002) 728–729.
[68] E. Garfield, How ISI selects journals for coverage: quantitative and qualitative considerations, in: Current Contents, 1990, pp. 5–13.
[69] J.M. Perkel, The future of citation analysis, The Scientist 19 (2005) 24–26.
[70] W.W. Gibbs, Lost science in the third world, Sci. Am. 283 (1995) 76–84.
[71] D.A. Kronick, Peer review in 18th century scientific journalism, JAMA 263 (1990) 1321–1322.
[72] M. Hojat, J.S. Gonnella, A.S. Caelleigh, Impartial judgment by the gatekeepers of science fallibility and accountability in the peer review process, Adv. Health Sci. Edu. 8 (2003) 75–96.
[73] J.P. Brady, Journal referees: gatekeepers of science, Biol. Psychiat. 20 (1985) 823.
[74] T. Opthof, R. Coronel, M.J. Janse, Where do peer reviewers come from? Cardiovasc. Res. 46 (2000) 1–13.
[75] F. Godlee, T. Jefferson (Eds.), Peer review in health sciences, BMJ Books, London, 1999.
[76] J.W. Reidenberg, Improving peer review: a guide for reviewers of biomedical research, Clin. Pharmacol. Ther. 72 (2002) 469–473.
[77] F. Rowland, The peer-review process, Learned Publ. 15 (2002) 247–258.
[78] F. Davidoff, Masking, blinding, and peer review: the blind leading the blinded, Ann. Intern. Med. 128 (1998) 66–68.
[79] I. Dimoliatis, Should peer reviewers of papers have their names published, BMJ 328 (2004) 1267.
[80] R. Dalton, Peers under pressure, Nature 413 (2001) 102–104.
[81] M.K. Cho, A.C. Justice, M.A. Winker, J.A. Berlin, et al., Masking author identity in peer review, JAMA 280 (1998) 23–45.
[82] R. Smith, Opening up BMJ peer review, BMJ 318 (1999) 4–5.
[83] S. Wessely, T. Brugha, P. Cowen, L. Smith, E. Psykel, Do authors know who refereed their paper? A questionnaire survey, BMJ 313 (1996), 1185.11.
[84] P.S. Tamber, F. Godlee, P. Newmark, Open access to peer reviewed research—making it happen, Lancet 362 (2003) 1575–1577.
[85] D. Rennie, A. Flanagin, V. Yank, The contributions of authors, JAMA 284 (2000) 89–91.
[86] Anonymous (editorial), Games people play with authors names, Nature 387 (1997) 831.
[87] R. Chambers, E. Boath, S. Chambers, The A to Z of authorship analysis of influence of initial letter of surname on order of authorship, BMJ 323 (2001) 1460–1461.
[88] J.A. Erlen, L.A. Siminoff, S.M. Sereika, L.B. Suttopn, Multiple authorship: issues and recommendations, J. Prof. Nurs. 13 (1997) 262–270.
[89] J. Hoey, Who wrote this paper anyway? CMAJ 163 (2000) 716–717.
[90] D. Rennie, A. Flanagin, Authorship! Authorship! Guests, ghosts, grafters, and the two-sided coin, JAMA 271 (1994) 469–471.
[91] S. Nagi, J.L. Gold, S.S. Gill, P.A. Rochon, Haunted manuscripts: ghost authorship in the medical literature, Acc. Res. 12 (2005) 103–114.
[92] J.W. Reidenberg, Unmasking ghost writers, Clin. Pharmacol. Ther. 70 (2001) 208–209.
[93] A. Flanagin, L.A. Carcy, P.B. Fontanarosa, S.G. Pace, et al., Prevalence of articles with honorary authors and ghost authors in peer-reviewed medical journals, JAMA 280 (1998) 222–224.

[94] J.T. King Jr., How many neurosurgeons does it take to write a research article? Authorship proliferation in neurosurgical research, Neurosurgery 47 (2000) 435–440.
[95] J.P. Kassirer, M. Angell, On authorship and acknowledgement, N. Engl. J. Med. 325 (1991) 1510–1512.
[96] C. Lee Giles, I.G. Council, Who gets acknowledged: measuring scientific contributions through automatic acknowledgement indexing, PNAS 101 (2004) 17599–17604.
[97] D. Rennie, V. Yank, L. Emanuel, When authorship fails—a proposal to make contributors accountable, JAMA 278 (1997) 579–585.
[98] R.W. Byard, M. Tsokos, Research, publishing and forensic pathology, Forensic Sci. Med. Pathol. 1 (2005) 237–238.
[99] B.J. Culliton, Scientific ''experts'' and the law, Nat. Med. 3 (1997) 123.
[100] M. Angell, Science on trial, W.W. Norton & Company, London, 1997.
[101] M. Deahl, Smoke, mirrors and Gulf war illness, Lancet 365 (2005) 635–638.
[102] K.R. Foster, P.W. Huber, Judging science: scientific knowledge and the Federal Courts, MIT Press, Cambridge, MA, 1999.
[103] C. Montgomery, Forensic science in the trial of Sally Clark, Med. Sci. Law 44 (2004) 185–188.
[104] E. Hey, Suspected child abuse: the potential for justice to miscarry, BMJ 327 (2003) 299–330.
[105] Forensic Science on Trial, Seventh report from the Select Committee on Science and Technology of the United Kingdom Parliament, HC 96-1 and HS 96-11, 2005.
[106] H.H. Kaufman, The expert witness. Neither *Frye* nor *Daubert* solved the problem: what can be done? Sci. Justice 41 (2001) 7–20.
[107] Anonymous (editorial), Criteria for science in the courts, Nature 362 (1993) 481.
[108] M.J. Tobin, Rigor of peer review and the standing of a journal, Am. J. Respir. Crit. Care Med. 166 (2002) 1013–1014.
[109] D.G. Altman, Statistical reviewing for medical journals, Stat. Med. 17 (1998) 2661–2674.
[110] P. Bacchetti, Peer review of statistics in medical research. The other problem, BMJ 321 (2002) 1271–1273.
[111] M.J. Gardner, D. Machin, M.J. Campbell, Use of check lists in assessing the statistical content of medical studies, BMJ 292 (1986) 810–812.
[112] M. Frank, Impact factors—arbiter of excellence, J. Med. Lib. Assoc. 91 (2003) 4–6.
[113] E. Garfield, Use of journal citation reports and journal performance indicators in measuring short and long term journal impact, Croat. Med. J. 41 (2000) 368–374.
[114] T.A. Brettell, J.M. Butler, R. Saferstein, Forensic science, Anal. Chem. 77 (2005) 3839–3860.
[115] A.W. Jones, Citation trends and practices in the *Journal of Forensic Sciences* as documented by ISI's journal citation report, J. Forensic Sci. 43 (1998) 439–444.
[116] E.J. Huth, Scope-adjusted impact factor, J. Med. Lib. Assoc. 91 (2003) 28.
[117] R. Horton, 21st century biomedical journals: failures and futures, Lancet 362 (2003) 1510–1512.
[118] M. Frank, Access to the scientific literature—a difficult balance, N. Engl. J. Med. 354 (2006) 1552–1555.
[119] B. Cronin, H.B. Atkins (Eds.), The Web of Knowledge—A Festschrift in Honor of Eugene Garfield, ASIS Monograph Series, Information Today Inc., Medford, 2000.