British Journal of Anaesthesia **107** (3): 351–6 (2011)
Advance Access publication 26 May 2011 · doi:10.1093/bja/aer124

BJA

CLINICAL PRACTICE

Bibliometrics of anaesthesia researchers in the UK

I. K. Moppett* and J. G. Hardman

Division of Anaesthesia and Intensive Care, University of Nottingham, Queen's Medical Centre Campus, Nottingham University Hospitals NHS Trust, Nottingham NG7 2UH, UK

* Corresponding author. E-mail: iain.moppett@nottingham.ac.uk

Editor's key points

- Bibliometric indices can be useful in measuring the quality and quantity of research productivity.
- Bibliometric tools were used to assess research output by individual UK anaesthetic researchers and departments.
- Research output was comparable with other medical specialities in Europe and North America.
- Four anaesthesia departments out of 23 contributed to >50% of research publications and citations.

Background. Bibliometrics provide surrogate measures of the quality and quantity of research undertaken by departments and individuals. Previous reports have suggested that academic anaesthesia research in the UK is in decline. We wished to provide a comprehensive description of current and historical published output of UK anaesthesia researchers.

Methods. Bibliometric indices (Web of Science®) were calculated for anaesthesia researchers in the UK for the whole period covered by the database, and for 2004–8. A parallel search was made using the Scholarometer™ tool, which parses output from Google Scholar™. Calculated indices included total number of publications; total number of citations; citations per paper; *h*-index; *g*-index; and modified impact index.

Results. One hundred and four individuals and 23 academic departments were identified. Median values (inter-quartile range) for the indices were: total papers 57 (24–95) (individuals for the whole period), 11 (6–20) (individuals 2004–8), 50 (30–70) (departments 2004–8); total number of citations 571 (175–1328), 93 (38–207), 383 (239–845); *h*-index 13 (8–20), 6 (3–8), 11 (9–14). Four departments were ranked in the top 5 for all indices.

Conclusions. The general distribution of bibliometric data is similar to that seen in other specialities in Europe and North America. Four departments contribute to more than 50% of published anaesthesia research output in this data set. These data provide useful comparative tools for individuals, departments, and national bodies.

Keywords: achievement; anaesthesia; bibliometrics; publications

Accepted for publication: 4 April 2011

Several reports have commented on the apparently poor state of academic anaesthesia in the UK. In his report to the Royal College of Anaesthetists,[1] Pandit wrote that 'There is a severe crisis in academic anaesthesia in the UK. Anaesthetic departments have performed poorly [and] their output is published generally in low-impact factor, specialist journals'. A longitudinal survey of anaesthesia publications also demonstrated a decline in UK-based publications in recent years.[2] Academic anaesthetic departments and individual academics are judged by their peers, funding bodies, and employers at least partly on the quality and quantity of academic output. Bibliometric indices have been used as surrogate measures of both quality and quantity of research, although the validity of this has been questioned. These indices have become both more sophisticated and easier to measure in recent years. The choice of search engine or indexing service can affect the indices produced, and at present, there is no 'gold standard' with which others should be compared. Although there have been some bibliometric reports of selected institutions in Europe[3] and North America[4–8] of both anaesthetic and non-anaesthetic medical research, to date there has been no systematic study of the bibliometrics of the UK anaesthesia research community, and consequently little evidence on which to base comparisons. We explored bibliometric indices of active anaesthesia researchers and their host departments in the UK.

Methods

Search and inclusion criteria

Academic (University) anaesthetic departments in the UK (England, Northern Ireland, Scotland, Wales) were identified using the list prepared by Pandit,[1] web searching, and identifying the host institution of members of the editorial boards of the *British Journal of Anaesthesia* and *Anaesthesia*. Individual researchers were identified by searching published lists of departmental researchers and web searching

(Google™, Web of Science®) using departmental/institutional names. UK-based members of the editorial boards of the *British Journal of Anaesthesia* and *Anaesthesia* were also specifically included [examination of the editorial boards of other anaesthesia journals (*Anesthesia and Analgesia, European Journal of Anaesthesiology, Critical Care Medicine, Anaesthesiology*) yielded no new names]. Additionally, the 2004–8 issues of the *British Journal of Anaesthesia, Anaesthesia,* and *Critical Care Medicine* were searched manually for highly published authors and centres. For the purpose of this study, an anaesthesia researcher was defined as either a medically qualified anaesthetist involved in publishing research or a non-clinical researcher based in a university department of anaesthesia, pain, or critical care. Where there was possible confusion about a potential individual, the two authors made a consensus decision on the basis of publications, web-based information, and known affiliations. Each paper title was read by the first author, which screened out authors with identical names and initials. Where there was doubt about the true attribution, the institutional and departmental affiliations in the abstract were checked. In almost all cases, this provided a clear yes/no regarding the authorship. In the handful of cases where it was unclear (due to identical names and initials and papers with multiple affiliations), discussion and agreement was reached with the second author.

Citation data sources

Publication data were extracted from Web of Science®[9] using an unrestricted date range. The raw data from this tool provide article name, authors, publication date, and number of times the article has been cited; *h*-index[10] and citation rate are also calculated. Publication names were checked by the authors to ensure correct attribution for those individuals with researchers in different fields with the same name. Non-clinical researchers were included. Meeting abstracts, book reviews, and obituaries were excluded from the sample. All other article types were included. These data were extracted to a spreadsheet for calculation of bibliometric indices. The same data were obtained restricting publications to 2004–8 in order to provide an assessment of current, as opposed to historical, output. The same individuals were also searched for using the newly developed Scholarometer™.[11] This is a freely available web-based engine that searches Google Scholar™[12] for publications and produces a similar battery of indices.

Data were extracted over a 4 week period in October and November 2010. Web of Science® and Scholarometer™ data were extracted on the same day for each individual.

The publication list for each department was combined into a single set, deleting duplicate citations. For simplicity and consistent with previous publications in the field, a publication was classified as coming from the current institution of the relevant author. These data were then also extracted into a spreadsheet for bibliometric calculation. There was no adjustment made for multiple authors or institutions. The data for departments were only abstracted for the 2004–8 period. We did not feel that data for the whole period would be reliable for departments as departments have been in existence for very different lengths of time; some departments have merged or ceased to exist; and it is not practically possible to identify work from departments from individuals who have retired or moved. Individuals not clearly affiliated with these academic/University departments were not included in the departmental data set.

Bibliometric indices

The following indices were calculated: total number of publications (N); total number of citations (total cites); number of citations per publication (citation rate); *h*-index; *g*-index; modified impact index (MII).

h-Index[9] is defined as the number of papers (H) attributed to an author that have H or more citations; for example, if an author has 10 papers with 10 or more citations, and only nine for the next most cited, then the *h*-index would be 10. The *h*-index is intended to provide a combined indication of both quantity and impact of publications.

g-Index[13] is defined as the number of papers (G) attributed to an author whose combined number of citations is greater or equal to G^2; for example, if an author's eight most cited papers have 70 citations in total and their nine most cited papers have 75 citations in total, then the *g*-index is 8 (because $70>8^2$, but $75<9^2$). The index is supposed to provide weight to highly cited papers, avoiding the tendency of *h*-index to generate misleadingly low values when authors have produced small numbers of very impactful publications.

The MII is designed to correct the *h*-index for the effects of publication volume and time.[14] The *h*-index is, necessarily, a function of the number of papers published (N); the more papers published, the greater the potential *h*-index. Previous workers have shown that within a given research population, $\log H$ and $\log N$ are linearly related and the gradient of this relationship is a corrected measure of the institution or author's publication impact.[3] Expressed algebraically, an MII can be defined as $\mathrm{MII}=H/(10^{\alpha}\times N^{\beta})$. β is the gradient of the $\log H/\log N$ relationship, and is an index of how the *h*-index increases with N. α is the intercept on the $\log H/\log N$ plot.

The data of interest are not normally distributed, so all data are presented here as median (inter-quartile range). The relationship between indices was examined using Pearson's and Spearman's rank correlation analyses as appropriate. The accuracy of Scholarometer™ citation analysis data compared with Web of Science® was assessed using the Bland–Altman analysis.

Results

Twenty-three academic units were identified across the UK (England, Wales, Scotland, and Northern Ireland). One hundred and four anaesthetic researchers were identified.

Bibliometric data and indices are detailed in Tables 1–3. There was a moderate correlation between *h*-index

Table 1 Bibliometric data and indices of individuals for the entire data set and restricted to articles published 2004–8 for both clinical and non-clinical researchers and solely clinical researchers. *h*-Index and *g*-index are defined in the text. The citations per article are the summary of the mean values for each researcher. Therefore, although most researchers have uncited articles, provided at least one article has been cited, the mean citations per article for an individual research is >0

Index	Median (inter-quartile range; range)			
	Clinical and non-clinical researchers		Clinical researchers only	
	All papers	2004–8	All papers	2004–8 (individual)
Total number of publications	57 (24–95; 3–333)	11 (6–20; 0–94)	49 (24–84; 3–330)	12 (6–20; 1–94)
Total number of citations	571 (175–1328; 7–15143)	93 (38–207; 0–1632)	520 (157–1209; 7–15143)	93 (37–218; 1–1632)
Mean citations per article	11.2 (7.0–19.0; 1.1–494)	8.3 (5.0–13.7; 0–61.9)	11.1 (6.7–19.0; 1.1–59.5)	8.3 (5–13.7; 1–61.9)
h-Index	13 (8–20; 1–60)	6 (3–8; 0–24)	13 (8–18.75; 1–60)	6 (3–8; 1–24)
g-Index	22 (12–32; 2–110)	9 (4–13; 0–38)	21 (11.25–31; 2–110)	9 (4–13; 1–38)

Table 2 Bibliometric data and indices by academic rank for papers published in the whole period and 2004–8. *h*-Index and *g*-index are defined in the text

Index	Median (inter-quartile range; range)			
	Whole period		2004–2008	
	Full professors (*n*=40)	Non-professor (*n*=64)	Full professors (*n*=40)	Non-professors (*n*=64)
Total number of publications	94 (68–127; 11–333)	29 (15–58; 3–265)	18 (11–29; 4–94)	8 (4–16; 0–59)
Total number of citations	1425 (935–2839; 213–15143)	245 (98–659; 7–2860)	170 (83–381; 14–1632)	79 (23–146; 0–1269)
Mean number of citations per article	16.2 (11.1–23.2; 5.1–59.5)	9.4 (6.2–14.5; 1.1–494)	9.4 (7.5–18.6; 1.4–61.9)	6.9 (3.7–12.7; 0–42)
h-Index	21 (16–26; 7–60)	9 (5–15; 1–30)	8 (5–10; 2–24)	4 (3–6; 0–20)
g-Index	35 (26–47; 11–110)	14 (9–23; 2–50)	12 (8–18; 3–38)	6 (3–10; 0–35)

and *g*-index for individuals (all dates: r^2=0.92; 2004–8: r^2=0.82) and departments (r^2=0.92; 2004–8). Correlation between log *H* and log *N* was moderate (r^2=0.88) with an α-coefficient of 0.19 and β-coefficient of 0.563 for the period 2004–8. The median (range) for MII across all departments was 0.99 (0.83–1.21). For comparison, the β-coefficients for MII from a comparative data set of 'high ranking' European universities (across medical research specialities) are 0.445, 0.554, and 0.594 for all medical research specialities, anaesthesia, and critical care, respectively.[3]

At the departmental level, the four largest departments in the UK are all ranked in the top 5 for total number of publications, total number of citations, *h*-index, and *g*-index: Oxford, Cambridge, University College London, and Imperial College. Of the 1481 publications listed in the departmental data, 680 (51%) were from these four institutions, as were 10 160 (54%) of 18 536 citations.

Median values for all indices were higher for professors than for non-professors, although there was a significant overlap in all the ranges.

Rank correlation between *h*- and *g*-indices generated by the Web of Science® and Scholarometer™ was strong (r^2=0.94 and 0.93). There was a positive bias for both *h*- and *g*-indices calculated by Scholarometer™ compared with Web of Science®. *h*-Index: bias +2, 95% limits of agreement of −2 to 7; *g*-index bias +6, 95% limits of agreement of −3 to 16 (Fig. 1).

Discussion

This is the first systematic description of the published output of UK anaesthesia researchers. There is a wide variation in all the indices described. At the departmental level, the MII lies well within the range described for a selected group of medical research units across Europe; it is also consistent with the European range for anaesthesia as a subspeciality, and with other European medical subspecialities. The distribution of bibliometric indices is similar to Canadian anaesthetic[4] and non-anaesthetic medical specialities.[5–7] These data suggest that what UK anaesthetists publish is on a par with their international peers in anaesthesia.

Despite the advent of electronic searchable databases, there is no perfect method to capture citation information. Web of Science®[8] was used as the 'gold standard' for this study. It has the advantage of being relatively conservative in the sources it searches, essentially only using Medline-indexed sources. Researchers can, therefore, be confident that citations are robust, appropriate, and not affected by changes in popular media focus or special interest groups. Conversely, the inherent conservatism of Web of Science® means that researchers who have a wider impact in the grey literature and particularly the web may not be fully recognized. Which is the 'correct' list of appropriate citation information is a matter of judgement.[15] There are several alternatives. Scopus™ searches an overlapping range of

Table 3 Department-specific data for the period 2004–8. Individuals not clearly affiliated with a University Department are not included in this table

Department	Total papers	Total citations	Citations/article	*h*-Index	*g*-Index	Professors	Non-professors
A	239	3907	16.35	33	52	3	5
B	225	3606	16.03	36	50	5	5
C	130	2299	17.68	27	41	1	4
D	97	1085	11.18	16	28	2	8
E	89	759	8.53	14	23	2	6
F	74	342	4.62	10	14	1	4
G	72	1075	14.93	17	30	4	0
H	59	478	8.1	13	19	2	3
I	58	332	5.72	11	14	2	5
J	57	383	6.72	10	16	2	4
K	55	566	10.29	14	20	2	0
L	50	546	10.92	13	20	2	1
M	50	874	17.48	16	28	1	1
N	45	329	7.31	13	16	2	1
O	37	225	6.08	9	13	1	2
P	33	238	7.21	10	13	2	1
Q	33	239	7.24	9	15	1	0
R	26	1283	50.92	10	26	1	1
S	25	254	10.16	9	15	1	3
T	15	231	15.4	9	15	2	0
U	15	155	10.33	5	12	0	1
V	4	30	7.5	3	4	1	0
W	4	37	9.25	4	4	0	1
Median (inter-quartile range; range)	50 (30–70; 4–239)	383 (239–845; 30–3907)	10.2 (7.2–12.6; 4.6–50.9)	11 (9–14; 3–36)	16 (14–25; 4–52)		

texts, but its citation data are limited in time to 1996 onward, which might disadvantage older researchers and was therefore not used in this study.[16] A more accessible approach is to use one of the engines that extract data from Google Scholar™ [11] to generate citation indices. Harzing's *Publish or Perish*[17] is a standalone application, whereas Scholarometer™ is web-based, and as part of the project is using 'tags' (meta-data) to create a global database of researchers and research fields. The bias of the indices from Scholarometer™ is consistent with previous work,[18–20] although to our knowledge this is the first direct comparison of Scholarometer™ with Web of Science® for a defined cohort of researchers. Incorrect citations are an issue with Scholarometer™, particularly for authors with relatively common names. A fuller review of the differences and similarities between the two approaches is given by Harzing.[21]

Undoubtedly, the sample used in this paper is incomplete and potentially biased. It is incomplete because there is no contemporary directory of anaesthesia researchers in the UK. Departmental websites vary in quality, so researchers who should have been included could be missed. Some research-active NHS clinicians will also have been missed, for similar reasons. Since the number of research-active anaesthetists is few, a database is achievable and desirable. These omissions will, of course, influence the median and upper ranges of the data, but the (probably) small number of missing data points is unlikely to make a meaningful difference. The sample is also heavily biased towards publishing researchers. In theory, the data could be supplemented by including the complete membership of UK anaesthesia organizations such as the Royal College of Anaesthetists and Association of Anaesthetists of Great Britain and Ireland. However, this would create a much-skewed distribution, with several thousand individuals having only a handful of publications, if any. Departmental data are unlikely to be greatly affected by either of these problems. The aim of the study is to describe explicitly the anaesthesia 'research community', rather than the UK 'anaesthetic community' as a whole. We chose to include non-clinical researchers who were clearly based within anaesthetic departments. These researchers might have skewed the results towards higher publication and citation rates as they are generally full-time researchers. For the period 2004–8 though, of the top 10 highest ranked researchers for total papers, total citations, and *h*- and *g*-indices, seven were clinical academics, one a full-time NHS clinician, and two were non-clinical researchers.

The literature on bibliometric analysis includes various approaches to author attribution and number of authors. We adopted the simplest approach of ascribing a full citation

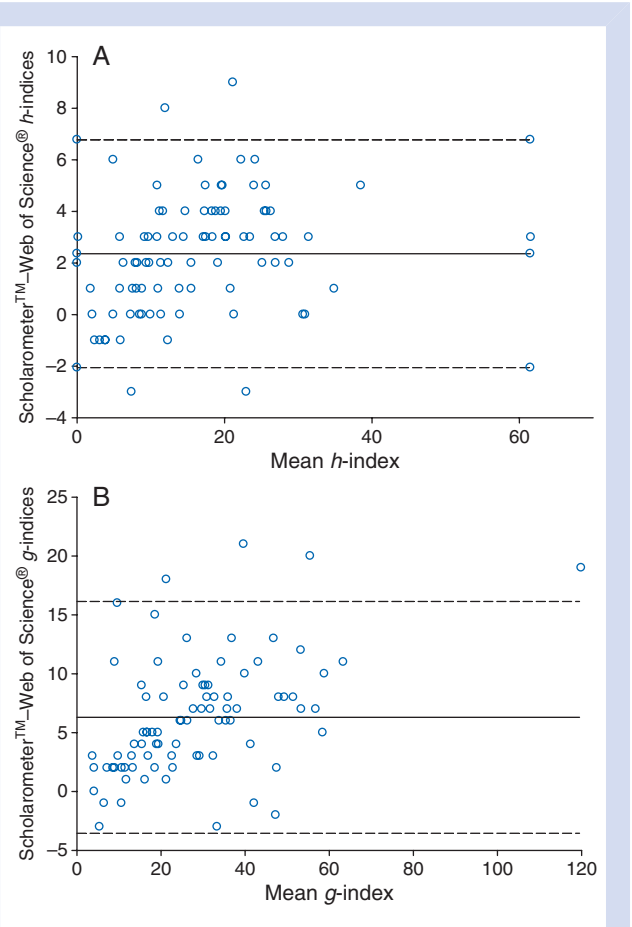

Fig 1 Bland–Altman plots of the mean of the indices *vs* the difference of the indices (Scholarometer™ Web of Science®): (A) *h*-index; (B) *g*-index. Following the example of Bould and colleagues,[4] a small random perturbation (between −0.5 and 0.5) has been added to the *x*-axis values to allow visual discrimination of the otherwise overlapping individual data points. The solid line represents the mean bias, and the dashed lines represent the 95% limits of agreement [mean (1.96 SD)].

for each author. There are arguments in favour of weighted allocation or fractional counting for papers with multiple authors.[22] However, there is no clear consensus on the best approach, the calculation is much more involved and less intuitive to non-specialists, and is not consistently provided by online data sources. Previous authors have suggested that there is little material difference, particularly in the case within a single speciality where the number of authors per paper is relatively constant. The correct method of attribution of past publications when researchers have moved is not clear. The UK anaesthesia 'research community' is relatively static, so in practice, it is a small issue in terms of individuals. However, individuals who do move might be those appointed to senior positions based upon their past record, which would clearly generate 'better' bibliometrics for those units. This effect is lessened, but not avoided, in the time-restricted data set as work from more than 6 yr ago is not counted. Whether this is an issue depends to an extent on the purpose for which bibliometric data are used. If they are taken to represent the 'strength' of a department or as indices of past performance of individuals within that department, then it is probably appropriate to include these data. They do not reflect the current work of a department, because all these indices are retrospective.

There is overlap between full professors and non-professors for all the bibliometric indices reported, although the median values are higher for all indices for professors. This analysis does not provide any information about the index values at which promotions were made, so possession of a chair could simply be a reflection of academic longevity. However, the greater indices of professors in the more recent 2004–8 period suggest that they at least have their names on relatively more high-quality papers.

The largest, and undoubtedly well respected, departments form a 'top flight' of anaesthetic research publications, which mirrors the level of funding reported by Pandit.[1] More than 50% of papers in this data set are from these four units, and more than 50% of citations are to their papers. This should not detract from the impact of research from other units, since individual papers from other units were also highly cited.

There is considerable controversy about the use of bibliometric indices since they can never completely capture the overall impact of an individual or departmental contribution,[14 23 24] and they are clearly open to a degree of manipulation.[25] Citation does not, of itself, indicate quality. A Web of Science® search for the now-discredited anaesthesia researcher Scott Reuben still ascribes him an *h*-index of 11 from 23 publications. Although some organizations have eschewed their use, some universities in the UK reportedly use some form of bibliometric assessment as part of the promotions process. As can be seen in Table 3, there is some correlation between the rankings for each of the indices in this sample. However, different indices favour different departments. It is not the purpose of this paper to explore the relative merits of each index. The data do highlight the problem of concentrating solely on a single summary value. Department R has published relatively few papers, but a few are very highly cited, leading to a high average citation rate and high *g*-index. Department F on the other hand is in the upper quartile for papers published, but has a relatively low citation rate, and hence lower *h*- and *g*-indices.

The various indices seem to be moderately speciality-specific, so it is important for academic anaesthesia as a research speciality to have some form of benchmark to inform discussions with funding organizations and employers. Despite previous pessimistic reports,[1 2] it would appear that UK anaesthesia research is not significantly different from pan-European clinical medical research output. Anaesthesia in Europe is not suggested to have any less impact (in terms of citations) than other specialities,[3] and these UK-specific data support this. Similar studies from Canada, with slight methodological differences, suggest that the bibliometric distribution of UK academic anaesthetists is similar to our Canadian colleagues.[4 5] The data in this paper are unlikely to have been affected significantly by the reforms

suggested by the Pandit report[1] due to the speed with which citations build up for any individual, and since a significant focus of that report was on strengthening academic training. Follow-up work is needed to assess whether these reforms will have positive benefits. Although the *per paper* impact of anaesthesia research is comparable with other specialities,[3] most departments are producing relatively few papers. Funding bodies and universities are already pushing for larger collaborative departments, and these data could be used to argue that case. Departments (and individuals) with a larger publishing output can be expected to have a higher citation impact as shown by the MII.

If units or individuals are assessed against others by employers or funding agencies, such as occurs with the UK Research Assessment Exercise/Research Excellence Framework (REF), we hope these data will help to inform these decisions. It is well recognized that different disciplines have different citation and publication cultures. We have not attempted to 'normalize' anaesthetic data to other specialities, so it will be for others to decide whether to view anaesthesia researchers within their peer group, as presented here, or in comparison with fields with different publication and citation data. Although attempts have been made to do this,[26] this approach still includes all of clinical medicine as a single category. These data are, to our knowledge, the only description of UK anaesthesia research output at individual and departmental levels, so would provide at least a reference point for research assessments.

In conclusion, this is the first description of the bibliometric profile of UK anaesthesia research. Although there is a wide variation between departments, the average profile for UK anaesthesia research does not seem to be particularly different from our European or Canadian counterparts. Individuals or departments will be able to benchmark these data if necessary, but individuals or departments reporting citation indices should clearly report the citation databases used, as they are not interchangeable. A follow-up study in 2 yr time is planned to map any changes over time.

Conflict of interest

I.K.M. has received honoraria from Schering-Plough in the past 5 yr. He is a member of the editorial board of the *British Journal of Anaesthesia*. J.G.H. is an editor and member of the editorial board of the *British Journal of Anaesthesia*.

Funding

No external funding was used for this study.

References

1 Pandit JJ. *A National Strategy for Academic Anaesthesia*. London: Royal College of Anaesthetists, 2005

2 Feneck RO, Natarajan N, Sebastian R, Naughton C. Decline in research publications from the United Kingdom in anaesthesia journals from 1997 to 2006. *Anaesthesia* 2008; **63**: 270–5

3 Sypsa V, Hatzakis A. Assessing the impact of biomedical research in academic institutions of disparate sizes. *BMC Med Res Method* 2009; **9**: 33

4 Bould MD, Boet S, Sharma B, Shin E, Barrowman NJ, Grantcharov T. h-indices in a university department of anaesthesia: an evaluation of their feasibility, reliability, and validity as an assessment of academic performance. *Br J Anaesth* 2011; **106**: 325–30

5 O'Leary JD, Crawford MW. Bibliographic characteristics of the research output of pediatric anesthesiologists in Canada. *Can J Anaesth* 2010; **57**: 573–7

6 Benway BM, Kalidas P, Cabello JM, Bhayani SB. Does citation analysis reveal association between *h*-index and academic rank in urology? *Urology* 2009; **74**: 30–3

7 Choi M, Fuller CD, Thomas CR Jr. Estimation of citation-based scholarly activity among radiation oncology faculty at domestic residency-training institutions: 1996–2007. *Int J Radiat Oncol Biol Phys* 2009; **74**: 172–8

8 Lee J, Kraus KL, Couldwell WT. Use of the *h* index in neurosurgery. *J Neurosurg* 2009; **111**: 387–92

9 Available from http://apps.isiknowledge.com (accessed October 22, 2010)

10 Hirsch JE. An index to quantify an individual's scientific research output. *Proc Natl Acad Sci USA* 2005; **102**: 16569–72

11 Available from http://scholarometer.indiana.edu/ (accessed October 22, 2010)

12 Available from http://scholar.google.co.uk/ (accessed October 22, 2010)

13 Egghe L. Theory and practise of the *g*-index. *Scientometrics* 2006; **69**: 131–52

14 Molinari JF, Molinari A. A new methodology for ranking scientific institutions. *Scientometrics* 2008; **75**: 163–74

15 Adler NJ, Harzing A-W. When knowledge wins: transcending the sense and nonsense of academic rankings. *Acad Manage Learn Educ* 2009; **8**: 72–95

16 Available from http://www.scopus.com (accessed October 22, 2010)

17 Available from http://www.harzing.com/pop.htm (accessed October 22, 2010)

18 Kulkarni A, Aziz B, Shams I, Busse J. Comparisons of citations in Web of Science, Scopus, and Google Scholar for articles published in general medical journals. *J Am Med Assoc* 2009; **302**: 1092

19 Falagas M, Pitsouni E, Malietzis G, Pappas G. Comparison of PubMed, Scopus, Web of Science, and Google Scholar: strengths and weaknesses. *FASEB J* 2008; **22**: 338

20 Jacsó P. Deflated, inflated and phantom citation counts. *Online Inform Rev* 2006; **30**: 297–309

21 Available from http://www.harzing.com/pop_gs.htm (accessed October 22, 2010)

22 Alonso S, Cabrerizo FJ, Herrera-Viedma E, Herrera F. *h*-Index: a review focused in its variants, computation and standardization for different scientific fields. *J Informetrics* 2009; **3**: 273–89

23 Kotov NA. Fraud, the *h*-index, and Pasternak. *ACS Nano* 2010; **4**: 585–6

24 Pandit JJ. Anaesthetic research in the United Kingdom: publishing or perishing? *Anaesthesia* 2008; **63**: 225–7

25 Williamson JR. My *h*-index turns 40: my midlife crisis of impact. *ACS Chem Biol* 2009; **4**: 311–3

26 Podlubny I, Kassayova K. Towards a better list of citation superstars: compiling a multidisciplinary list of highly cited researchers. *Res Eval* 2006; **15**: 154–62