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Current Comments®

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Science Watch Takes the Pulse of British Medicine and Other Fields

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I've often attended the annual meeting of the British Association for the Advancement of Science, and the Institute for Scientific Information® (ISI®) has for many years been represented at the meeting in some fashion, whether as a sponsor of sessions or in demonstrating ISI's range of products and services.

This year ISI was represented by David A. Pendlebury, analyst in the Research Department and editor of our scientometric newsletter *Science Watch*®.[1,2] Robert Kimberley and Elizabeth Hunt, from our newly relocated offices on the campus of Brunel University, Uxbridge, England, were also present to demonstrate the CD-ROM versions of our database. David spoke at a session, sponsored by ISI, that focused on the current state of British science. His "trip report" and an article that appeared simultaneously in *Science Watch*[3] appear here.

David's talk at the British Association meeting included a discussion of the uses and limitations of citation data, a subject featured in a recent issue of *Current Contents*®.[4] Often I marvel at how scientists, who undergo years of study and training in their chosen fields, embark on citation studies without ever thinking to educate themselves first on the proper methods of citation analysis and the previous literature of the field. Citation studies that are poorly executed only undermine confidence in these quantitative approaches to evaluation. While I have a strong interest in seeing citation analysis more widely exploited, it is painful whenever I see another shoddy article or report that is ill conceived or that pushes the data beyond their limits to arrive at unwarranted or indefensible conclusions.

For those who have recently "discovered" citation analysis, I encourage you to review the relevant and extensive literature. For those who think they know what citation analysis is all about, I would offer the same advice. David's article and the recent essay in *Current Contents* are good places to start.

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Can We Measure the UK's Research Success? A Summary

by David A. Pendlebury
Analyst, Research Department, and Editor, *Science Watch*

In August I traveled to Southampton, England, which this year played host to the 153rd annual meeting of the British Association for the Advancement of Science.

The BA meeting, as it is known, aspires to be more than a gathering of professionals who assemble into small, tight circles to murmur among themselves over narrow, impossibly inaccessible subjects. Rather, the BA organizers strive to design a program of broad appeal, one that will pique the interest of the general public as well as that of scientists. This effort at outreach is aided and abetted by the national and international science media—reporters from newspapers, television, and radio, who show up in force. Since it is held at the end of summer, a relatively slow time in the news business, the BA meeting generally receives excellent media coverage.[1]

The University of Southampton was most hospitable, the program rich with distinguished speakers who presented their research clearly and in easily understood terms, and the weather cooperated most of the week. I recall a soft breeze that seemed to constantly glide through the trees. It reminded me of Homer's description of Phaeacia....

That so many scientists would take time out of their busy schedules to attend this conference and that they would take the trouble to try to explain their research to nonspecialists came as something of a surprise to me: I find such willingness to communicate with the public all too rare among US scientists. Is science too much a business in the US, I wondered? I received the distinct impression that many British scientists—at least those in Southampton—felt that communicating their results to the public was part of their calling.

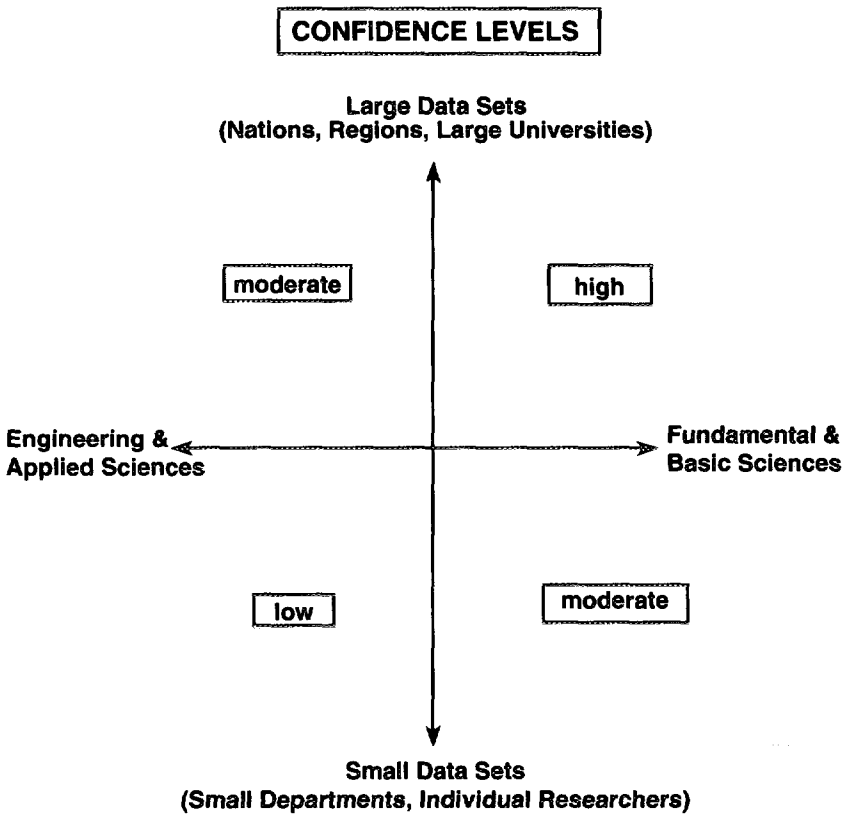
Having thus read the mood of the meeting, I was feeling a bit sheepish. I had been invited to participate in a session, organized by the General Section of the BA, entitled "Can We Measure the UK's Research Success?" I was going to ask, "What success?" But more on that later.

The session's speakers included myself, Ben Martin of the Science Policy Research Unit at Sussex University, Brighton, and Terence Kealey of the Department of Clinical Biochemistry of Cambridge University. In various journals and through other channels as well, Martin and Kealey have carried out a debate of several years' duration concerning the purported decline of British science and its implications. Martin, an expert in bibliometrics and other aspects of research evaluation both quantitative and qualitative, takes the view that British science has experienced a relative decline in its research strength during the last decade; much of his evidence, in fact, rests on publication and citation data from ISI's *Science Citation Index®*. Kealey, on the other hand, hotly contests that view. A skilled debater, Kealey sees the evidence that Martin and others marshal in proof of Britain's relative decline as either ill conceived and without real merit, hyperbolic and unnecessarily pessimistic, "inevitable" in its nature and therefore not worrisome, or, actually, as evidence of health.

It has been one lively debate. A recent article in *New Scientist* by Martin and a letter in response by Kealey represent only the latest volleys in this explosive exchange.[2,3] (I am happy to attest, however, that in Southampton I saw both of them sitting at the same table, enjoying lunch, and speaking to one another in civil, even congenial, tones.)

I was invited to speak at the session for three reasons: first, ISI sponsored the session; second, ISI's Research Department has during the past few years undertaken its own assessment of the health of British science and has published these results in several issues of *Science Watch*;[4,5] and, third, as a noncombatant in this long-stand-

ACCEPTING CITATION DATA AT FACE VALUE



ing dispute between Martin and Kealey, and as one knowledgeable regarding the data Martin advanced but without a personal stake in its interpretation, I was to be something of a referee, or so I thought.

I was feeling a bit sheepish, as I mentioned, because I came to the meeting armed with new readings based on the very latest publication and citation statistics (those representing research published and cited during the years 1987-1991). I had some bad news to report, especially about the health of clinical medicine in the UK. So to this happy "Science Festival 92," a meeting optimistically, even nobly conceived, an event meant to highlight for the public what the best of British brains had wrought, I saw myself as something of a wet blanket. What was worse, I knew the press would eat it up: Bad news sells better than good. And the press didn't surprise me.

But I took my presumed role as impartial referee seriously. So before launching into a litany of lamentable statistics on the current state of British science, I took some time to outline the reasonable uses and possible misuses of publication and citation data. Somewhat teasingly, I called my presentation "The Charms of Citation Analysis: Genuine or Merely Meretricious?"

It's true. Quantitative measures of research performance, such as citations, are

captivating, even seductive. The hard numbers give the appearance of objectivity and, therefore, of authority. And, I hasten to add, these statistics *are* objective and authoritative—to a degree. But citations also represent subjective judgments since they reflect the social structures and inherent biases of the people who do the citing, that is, the members of the scientific community itself. Moreover, some numbers are harder than others, and a great deal depends on how statistics are generated, which, in turn, depends on what questions have been asked in the first place. Finally, as everyone knows, two people can look at the same statistics and, with sincerity, arrive at completely different interpretations. Martin and Kealey, whom I both regard as sincere, illustrate this phenomenon.

After describing the nature of citations and what they seem to measure, and after pooh-poohing the familiar objections to citation analysis (negative citations; self-citations; citation circles or cooperatives—all of these are either overestimated in their significance or are handled in specific instances by special methods[6]), I made the point that the more measures one collects the better picture one obtains. A thoroughgoing evaluation would bristle with multiple measures: mean citations per paper; total citations; total papers; papers per researcher; whole and fractional publication counts; percentages of cited and uncited papers; baselines for comparisons; percentages of hot or highly cited papers; measures of means vs. medians; tests of skewness of citation distributions; time trends; citation flows; breakdowns by field or groups; coauthorship patterns and collaboration studies; paper-by-paper inventories, etc.

I also emphasized that qualitative techniques of evaluation, such as peer review, and quantitative techniques, such as citation analysis, should not be seen as competing but rather as complementary methods: Both should be pursued simultaneously in any assessment exercise.

A diagram I used, which appears here, provides a thumbnail sketch of how one should approach citation data—which data sets can be taken at face value and which can't. Generally speaking, the larger the data set and the more basic the field being examined, the more reliable the results, even when only summary citation statistics are presented. The smaller the data set and the more applied the area under review, the less reliable are the citation data at face value.

After offering this advice, I turned to the latest citation data on British science. These data were featured, in summary form, in the August 1992 issue of *Science Watch*.[7] That article is reprinted here.

And now for a confession.

After having assigned British medicine a failing grade, having pronounced its condition "critical," and having done so before a national audience of scientists and media representatives, I found myself almost instantly in need of medical treatment and turned to the local clinic of the National Health Service. There I received immediate attention and excellent care.

So much for scientometrics!

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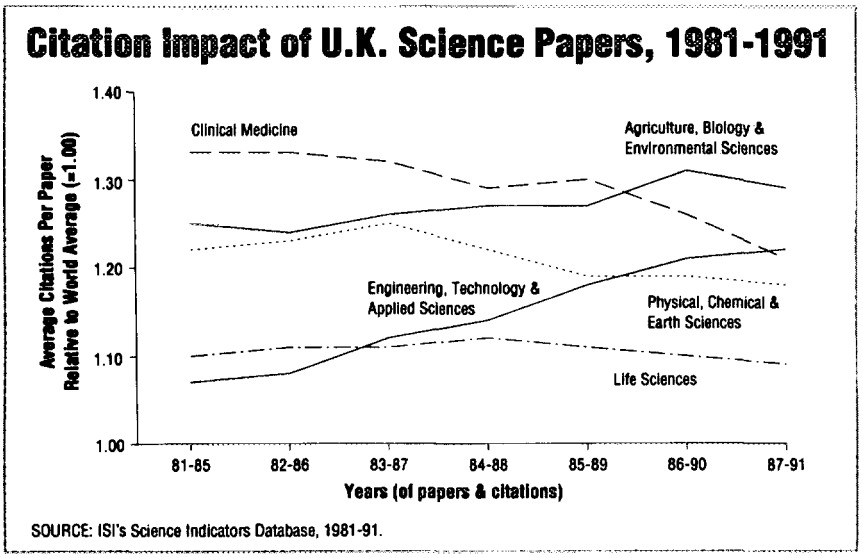
Critical Condition: Clinical Research in UK Fading Fast



If clinical research were represented by a ward of patients in hospital, the British fellow would have his doctors worried. An alarming decline in his vital signs has been noted and suggests an urgent need for immediate and aggressive therapy.

This diagnosis springs from *Science Watch*'s latest effort to assess the health of British science, a topic treated in these pages previously (see *Science Watch*, 2[1]:1-2, January/February 1991; 2[2]:8, March 1991). The present examination includes newly available citation data for the period 1987-91.

The newest statistics suggest that the decline in citation impact (average citations per paper) witnessed in the past for British science may be starting to level off. For the period 1987-91, U.K. papers representing all science fields earned 16% more citations than the world average. That is identical to the reading for 1986-90, so the decline in relative citation impact would appear to have halted—at least for the moment. Both readings, however, are well below the figure for 1981-85, when UK papers collected 23% more citations than the world average.

That the past decade has been a period of weakness for British science is also supported by output, world share, and citedness statistics for 1981 and for 1991. First, U.K. science papers increased in number 34.8%, comparing 1981 to 1991, while the world's output increased 41.7%. Second, British science held a 9.1% share of the world's papers in 1981, but only an 8.6% share in 1991. Third, the percentage of U.K. papers cited within a five-year period fell .2% during the decade, whereas citedness actually rose 1.5% for the world.

When the publication and citation data are disaggregated into five broad areas of research, further details emerge, and especially disturbing ones for clinical medicine.

U.K. Standings in Science by Subfield, 1987-91: Citation Impact of U.K. Papers Relative to World

Rank	Subfield	UK Papers 1987	UK Impact	World Impact	UK: World
1	Geology/Petrology/Mining	471	.54	.27	+100%
2	Surgery	2,240	2.23	1.17	+91%
3	Agriculture/Agronomy	1,419	1.38	.76	+82%
4	Veterinary Medicine	2,075	1.81	1.02	+77%
5	Metallurgy	899	.88	.55	+60%
6	Food Sciences/Nutrition	1,318	2.10	1.33	+58%
7	Instrumentation/Control	1,318	1.41	.89	+58%
8	Pharmacology	6,025	4.60	3.00	+53%
9	Entomology/Pest Control	1,177	1.92	1.26	+52%
10	Analytical, Inorganic Chemistry	3,720	3.35	2.28	+47%
11	General Chemistry	3,022	3.47	2.37	+46%
12	Animal Sciences	2,714	2.27	1.55	+46%
13	Neurology	1,326	4.35	3.00	+45%
14	General Clinical Medicine	11,346	3.85	2.68	+44%
15	Orthopedics/Traumatology	2,684	1.86	1.33	+40%
16	Optics/Acoustics	2,041	2.63	1.89	+39%
17	Mechanical Engineering	2,331	1.24	.90	+38%
18	Botany	3,792	2.90	2.12	+37%
19	Mathematics	3,093	1.46	1.07	+36%
20	Multidisciplinary	3,895	13.94	10.71	+30%
21	Electrical Engineering	3,294	1.66	1.29	+29%
22	Reproductive Medicine	1,982	2.92	2.27	+29%
23	Agricultural Chemistry	873	2.73	2.18	+25%
24	Astronomy/Astrophysics	2,800	5.49	4.44	+24%
25	Medical Technology	2,567	4.70	3.78	+24%
26	Pediatrics	1,808	2.45	1.98	+24%
27	Nuclear Engineering	816	1.41	1.14	+24%
28	Molecular Biology & Genetics	3,636	9.31	7.75	+20%
29	Physiology	2,041	5.40	4.54	+19%
30	Physics	6,576	4.88	4.15	+18%

As the [time-series] chart shows, the decline in the impact of U.K. clinical studies, seen previously, has actually accelerated. While it is true that clinical reports by British physician-scientists are still earning about 21% more citations than the world average, this is down sharply from 33% more than the world average in 1981-85 and from 30% more than the world as recently as 1985-89. Clearly, 1986 to 1991 were not good years for clinical research in the United Kingdom. Among the five areas surveyed, only in clinical medicine did the United Kingdom surpass the world in output from 1981 to 1991 (+44.3% vs. +38.3%) and increase its world share over the same period (from 11.6% to 12.1%). At first glance, these figures would seem heartening; however, the accompanying decline in citation impact suggests that, while more was produced, much of that more was marginal.

The weakness in clinical studies is also evident in the table above, which presents U.K. publication and citation data for 1987-91, this time sorted by subfield. The clinical specialties of gastroenterology, oncology, urology, dentistry, hematology, radiology, and social and environmental medicine were all underperformers for 1987-91, when compared to the world average. Not all clinical areas were weak, of course: British surgery papers scored 91% more citations than the world average, and neurology, orthopedics, reproductive medicine, medical technology, and pediatrics

U.K. Standings in Science by Subfield, 1987-91: Citation Impact of U.K. Papers Relative to World (continued)

Rank	Subfield	UK Papers 1987	UK Impact	World Impact	UK: World
31	Biochemistry/Biophysics	8,188	6.84	5.83	+17%
32	Dermatology	1,384	2.46	2.10	+17%
33	Experimental Biology & Medicine	12,383	4.64	4.11	+13%
34	Neurosciences & Behavior	7,686	5.15	4.61	+12%
35	Environmental Sciences/Ecology	2,895	2.16	1.94	+11%
36	Cardiology/Pulmonary Medicine	2,888	3.84	3.46	+11%
37	Aquatic Sciences	2,009	2.41	2.17	+11%
38	Organic Chemistry	4,506	2.93	2.66	+10%
39	Chemical Engineering	1,567	1.10	1.00	+10%
40	Clinical Psychology/Psychiatry	1,676	3.59	3.29	+9%
41	Anesthesia/Intensive Care	1,637	2.51	2.33	+8%
42	Microbiology/Cell Biology	6,808	6.56	6.12	+7%
43	Materials Science	2,877	1.19	1.12	+6%
44	Earth Sciences	4,085	2.89	2.74	+5%
45	Biotechnology	1,008	2.13	2.13	—
46	Physical Chemistry/Chemical Physics	5,552	3.01	3.02	—
47	Gastroenterology	3,191	3.85	3.90	-1%
48	Immunology	3,779	6.32	6.48	-2%
49	Oncology	455	3.37	3.44	-2%
50	Urology	1,444	2.07	2.13	-3%
51	General Biology	2,315	2.48	2.62	-5%
52	Dentistry	1,554	1.33	1.40	-5%
53	Computer Sciences	2,505	.99	1.05	-6%
54	Applied Physics/Condensed Matter	7,016	2.78	3.07	-9%
55	Hematology	1,032	4.76	5.31	-10%
56	Otolaryngology/Ophthalmology	2,290	1.18	1.34	-12%
57	Environmental/Civil Engineering	1,807	.92	1.05	-12%
58	Radiology	1,990	2.47	2.90	-15%
59	Social/Environmental Medicine	1,064	2.03	2.56	-21%
60	Aerospace Engineering	243	.35	.45	-22%

studies all collected more than 20% of the world's average citations per paper. However, every clinical specialty but four lost ground in relative terms from 1981-85 to 1987-91. These four are medical technology and surgery, which both advanced 15% in relative citation impact, and clinical psychology/psychiatry and dentistry, which increased 5% and 2%, respectively. On the down side, oncology papers dropped 37% in relative terms from 1981-85 to 1987-91, neurology and gastroenterology declined 25%, radiology slid 18%, and hematology fell 16%. All other clinical specialties registered declines of between 11% and 1%.

The performance of the United Kingdom in the other four broad areas of research was somewhat mixed. Engineering, technology, and applied sciences papers, which have improved greatly in relative citation impact since 1981, added 1% in 1987-91. Studies in agricultural biology and environmental sciences slipped 2% in the most recent period, but the trend in this sector has been mostly upward since the early 1980s. Basic biological research has proven itself the steadiest performer for British science. The latest reading is just 1% below that of 1986-90. The physical, chemical, and earth sciences also fell 1% below the reading for the previous five-year period, but the weakening trend in this sector seems now to have slowed, thanks in part to an upturn in the impact of astronomy papers.