

5 MEASURING IMPACTS

One of the major benefits of bibliometric research is the fact that it techniques allowing to assess the quality of scholarly endeavour. The concept of quality can be seen as highly subjective. But quantitative methods within bibliometrics can help assess the impact that a paper may have on the discipline – and thus provide a certain measure of the paper’s quality. One way of doing so is to measure the influence of the journal which publishes the paper – the journal’s impact factor.

It is also important to attempt to measure the impact of research outside the narrow scientific community. One of the areas where biomedical research can impact significantly is clinical practice. As an example we analysed two types of clinical guidelines developed in the UK and how they cite biomedical papers.

5.1 Journal potential impact category (PIC)

The overall potential impact of a journal can be measured in several ways. In this study we calculate it as the mean number of citations received by papers published in the journal over the period of their publication year and the four following years (designated C_{0-4}).

This is not the conventional impact factor (IF) published annually by the Institute for Scientific Information¹, but it has two notable advantages:

1. It covers a longer time period, which normally includes the peak year for citations to a research paper

¹ For definition and usage see: <http://www.isinet.com/essays/journalcitationreports/7.html/> (visited on 9 December 2003)

2. The C_{0-4} journal citation score can then be directly compared with the citations received by the paper.

Once a mean citation count for the journal is calculated, the citations for any group of papers in the journal are distributed around the mean – making it possible to identify which papers are of higher or lower impact.

A higher impact group of papers will have a higher average citation score and those of lower impact will have a lower average.

Mean impact factors change with time. Highly-cited, well-recognised journals tend to expand – their PIC will rise – while those that are less-cited may contract, merge or even close.

For practical purposes, we group journals into four different potential impact categories (PICs), according to C_{0-4} value, with the highest quality papers in PIC 4, and the lowest in PIC 1. These, including the critical C_{0-4} values, are shown in Table 5.1.1. Normally, we expect about 10% of journals to fall into the top (PIC 4) category, 20% - into PIC3, 30% - PIC2 category and 40% - into the lowest-impact (PIC1) category. UK biomedical research fits well within this pattern.

Table 5.1.1 Classification of journals by potential impact category (PIC)

PIC	C_{0-4} values	Examples	% UK*
1	Below 6	<i>Age & Aging, Brit. Dent J, J Epidem & Comm Hlth</i>	39.6
2	From 6 to 11	<i>Int Arch Allergy Immunol, Anesth Analg, Neurosci Lett, J Urol</i>	29.8
3	From 11 to 20	<i>FEBS Lett, J Invest Dermatol, Eur J Biochem, Biochem J</i>	20.8
4	20 and above	<i>J Biol Chem, Blood, J Immunol, Proc Nat Acad Sci, Lancet</i>	9.8

*based on the analysis of all UK ROD papers between 1989 and 2000.

The impact of UK biomedical papers appears to have risen over this study's 12-year period. The proportion of ROD papers that fall into PIC4, the highest category, has more than doubled, rising from 5.9% to 13.2% (fig 5.1.1). The

percentage of papers in the PIC3 and PIC2 categories also rose causing a significant drop (above 11%) in the share of the papers in the lowest impact category, PIC1.

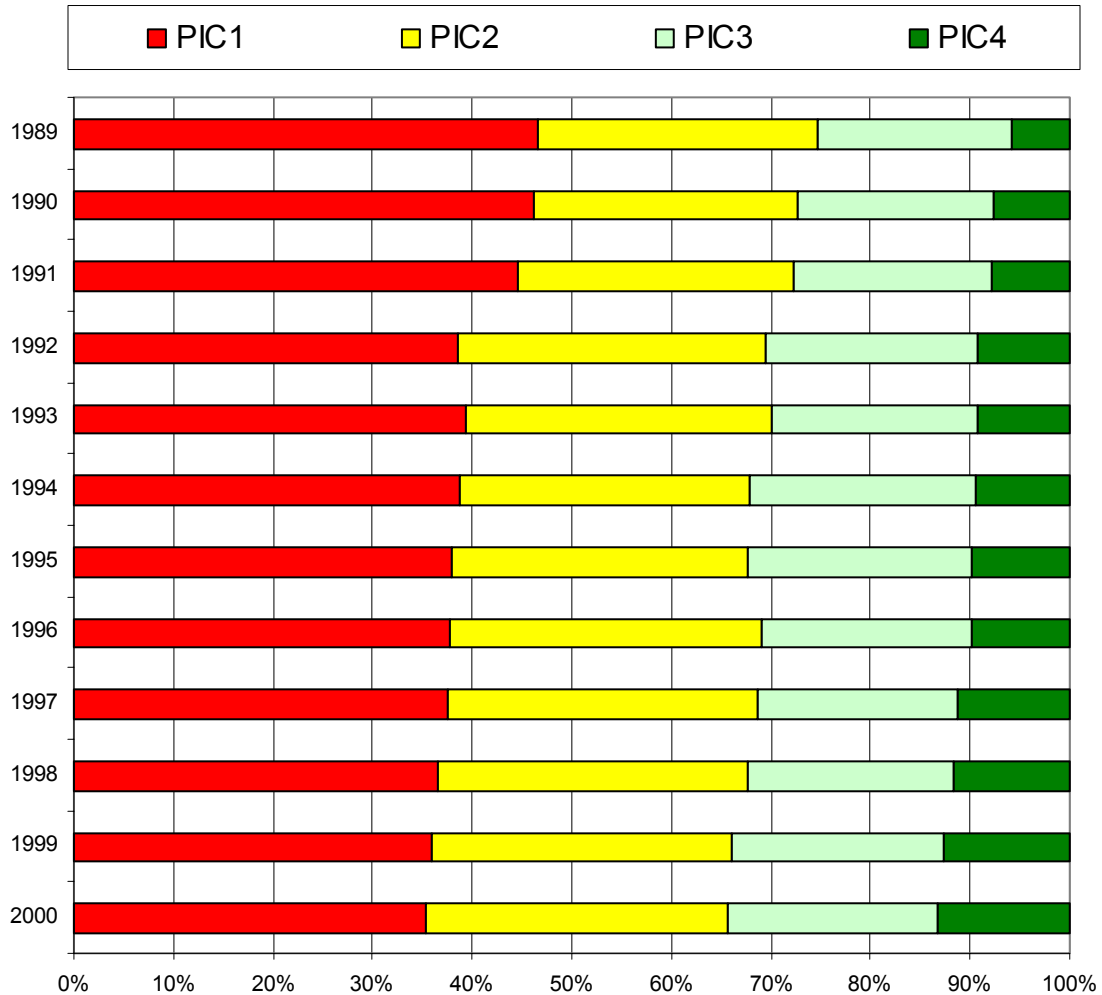


Figure 5.1.1 Distribution of potential impact category (PIC) of all UK ROD papers, 1989-2000.

It is not immediately clear if these changes are a result of an actual improved quality in UK biomedical papers, or if they are due to other factors.

The effect of research level on potential impact categories

For example, as we showed in chapter 3 (table 3.4.1), the output of UK biomedical researchers has shifted from applied clinical (RL2 and RL3) towards basic research (RL4). Basic research is generally more highly cited, meaning that basic journals tend to have a higher PIC score than clinical journals (figure 5.1.2 shows the correlation between research level – with RL4 as the most basic research level and RL1 the most clinical – and PIC of ROD papers). This would suggest the rise in PIC is not due to improved output impact.

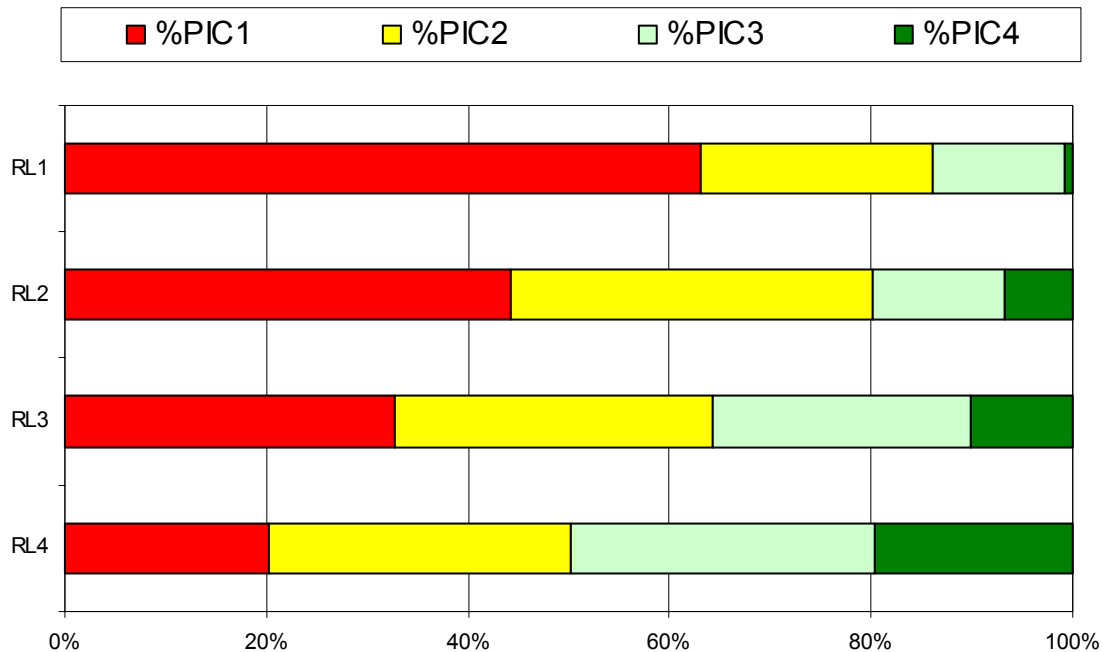


Figure 5.1.2 Correlation between research level (RL) and potential impact category (PIC) for all ROD UK papers 1989-2000.

The effect of the number of funding bodies on PIC

There seems to be a strong positive correlation between numbers of funding bodies that provide support for a paper and its PIC value (figure 5.1.3). Papers with multiple funding sources are more likely to be published in higher-impact

journals. This may be because a research proposal has to go through a rigorous assessment every time funding is sought – thus sharpening its focus and raising its impact.

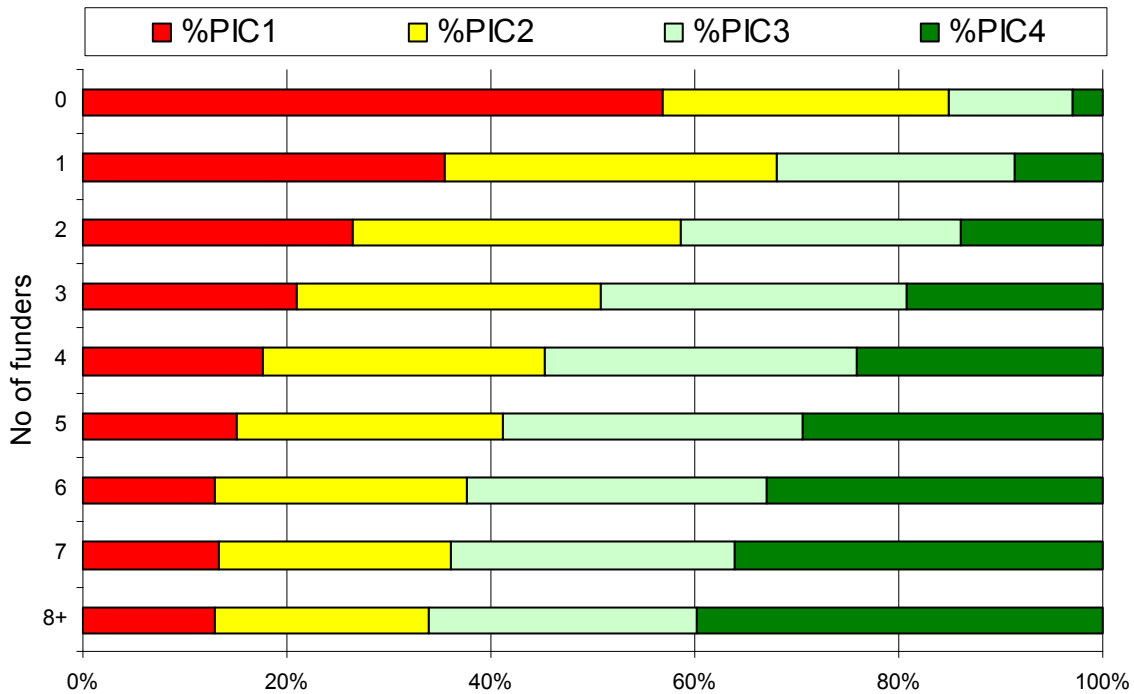


Figure 5.1.3 Correlation between numbers of funders acknowledged in a paper and its potential impact category (PIC) for ROD UK papers 1989-2000.

Positive correlation between numbers of authors and numbers of funding acknowledgements per paper and its PIC value was also noted, while, interestingly, inter-institutional collaboration had a negative impact. The following formula (drawn from regression analysis of PIC) and figure 5.3.1 illustrate this:

$$PIC = 0.056A + 0.000A^2 - 0.055D + 0.005D^2 + 0.104F - .009F^2$$

where A = Authors; D = Addresses and F = Funding acknowledgements

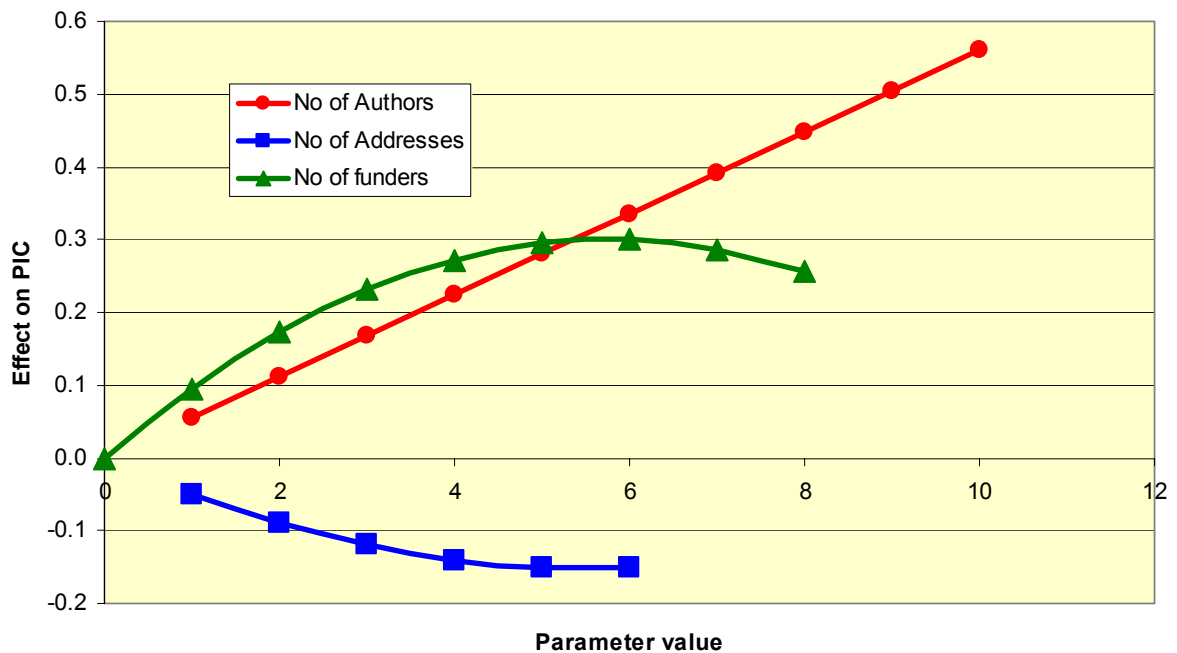


Figure 5.1.4. Effect of funding, authorship and addresses on the PIC of UK biomedical journals.

5.2 Analysis of sub-fields

Genetics and multiple sclerosis are the two UK biomedical sub-fields with the highest PIC values (figure 5.2.1). Over a fifth of all papers in these two fields were published in the highest PIC journals (PIC4). Neuroscience, diabetes and AIDS research are also high impact – more than 60% of papers in these sub-fields were published in journals from PIC 3 or 4.

Tropical veterinary medicine, veterinary medicine and dentistry papers tend to be published in low impact journals (PIC1), which may reflect their predominantly clinical nature or limited/localised scope. For instance, veterinary medicine research may be often of interest only within a limited geographic region. The changes in PIC values over time are shown for all 32 subfields in the Appendix (Figures: A5.2.1a, A5.2.1b, A5.2.1c and A5.2.1d)

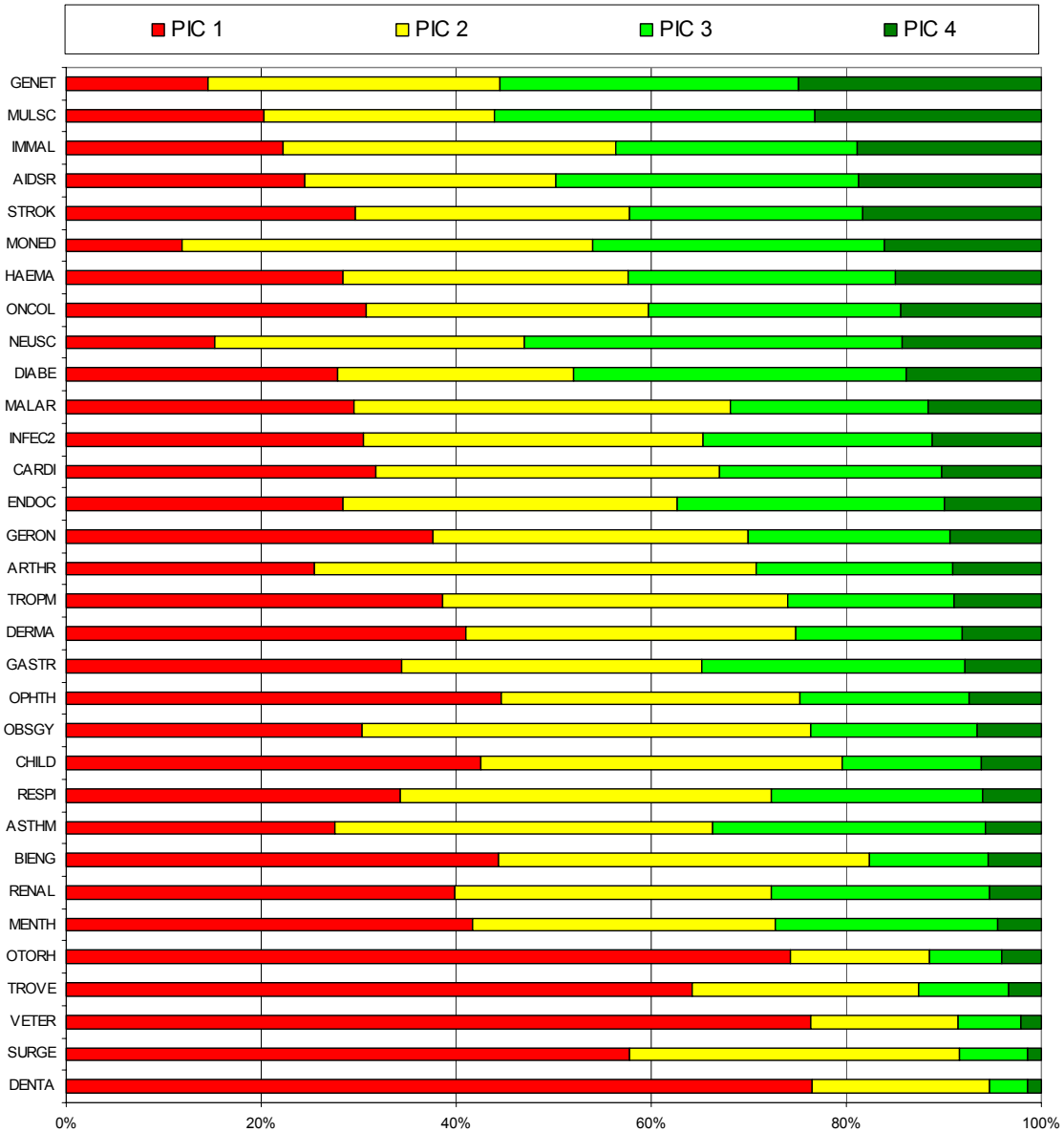


Fig. 5.2.1 Distribution by potential impact category (PIC) of UK papers in 32 subfields, 1989-2000.

As noted earlier, basic research journals tend to have higher citation rates than clinical journals. Thus it is no coincidence that the sub-fields with the most basic research (genetics, multiple sclerosis and neuroscience) are those with papers in the highest impact journals. The relationship, for ROD papers, between the

mean RL and mean PIC is shown in figure 5.2.2 and demonstrates a correlation between the two. After discarding outlying VETER and TROVE, $r^2 = 0.5516$.

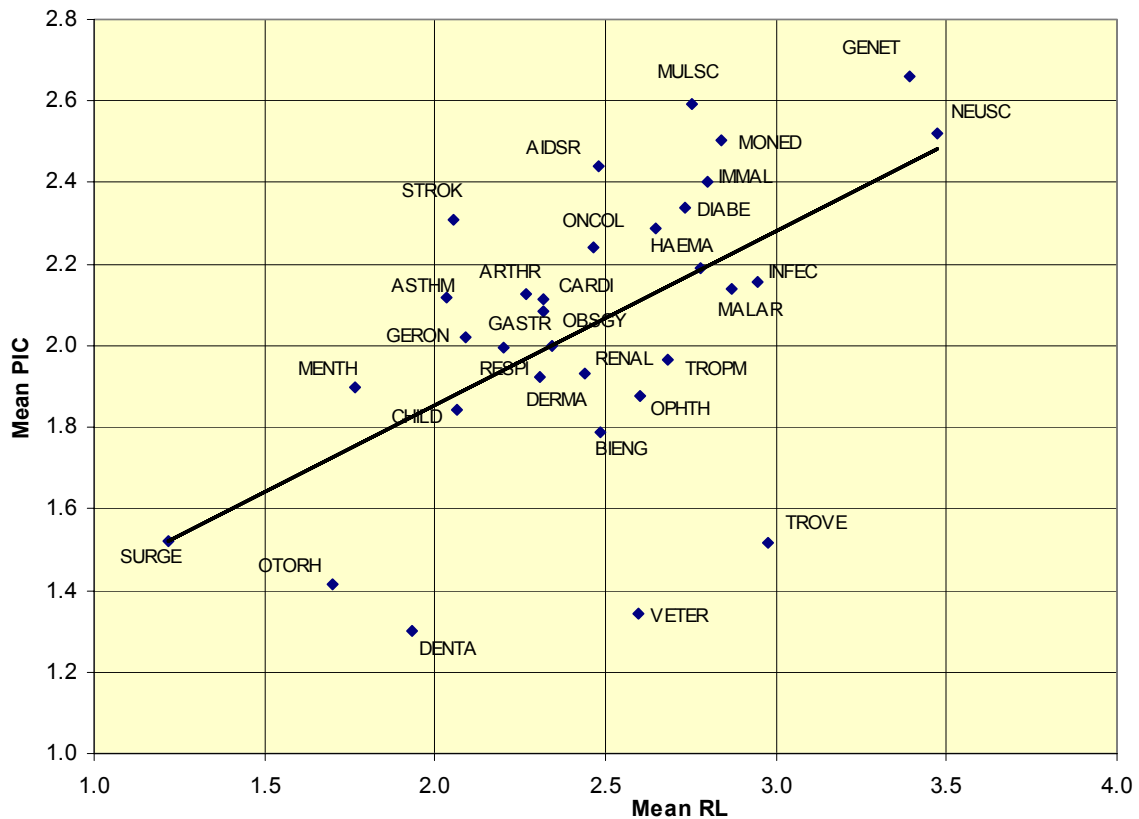


Figure 5.2.2 Mean potential impact category PIC (1 = low, 4 = high) plotted against mean research level RL (1 = clinical, 4 = basic) for UK ROD papers in 32 subfields 1989-2000.

5.3 Citations on clinical guidelines (NICE and SIGN)

One of the ways of assessing the impact of biomedical research outside a narrow scientific/research community is to analyse the usage of biomedical research on clinical guidelines. These guidelines are created in the UK (and other countries) in order to provide clear information to physicians, healthcare administrators and healthcare consumers on medical treatments which were proved to be effective.

These guidelines normally analyse and evaluate medical research on selected medical topics.

There are many different sets of clinical guidelines in the UK. However, they do not all enjoy the same degree of dissemination or use. For example, until fairly recently, only guidelines endorsed by the NHS Appraisal Centre for Clinical Guidelines at St George's Hospital Medical School were viewed as superior (the Centre's role was to advise the NHS on the quality of guidelines).

Grant *et al.*² studied the references to biomedical papers in 15 different sets of these guidelines.

- 25% of all citations were to British research (this is 2.5 times more than expected, as the UK produces 10% of the world biomedical literature);
- Most of the references were to papers in clinical rather than basic journals
- The median time lag between publication of papers and citation in guidelines was eight years.

Since then, the National Institute for Clinical Excellence (NICE) has begun to develop guidelines for the NHS. To date, they have published 47 sets of guidelines, supported by 64 Health Technology Appraisals (TAs).

Most of the TAs were prepared by specialist units at English universities, notably York, Birmingham and Sheffield. Many of the guidelines deal with the efficacy of pharmaceutical drugs for particular disorders and diseases. Some have proved contentious, both with pharmaceutical companies and with patient groups.³

In Scotland, the Scottish Intercollegiate Guidelines Network (SIGN) has published 61 clinical guidelines since 1993. These are recommended for use in

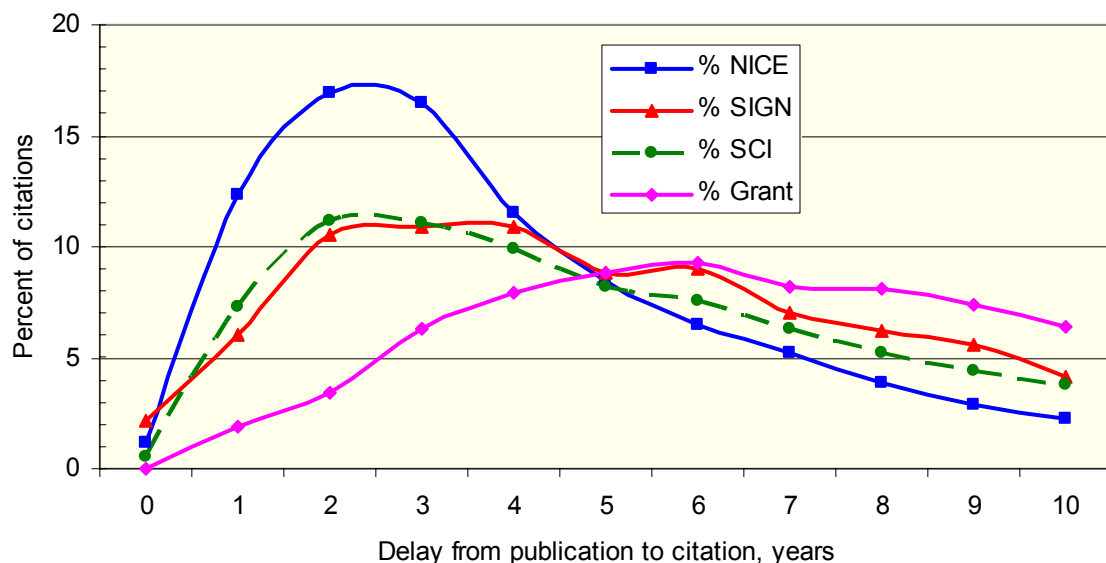
² Grant, J. et al. (2000) "Evaluating 'payback' on biomedical research from papers cited in clinical guidelines: applied bibliometric study." *British Medical Journal*, v. 320, 22 April, pp. 1107-11.

³ Kmietowicz, Z. (2000) "NICE's appraisal procedures attacked." *British Medical Journal*, v. 321, 21 October, p. 980; Anon. (1999) "A nasty start for NICE." *The Lancet*, v. 354, 16 October, p. 1313.

the NHS in Scotland (although 13 of them have since been withdrawn for revision).

The references in all NICE and SIGN guidelines have been matched to the SCI and SSCI (articles, notes and reviews only) and analysed in order to up-date Grant's⁴ study and reveal which papers have had an influence on patient treatment in this way. There were 2,254 SCI/SSCI papers cited by the 46 NICE TAs and 4045 papers cited by the 48 SIGN guidelines published in 1980 or later.

The first discovery was that the references on both the NICE and SIGN guidelines are very recent. Figure 5.3.1 shows the ages of the SCI/SSCI references, relative to the publication dates of the guidelines that cite them. It also shows the distribution of ages of papers cited on a sample of UK biomedical papers in the SCI and, for comparison, the distribution for the SCI papers cited on the St George's guidelines studied by Grant.⁵ Clearly, the former are the most recent; the median time to citation is 3.3 years for the NICE and 5.1 years for the SIGN guidelines, compared with 5.2 years for the SCI citations and 7.5 years for the St George's guidelines.



⁴ Grant, J. *et al.* (2000) *op. cit.*

⁵ Grant, J. *et al.* (2000) *ibid.*

Figure 5.3.1 Distribution of time intervals between publication and citation of biomedical papers by SIGN guidelines and NICE TAs, UK biomedical papers in the SCI, and St George's guidelines (first 10 years only).

Figure 5.3.2 shows the nationality of the papers cited on the two sets of guidelines, compared with the countries' relative presence in world biomedical literature for 1995-2000. The UK papers are cited on guidelines more often than in SCI in general, as would be expected, but so are several northern European countries. By contrast, papers from Japan and from several leading developing countries are seldom cited on UK clinical guidelines.

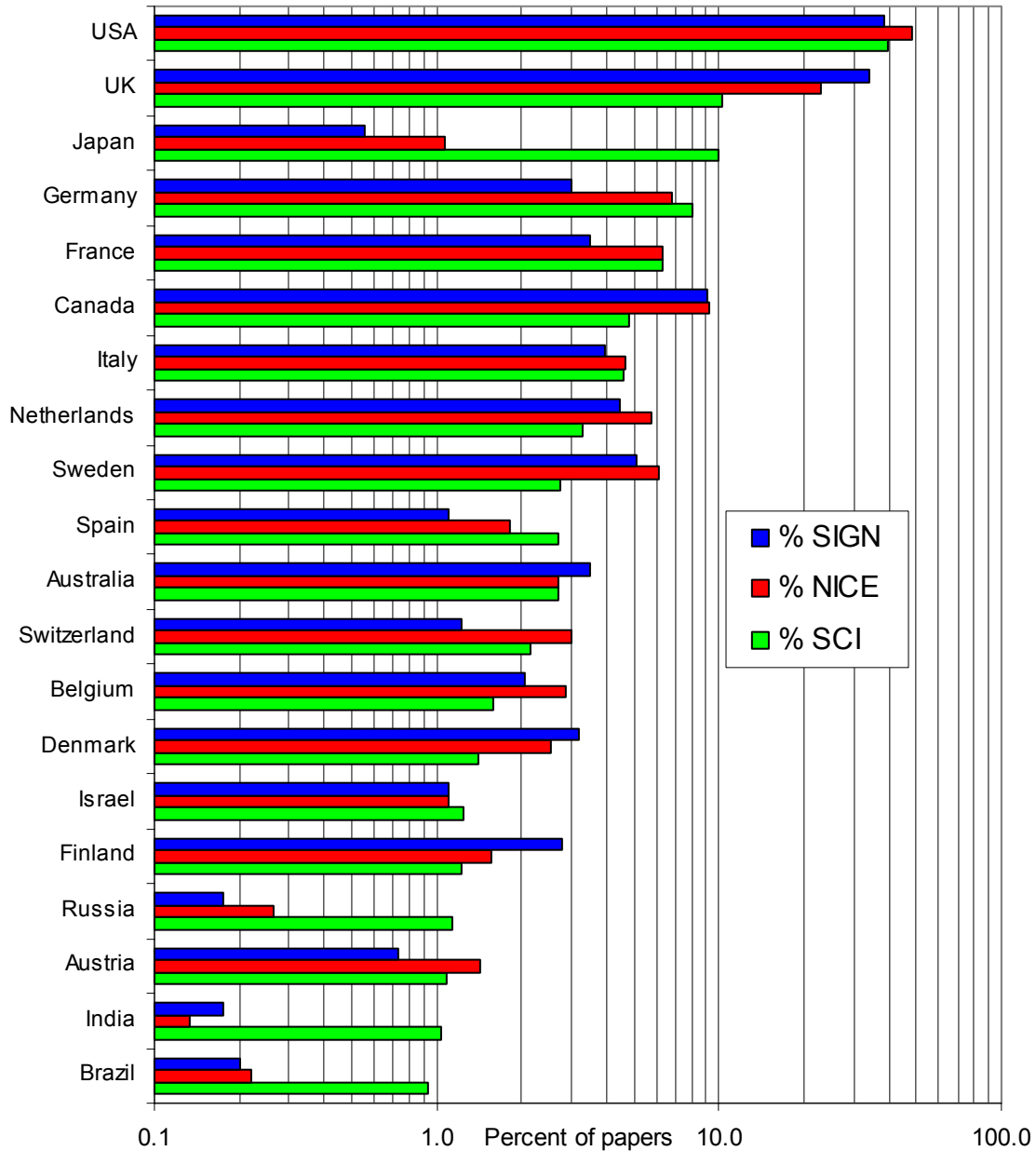


Figure 5.3.2 Relative presence of 20 leading countries in the addresses of papers cited by 49 SIGN guidelines and by 46 NICE TAs and in the world biomedical literature in the SCI, 1995-2000

Figure 5.3.3 shows the distribution of the papers by research level, compared with a large sample of world biomedical literature for one year (1997). The distributions are clearly very different, with the guidelines mostly (89% for NICE,

91% for SIGN) citing to papers classified as “clinical observation” or “clinical mix” – RL1 and RL2.

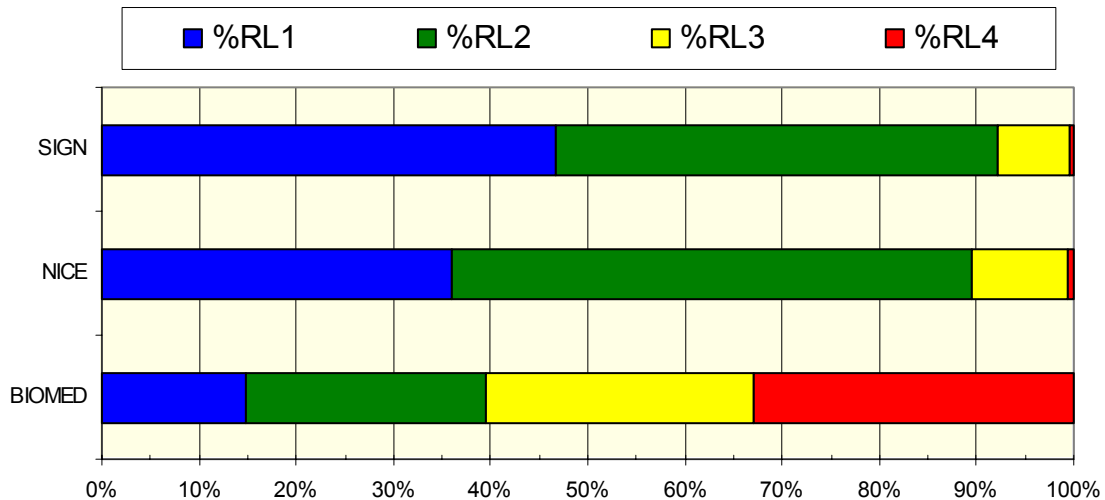


Figure 5.3.3 Distribution by research level (RL; 1 = clinical, 4 =basic) for papers cited on SIGN guidelines and NICE TAs, and for world biomedical papers in the SCI (1997).

For a comparison of the papers’ potential citation impact (the PIC distribution of the journals in which they are published), we need to compare them with groups of world biomedical papers with the same RL distribution (BM-SIGN and BM-NICE), because clinical journals normally have lower PIC values than basic ones. Figure 5.3.4 has therefore been prepared to show the comparison between the PICs of the papers cited by the two sets of guidelines and samples of the world 1997 biomedical literature. This shows that these cited papers are published in high impact journals, with 22% of NICE citations and 24% of the SIGN ones being in journals rated PIC = 4.

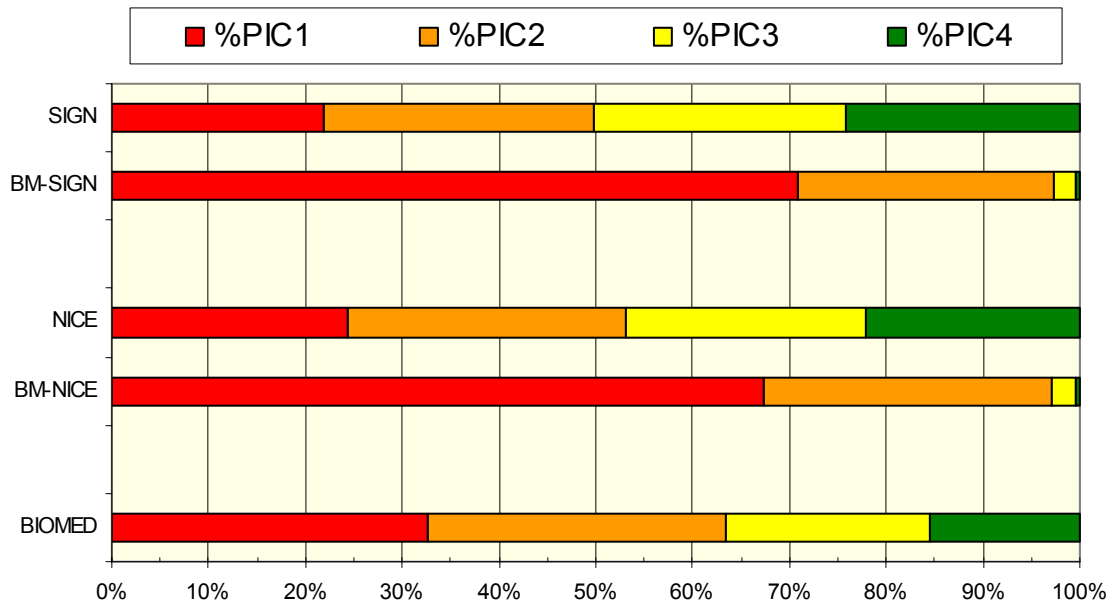


Figure 5.3.4 Distribution by potential impact category (PIC1=low, 4=high) for papers cited on SIGN guidelines and NICE TAs, for world biomedical papers in the SCI (1997) and for a sample of world biomedical papers with the same RL distribution as that of the NICE citations.

Finally, funding data and authors' addresses for the UK papers cited in the two groups were identified. The results of the funding analysis are shown in Figure 5.3.5. The data for the ROD has been taken from a comparison group from 1995-99 constructed so as to have the same RL distribution as the UK papers cited on the guidelines.

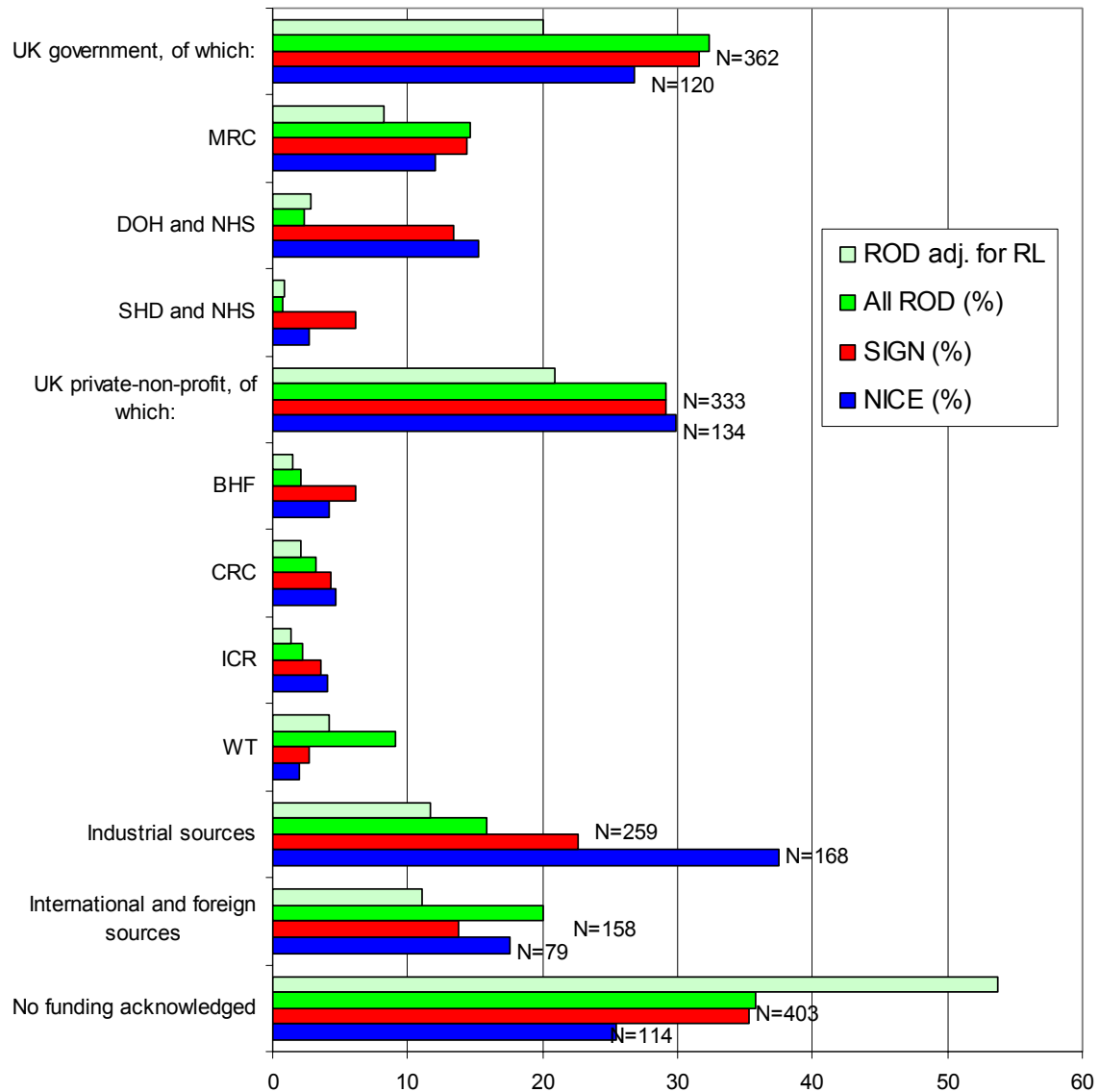


Figure 5.3.5 Funding of UK papers cited on NICE TAs (n = 448) and on SIGN guidelines (n = 1145), compared with all ROD papers overall and with similar RL distribution (RL adj: RL1, 51.5%; RL2, 40.7%; RL3, 7.5%; RL4, 0.3%)

The funding of the structured sample ROD papers (RL adj) is somewhat different from that of all ROD papers, with most funders (except for the two government departments) funding much less of this clinical work. We can see that, compared with the adjusted ROD sample, most funders are more active in supporting research cited on guidelines. The notable exception is the Wellcome Trust, very

little of whose work is put to such use. This may be because the Wellcome Trusts does not fund clinical trials, which constitute a large proportion of all papers cited in both sets of guidelines. Overall, the UK government and private-non-profit sources each fund a little less than one third of the papers, but the industrial share is much greater, particularly for the NICE TAs, many of which are concerned with the cost-effectiveness of new drugs.

The geographical analysis is shown in Table 5.3.1, with the leading postcode areas ranked in descending order of their relative presence on all UK biomedical papers for 1996.

Table 5.3.1 Leading UK post-code areas represented on NICE TAs and SIGN guideline citations and on UK biomedical papers for 1996: numbers of papers (N) and percent of UK total (%).

<i>Code</i>	<i>Post town</i>	<i>NICE</i>	<i>NICE %</i>	<i>SIGN</i>	<i>SIGN %</i>	<i>UK BM</i>	<i>UK BM %</i>
WC	London (West Central)	46	8.91	111	8.19	2682	9.73
CB	Cambridge	22	4.26	66	4.87	2097	7.60
OX	Oxford	65	12.60	129	9.51	2037	7.39
W	London (West)	33	6.40	78	5.75	1900	6.89
SE	London (South East)	45	8.72	112	8.26	1579	5.73
SW	London (South West)	28	5.43	102	7.52	1435	5.20
EH	Edinburgh	24	4.65	126	9.29	1365	4.95
M	Manchester	45	8.72	104	7.67	1304	4.73
G	Glasgow	24	4.65	164	12.09	1282	4.65
NW	London (North West)	19	3.68	48	3.54	1000	3.63
B	Birmingham	32	6.20	55	4.06	961	3.48
BS	Bristol	15	2.91	57	4.20	929	3.37

L	Liverpool	16	3.10	54	3.98	912	3.31
NE	Newcastle upon Tyne	11	2.13	53	3.91	851	3.09
S	Sheffield	22	4.26	55	4.06	807	2.93
LS	Leeds	27	5.23	52	3.83	761	2.76
NG	Nottingham	39	7.56	66	4.87	747	2.71
SO	Southampton	25	4.84	64	4.72	575	2.09
DD	Dundee	12	2.33	58	4.28	540	1.96
EC	London (East Central)	18	3.49	51	3.76	527	1.91
AB	Aberdeen	22	4.26	66	4.87	518	1.88

Several cities are much more strongly represented in the research cited on the clinical guidelines than they are on the ROD papers, notably Oxford, London SE, SW and EC, Manchester, Birmingham, Sheffield, Leeds, and in particular Nottingham and Southampton. The Scottish guidelines preferentially cite Scottish research papers, which account for almost 10% of all references compared with 1.5% of world biomedical literature, and the four major cities – Edinburgh, Glasgow, Dundee and Aberdeen are all well represented. Cambridge is represented very poorly on the guidelines in relation to its overall participation in UK biomedical outputs.

Key Findings

- Some 10% of all UK biomedical articles are published in the highest impact journals (PIC4) and just below 40% in the lowest impact journals (PIC1).
- The PIC of UK biomedical papers increases with time (for instance, from 4% in 1989 to 13% in 2000 for RL4).
- Positive correlation was noted for the value of PIC and numbers of authors per article and numbers of acknowledged funding bodies. Surprisingly, negative correlation was recorded for numbers of addresses on papers.
- As expected, positive correlation was observed for PIC and RL levels, i.e. more clinical papers tend to be published in lower impact journals. Veterinary medicine and tropical veterinary medicine were exceptions: despite high mean RL, their mean PIC scores were relatively low.
- Over 50% of UK papers in genetics, multiple sclerosis, neuroscience and AIDS research are published in high impact journals (PIC3 and PIC4), while over 80% of papers in biomedical engineering, otorhinolaryngology, tropical & veterinary medicine, veterinary medicine, surgery and dentistry are published in lower impact journals (PIC 1 and PIC 2).
- UK clinical papers are most heavily cited on British clinical guidelines. However, these papers tend to be of higher potential impact than all ROD clinical papers.
- Papers acknowledging funding from industry are relatively better represented on clinical guidelines than in all ROD papers (40% on SIGN, 22% on NICE and only 16% in ROD).
- Amongst funders most frequently acknowledged in ROD, the Wellcome Trust is the least well represented in the guidelines (2 and 2.7 respectively on SIGN and NICE as opposed to 9% in ROD).