

**FROM HEALTH RESEARCH TO CLINICAL
PRACTICE: UNDERSTANDING PATHWAYS THAT
USE JOURNAL ARTICLES AND INFORMING IMPACT
ASSESSMENT**

A thesis submitted for the degree of Doctor of Philosophy

by Published Works

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by

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Abstract

For biomedical research to improve clinical practice, and for funding levels to be sustained, it is increasingly important to understand the pathways from research to clinical practice and to assess the societal impact of research. Approaches to research evaluation through traditional study of journals, journal articles and standard citation analysis, have played comparatively small roles in these developments.

In this thesis I critically review how I applied existing methods, and developed a new approach, to study two pathways from research to clinical practice. For Pathway 1, questionnaire surveys of clinicians' views on journals read to inform their clinical practice, and comparisons with impact factors, revealed that a few journals were read widely and considered important by clinicians. Relationships between journal importance and impact factor were complex. For Pathway 2, I applied a novel methodology to identify important citations to four key research papers in an attempt to trace important citations through numerous citing generations. My findings included: few cited papers were important to the citing papers; the number of citation occasions within the citing paper correlated strongly with a cited paper's importance; self-citations were also important; and it was feasible to trace through a series of generations of citations. Evidence of societal impact of the four key research papers examined in my studies included important papers in subsequent generations cited in clinical guidelines, many of which were international.

In assessing the impact of my own studies, I found Pathway 1 papers had societal impact on research evaluation methodology; journal editorial policy; and medical library provision policy and practice. Societal impacts of the new methodology, Pathway 2, included informing further methodological development and research evaluation. My portfolio, together with my critical review, adds understanding and provides additional data to current assessment methods of wider impacts of research, and bases for further studies.

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Acknowledgements

I would like to acknowledge the permissions as detailed below that I received enabling me to include the six published papers in this thesis:

Paper P1

Jones, T., Hanney, S., Buxton, M. and Burns, T., (2004) What British psychiatrists read: Questionnaire survey of journal usage among clinicians, *British Journal of Psychiatry* 185 (1): 251 - 257.

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This is an author-produced electronic version of an article accepted for publication in the *British Journal of Psychiatry*. The definitive publisher-authenticated version is available online at <http://bjp.rcpsych.org>.

Paper P2

Jones, TH., Hanney, S. and Buxton, MJ. (2006) The journals of importance to UK clinicians: A questionnaire survey of surgeons, *BMC Medical Informatics and Decision Making* 6 (24): 24

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Paper P3

Jones, TH., Hanney, S. and Buxton, MJ. (2007) The information sources and journals consulted or read by UK paediatricians to inform their clinical practice and those which they consider important: A questionnaire survey, *BMC Pediatrics* 7 (1): 1

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Paper P4

Jones, TH. Hanney, S. Buxton, MJ. (2008) The role of the national general medical journal: Surveys of which journals UK clinicians read to inform their clinical practice. *Medicina Clinica*. 131 (Supplement 5): 30-35

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Paper P5

Jones, TH., Donovan, C. and Hanney, S., (2012) Tracing the wider impacts of biomedical research: A literature search to develop a novel citation categorisation technique, *Scientometrics* 93 (1): 125 - 134

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Paper P6

Jones, TH., Hanney, S. (2016) Tracing the indirect societal impacts of biomedical research: development and piloting of a technique based on citations. *Scientometrics* 107 (3): 975-1003

This article is available from: <http://link.springer.com/article/10.1007/s11192-016-1895-4>

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Papers P5 and P6

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I couldn't have completed this work without input from a lot of people but my two supervisors, Steve Hanney and Subhash Pokhrel, have been stalwarts and my mainstay. Without them this critical review would not even have been started let alone completed.

I have worked with Steve throughout all of the publications in my portfolio; he has shown endless patience, limitless knowledge and a constant willingness to help throughout. It was Steve and Martin Buxton who introduced me to this particular area of research, who have patiently encouraged and guided me through.

I started working with Subhash about four years ago, now, in a different area of research. That work, with Subhash's constant, calm encouragement instilled in me a belief that I could do this.

So I would like to thank both Steve and Subhash who have been with me through the development of this PhD by Published Works and critical review. Their many suggestions, thoughts and support, together with all of the hours of precious time that they have provided has enabled me to put this thesis together.

I would also like to thank those who have created a supportive environment during my time here as a member of HERG, especially to Martin Buxton and Julia Fox-Rushby, directors, who have led the many team members over the years, providing a wealth of knowledge and expertise that they have always willingly shared.

Finally, to my long-suffering family who have got used to me not being available, too busy, or asleep. This PhD is also theirs in many ways!

Author's declaration

I declare that the work I claim to be mine and describe in my critical review was performed by me. However, I was a member of the research teams that were responsible for conducting the research described in each of the portfolio papers submitted as part of this thesis. In the text of the critical review I try to indicate my contribution. I was lead and corresponding author on all six papers that form my portfolio. My contribution, which has been substantiated by all of my co-authors (Appendix 1), is summarised in the details below.

	<i>Paper 1</i>	<i>Paper 2</i>	<i>Paper 3</i>	<i>Paper 4</i>	<i>Paper 5</i>	<i>Paper 6</i>
<i>Number of authors</i>	4	3	3	3	3	2
<i>Conception</i>	25	30	30	40	45	40
<i>Design</i>	50	60	65	60	70	50
<i>Execution/Data acquisition</i>	90	90	90	90	95	65
<i>Data analysis/ interpretation</i>	75	80	80	90	85	85
<i>Publication</i>	40	45	45	70	90	85

Table: Estimated percentage contribution by THJ to multi-authored papers submitted as part of her PhD by Publication*

*The percentage contribution analysis is based on the guidance provided by the International Committee of Medical Journal Editors (ICMJE) 2017 on definition of authorship as well as the requirements of each publishing journal for the articles listed. Further details for the ICMJE definition can be found at:

<http://www.icmje.org/recommendations/browse/roles-and-responsibilities/defining-the-role-of-authors-and-contributors.html>.

Paper 1 - Jones, T. , Hanney, S. , Buxton, M. and Burns, T. (2004) 'What British psychiatrists read: Questionnaire survey of journal usage among clinicians'. *British Journal of Psychiatry*, 185(1); pp.251-257. <http://bjp.rcpsych.org/content/185/3/251>

TJ's findings in the early stages of her NHS Research Fellowship identified the requirement for and informed the changes to the lines of investigation from the originally proposed project plan towards surveying about the journal read to inform clinical practice. TJ, MB, SH and TB were involved in the conception, planning, preparation and approval of the consequent survey questionnaire. TJ conducted and managed the questionnaire survey and data collection, including preparation of the first draft of the questionnaire and preparation of the list of names of recipients from the data supplied by the Royal College of Psychiatry. TJ carried out the data analyses, including preparation and presentation for discussion and publication, with additional intellectual input from MB, SH and TB. TJ wrote the first draft of the paper and all authors read and revised the text and approved the final manuscript. TJ liaised closely on the paper with TB who was based at the Warneford Hospital, University of Oxford. TJ was first and corresponding author.

Paper 2 - Jones TH, Hanney S, Buxton MJ. The journals of importance to UK clinicians: a questionnaire survey of surgeons. *BMC Medical Informatics and Decision Making*. 2006;6:24. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1559602/>

TJ, MB and SH were involved in the conception, planning, preparation and approval of the original survey questionnaire, with TJ identifying lessons from the psychiatrists' survey. TJ conducted and managed the questionnaire survey and data collection, including preparation of the first draft of the questionnaire and sourcing and preparing the list of names of recipients. TJ carried out the data analyses, including preparation and presentation for discussion and publication, with additional intellectual input from MB and SH. TJ wrote the first draft of the paper, all authors read and revised the text and approved the final manuscript. TJ was first and corresponding author.

Paper 3 - Jones TH, Hanney S, Buxton MJ. The information sources and journals consulted or read by UK paediatricians to inform their clinical practice and those which they consider important: a questionnaire survey. *BMC Pediatrics*. 2007;7:1.

<http://bmcpediatr.biomedcentral.com/articles/10.1186/1471-2431-7-1>

TJ, MB and SH were involved in the conception, planning, preparation and approval of the original survey questionnaire, with TJ identifying lessons from the psychiatrists' survey. TJ conducted and managed the questionnaire survey and data collection, including preparation of the first draft of the questionnaire and sourcing and preparing the list of names of recipients. TJ carried out the data analyses, including preparation and presentation for discussion and publication, with additional intellectual input from MB and SH. TJ wrote the first draft of the paper, all authors read and revised the text and approved the final manuscript. TJ was first and corresponding author.

Paper 4 - Jones TH, Hanney S, Buxton MJ. The role of the national general medical journal: surveys of which journals UK clinicians read to inform their clinical practice. *Medicina Clínica*. 2008;131:30-5. www.elsevier.es/es-revista-medicina-clinica-2-pdf-13134418-S300

TJ, MB and SH were involved in the conception, planning and preparation of the work using data collected predominantly in the surveys reported in papers 1, 2 & 3. TJ carried out the data analyses, including preparation and presentation for discussion and publication, with additional intellectual input from MB and SH. TJ wrote the first draft of the paper and all authors read and revised the text and approved the final manuscript. TJ was first and corresponding author.

Paper 5 - Jones TH, Donovan C, Hanney S. Tracing the wider impacts of biomedical research: a literature search to develop a novel citation categorisation technique. *Scientometrics*. 2012; 93(1):125-34. <http://link.springer.com/article/10.1007/s11192-012-0642-8>

TJ and SH were involved in the conception and preparation of grant submissions for a project to explore the use of journals in the study of the impact of research on clinical practice using bibliometrics as a tool. TJ was named researcher on the project as she was not Brunel staff at that time. TJ and SH were involved in the planning and preparation of the project. TJ designed and conducted the extensive literature search, with additional intellectual input from SH. TJ analysed the findings with additional intellectual input from SH and CD. TJ presented the findings at an international conference in Istanbul, Turkey and following an offer from *Scientometrics*, a leading bibliometrics journal, wrote the first draft of the paper. All authors read and revised the text and approved the final manuscript. TJ was first and corresponding author.

Paper 6 - Jones TH, Hanney S. Tracing the indirect societal impacts of biomedical research: development and piloting of a technique based on citations. *Scientometrics*. 2016; 107(3):975-1003. <http://link.springer.com/article/10.1007/s11192-016-1895-4>

TJ and SH were involved in the conception and preparation of grant submissions for the project. TJ and SH were involved in the planning and preparation of the project and the invitation of the experts to join the advisory group. TJ recruited, selected, trained and directed the group of eight postgraduate assessors. TJ developed and managed the assessment data collection procedures for both the test template and the pilot template with additional intellectual input from SH. TJ carried out the data analyses with additional intellectual input from SH and the group of experts. TJ and SH presented the findings, including TJ's identification of the possibility of increasing the efficiency of the assessment method and the importance of self-citations in this type of analysis, to meetings of the panel of experts. TJ wrote the first draft for the paper, both authors read and revised the text and approved the final manuscript. TJ was first and corresponding author.

Chapter 1 - Introduction

Aim of the thesis

A key goal of biomedical research is to improve clinical practice and outcomes for patients. However, many research findings do not reach this end-goal. The concept of research on research has developed, in part, to inform understanding of this process. Greater understanding could help more researchers contribute to the goal of improving outcomes for patients. Furthermore, funders of health research and others increasingly recognise the need not only to understand the pathways from research into improved healthcare but also to assess the extent to which these wider impacts or benefits to society are achieved (Buxton and Hanney, 1996, Cooksey, 2006). Assessing impact can be valuable for various reasons including for accountability and to advocate for continued or increased funding in future.

This thesis addresses the above issues and is organised to satisfy the requirements for a PhD by Published Works as set out in Brunel University London's guidance (Senate Regulation 5.50, Brunel University London, September 2106). I am submitting a portfolio of six published papers around a central theme together with this critical review. My aims in this critical review are, as set out in the university's guidance, to: (a) outline the theme that gives the work its defining coherence (Chapter 1); (b) justify the overarching approach and methodologies used (Chapter 2); (c) show how the work makes a significant and coherent contribution to knowledge (Chapter 3); and (d) provide an assessment of the impact of the work contained in the submission (Chapter 4).

Details of the six published papers are included in Table 1. I am lead and corresponding author on all six papers and documentary evidence confirming my contribution to each, substantiated by all of my co-authors, can be found in the Author's Declaration and Appendix I. The full papers together with any attachments can be found in Appendices II-VII.

Table 1 – The six published articles that form my portfolio of papers submitted as part of the requirements for a PhD by Published Work

<i>Paper number</i>	<i>Paper details</i>	<i>Research type</i>
P1	Jones, T., Hanney, S., Buxton, M. and Burns, T. (2004) What British psychiatrists read: Questionnaire survey of journal usage among clinicians, <i>British Journal of Psychiatry</i> 185 (1) : 251 - 257	Questionnaire survey
P2	Jones, TH., Hanney, S. and Buxton, MJ. (2006) The journals of importance to UK clinicians: A questionnaire survey of surgeons, <i>BMC Medical Informatics and Decision Making</i> 6 (24) : 24	Questionnaire survey
P3	Jones, TH., Hanney, S. and Buxton, MJ. (2007) The information sources and journals consulted or read by UK paediatricians to inform their clinical practice and those which they consider important: A questionnaire survey, <i>BMC Pediatrics</i> 7 (1) : 1	Questionnaire survey
P4	Jones, TH., Hanney, S. and Buxton, MJ. (2008) The role of the national general medical journal: Surveys of which journals UK clinicians read to inform their clinical practice, <i>Medicina Clínica</i> 131 (Supplement 5) : 30 - 35	Meta-analysis
P5	Jones, TH., Donovan, C. and Hanney, S. (2012) Tracing the wider impacts of biomedical research: A literature search to develop a novel citation categorisation technique, <i>Scientometrics</i> 93 (1) : 125 - 134	Literature survey
P6	Jones, TH., Hanney, S. (2016) Tracing the indirect societal impacts of biomedical research: development and piloting of a technique based on citations. <i>Scientometrics</i> 107 (3): 975-1003	Methodological study

Why this portfolio of papers?

My work draws on at least three areas of study, one long-standing and two newer, that crucially are brought together to explore questions that had not previously been fully answered.

The best way of assessing research quality is generally considered to be by peer-review. However drawbacks, such as the time for experts to evaluate a paper and the scepticism that can exist over the objectiveness of peers' judgement (Martin and Irvine, 1983, Cave et al., 1997), are addressed, at least in part, by the development of more quantitative research assessment methods. These quantitative methods include many bibliometric indicators such as: numbers of publications; assessment of the publishing journal for example by journal impact factor (JIF); and citation analysis. The advantages and disadvantages of the various bibliometric indicators, including the difficulties of understanding what citations mean, are discussed widely

(Adam, 2002, Cronin, 1984, Garfield, 1979, Price de Solla, 1963, Van Leeuwen et al., 2001). In particular, the use of JIF in research evaluation is widely criticised (Seglen, 1998). An early consensus appeared to be that these quantitative methods were best used to support peer-review (Croxson et al., 2001, Kostoff, 1998, Nederhof and Van Raan, 1993).

In contrast to the area of research evaluation, the developing field of implementation often paid comparatively little attention to the role of journals as a direct step in the process (Coomarasamy et al., 2001, Grol and Grimshaw, 2003, Haines and Jones, 1994). Implementation of research findings is a complex process and improving understanding is desirable in order to increase the speed and effectiveness of implementation and eventual improvements to patient care. A multi-strand approach incorporating numerous components was considered necessary by both Haines and Jones (1994) and Grol and Grimshaw (2003). However, when diverse approaches to implementation were studied, as in the NHS Implementation Methods Programme in the 1990s, the role of journals in providing a direct pathway from research to clinical practice played a very small part (Hanney et al., 2007).

If the aim of biomedical research is to improve clinical practice and outcomes for patients, then perhaps the research should, at least in part, be assessed by its impacts or outcomes rather than its outputs alone? New research assessment methods increasingly incorporate the examination of the wider impacts and outcomes. Buxton and Hanney's Payback Framework (1996) was one of the first approaches covering both traditional academic assessment and assessment of wider impacts. It includes analysis of five categories of benefits from research, the first two of which, knowledge production and research capacity building, are assessed using approaches such as the traditional ways described above. Then there are also the wider benefits to society. Various research funders, including UK public sector bodies such as the NHS R&D programme, (Buxton and Hanney, 1996) and medical research charities such as the arthritis research campaign (arc) (Wooding et al., 2005) commissioned early studies to show the wider impact that was made by the research that they had funded.

Whilst there are recognised limitations of journals as a route for dissemination, even "passive dissemination" has a role in getting research into practice (Coomarasamy et

al., 2001). Journal articles remain the major output of research findings and perhaps studies of the roles they play in the implementation of research findings are too limited. Overall, there is comparatively limited work applying traditional techniques to examine the role of journals, journal articles and standard citations in subsequent generations of articles in assessing the societal impact of research. Specifically, there seems to be little about their role in providing either a direct pathway from research to clinical practice, or a very indirect pathway via a series of generations of citations. Study of these pathways might potentially open up additional avenues to aid understanding of the implementation of biomedical research and the assessment of the wider societal impacts.

Research questions

In this critical review I focus on the research on research work I conducted with colleagues both to understand some of the various ways in which journal articles are a route through which research findings translate to better clinical practice; and to explore ways in which this wider impact can be assessed. The questions that I have aimed to address are:

1. How far do journals play a role as a direct pathway from health research to clinical practice?
2. What role can successive generations of citations play as a very indirect pathway from health research to clinical practice?

The answers to the above questions provide understanding of the pathways and could inform impact assessment.

Study of a direct pathway: Investigating the importance of journals to clinicians.

Initially we (my collaborators and I) examined the more direct influence of published articles on clinical practice by surveying the views of UK clinicians on the journals they read and the importance of journals to inform their clinical practice. Whilst publications are still included as part of traditional research assessment, we considered it important to understand clinicians' views on the importance of journals

to inform their clinical practice. There are of course limitations on how far just reading articles might influence clinicians (Coomarasamy et al., 2001), but in the search for new ways to implement research findings it is possible that the role of journals has become somewhat overlooked. So we considered it important to explore the role that journals play from the perspective of clinicians. Even Grol and Grimshaw (2003) note that sometimes research findings can easily be adopted depending on the characteristics of the evidence. They provide details of a new finding on conservative treatment of acute otitis media in children:

“Publication of this finding in a scientific journal was sufficient for almost all doctors to stop doing this procedure within a short time, probably because the study was triggered by practitioners’ scepticism of the benefits of the established practice” (Van Weel et al 2003, cited in (Grol and Grimshaw, 2003)).

When publishing their research findings researchers will usually carefully consider which journal to approach. The prestige of the journal, using JIF as an indicator, is often influential but whether JIF reflects the importance of a journal to clinicians was an issue we also wished to understand (Seglen, 1998). At the time of this work, a few other authors such as Lewison et al (2001) were beginning to explore issues around the readership of journals by clinicians. However, as I analyse in Chapter 3, it is not clear that any co-ordinated series of studies with the capacity to propose generalisable findings had been conducted or previously published.

Study of an indirect pathway: Investigating the role of successive generations of citations for indirect societal impact

Next, we revealed the more indirect influence of a research article on clinical practice by developing a novel methodology to selectively identify important citations and, by using this method, trace across up to six generations of citations. Citations to journal articles have been considered as a possible tool for studying the development of science since the early days of bibliometrics (Garfield et al., 1964, de Solla Price, 1965).

Kostoff (1998) suggested that citations could potentially be used like radioactive tracers across generations of citations to explore the indirect outcomes of research. Kostoff recognised that this process would be difficult, but suggested that whilst the

impact from one of these indirect outcomes could be small, the sum of many could be more significant than the direct impacts. Kostoff also suggested that using this method could reveal impacts in completely different disciplines from that of the researcher which perhaps otherwise would remain hidden (Kostoff, 1998). Kostoff, using text mining along with citation bibliometrics, aimed to examine more than one generation of citations but he found that very quickly the numbers of citations become too large to handle (Kostoff et al., 2001).

Rousseau (1987) developed a mathematical method of apportioning influence on a research article from the references included in the bibliography. He described the 'Gozinto' theorem whereby the total influence on a research article consisted of the direct influences plus the indirect influences. The direct influences from all references in a research article were calculated by weighting of the references depending on the number and location of citation occasions in the paper to each reference. The 'Gozinto' theorem then included the indirect influences calculated in the same manner but from the earlier generation of references. However, Rousseau foresaw a similar problem to Kostoff's of needing to deal with very large numbers of references when progressing to further generations, though in his case going backwards.

We aimed to search for evidence that might inform the development of a qualitative assessment of the importance of citations that would help us to identify key citations on which to focus, and thus overcome the difficulties that Rousseau and Kostoff report. Having overcome some of these difficulties, we aimed to trace through successive generations of citations to study additional pathways to clinical practice and to identify the wider impacts realised later on in such pathways.

The evolving context of the research area

Since I started my studies in 2002, the context of this work has continued to evolve in ways that might both enhance and challenge its relevance. I briefly outline these issues in this section and return to them more fully in the Discussion. In relation to the role of publications, there has been enormous change due to Open Access publication and web-based information etc. (Moed, 2006, Björk, 2017).

Inevitably, the context had moved on before the start of my second strand of work in 2009 and interest in research impact assessment had increased: for example, in 2006 the UK Evaluation Forum stated that the evaluation of medical research benefits was crucial to stakeholders (UK Evaluation Forum, 2006). Indeed, as I describe in Chapter 4, in an influential paper, Weiss (2007) drew on my first strand of work to help build the argument that the measurement of outcomes, rather than measurement of outputs, would provide a better assessment of the success of a research funding organisation. Over the last five years or so there have been many new ideas developing (Stern, 2016, Higher Education Funding Council for England, 2014) and increasing efforts to draw up standards to encourage the appropriate application of methods of research evaluation (Hicks et al., 2015, Guthrie et al., 2013).

Ethics approval

Ethics approval, as required, was obtained from the Brunel University Ethics Committee for the questionnaire surveys described in papers P1, P2, P3 and P4 and for the categorisation of citations project described in papers P5 and P6.

Chapter 2 – Overarching approach and methodologies

Overall approach to this research

As the specific aims of the two strands to this work differed, my colleagues and I used somewhat different methods across the individual studies but they all involved journals, articles and/or citations. Study of Pathway 1 required a series of surveys to try to understand medical specialists' views about the role of journals to inform their clinical practice. Study of Pathway 2 aimed to refine and combine existing techniques to develop a novel methodology to trace the societal impacts of research through indirect citations across generations of citing articles.

Overview of specific methods used

Study of a direct pathway: Investigating the importance of journals to clinicians

We were aware of the uniqueness of each UK medical specialty and also the variety of sub-specialties within each. Due to constraints on resources, my colleagues and I were not able to examine all specialties, therefore we aimed to study a diverse range to increase understanding about the role of journals. With these diverse specialities - psychiatry, surgery and paediatrics - we considered that it may be possible to provide at least some information on: similarities that may apply more widely; and differences where the specific situation varied from one specialty to another and might need to be established separately for each. Published findings are described in P1, P2 and P3. In P4 we draw on these three surveys and analyse one common finding. Although the three specialties were chosen because of their perceived diversity, we have no direct evidence of how representative of all UK medical specialties they are.

Direct collection of the views of clinicians by postal survey seemed the most appropriate method of data collection (Browner, 1988). Table 2 includes features of all three predominantly structured and quantitative surveys. Copies of the papers (P1, P2 and P3) and the accompanying questionnaires are included in Appendices II - IV.

Table 2 – Features of the three UK postal surveys: Psychiatrists, surgeons and paediatricians

<i>Parameter</i>	<i>Focus of surveys</i>		
	<i>Psychiatrists</i>	<i>Surgeons</i>	<i>Paediatricians</i>
<i>Aims of the research</i>	To study which peer reviewed journals clinicians read and perceive as important. Comparison with JIF.		
<i>Design</i>	Cross-sectional postal questionnaire surveys		
<i>Subjects</i>	Members and Fellows of the Royal College of Psychiatrists	Specialists listed on the Medical Directory 2003/4* produced in association with Royal Society of Medicine	
<i>Selection criteria</i>	The Royal College of Psychiatrists selected an equal sized sample from each sub-specialty, using SPSS** version 10.1, for one-off use.	Whole population	
<i>Sampling design</i>	Stratified random sampling	Whole population after removal of names due to any duplication and the privacy policy of the Medical Directory	
<i>Variables, predictor</i>	Sub-specialty, academic status		Sub-specialty, academic status, position (consultant or non-consultant career grade)
<i>Variables, outcome</i>	Number of journals read to inform clinical practice, names of journals read, journals considered to be most important to inform clinical practice, comparison of perceived importance of journals with JIF	Relative importance of journals as an information source to inform clinical practice, number of journals read to inform clinical practice, names of journals read, journals considered to be most important to inform clinical practice, comparison of perceived importance of journals with JIF	
<i>Sample size</i>	1,200	2,660	2,330
<i>Whole population</i>	2,231	4,400	Unknown
<i>Data Analysis</i>	Double data entry onto Excel for analysis. Added journal names were verified using Ulrich's International Periodicals Directory (Bowker, 2003) or the internet. Statistical analysis using SPSS**.		
<i>Overall Response rate (%)</i>	47	38	43
<i>Responses per sub-specialty</i>	38-52%	n=40-354***	n=279-412***

*The Medical Directory contains entries for the majority of doctors practising in the UK; inclusion in the Directory is the choice of the doctor.

**SPSS - Statistical Package for the Social Sciences statistical software

***There was some uncertainty within the Medical Directory of each consultants sub-specialty(ies), but this range is approximately correct.

To minimise sampling errors, respected, national databases were chosen for the names and contact details of recipients. However, the databases were not directly

comparable. I approached as large a sample of consultants within each of the three specialties as were available to me and provided pre-paid reply envelopes. Due to uncertainties with the sub-specialty allocation for surgeons and paediatricians in the Medical Directory, responders were asked their sub-specialty/sub-specialties. As with any database of names and addresses, some may have been incorrect due either to unrecorded changes or to errors in recording. This may have introduced bias e.g. specialists are more likely to relocate at certain times in their careers such as in their early years. This could have distorted the distribution of the population receiving the questionnaires and the views of respondents may have been different from the views of non-respondents. There may be some effect on the findings from some questions, for example on the information sources of importance, as recently qualified specialists may have received different training for that topic.

I prepared the list of journal names for the three surveys from the Research Outputs Database (ROD), constructed by The Wellcome Trust and extracted from the Science Citation Index (SCI) and Social Science Citation Index (SSCI). The outputs contained in the ROD included only papers published in the journals listed in the SCI and SSCI. The ROD team prepared a sub-set, the NHS ROD, containing all publications from England that included some funding from the NHS. I included the journals ranked top in the NHS ROD for publishing the most articles on the specific field. For psychiatry, I included the top 32 journals which contained 60% of NHS funded publications on mental health between 1990 and 1999. Inevitably those journals included in the list would be expected to be ticked more frequently than journals not on the list. The opportunity for clinicians to add their own journal names helped to limit this bias but could not eliminate it.

The list of 39 journals produced for the survey of surgeons, included those accounting for publication of 75% of surgery articles on the NHS ROD. We had learned from the limitations of the survey of psychiatrists that to conduct a true comparison of readership with JIF we should ensure that we had included the names of the journals with the top JIFs in the questionnaire. Therefore, I ensured that both the top 20 surgery journals and the journals published in the UK from the top 20 general medical journals, as ranked by JIF on the Journal Citation Reports (JCR) 2002 from ISI, were included in the list.

The list of 39 journals in the survey of paediatricians included the top 20 journals in the NHS ROD that published most paediatric and neonatology research articles. In addition, any journals in the top 20 from the field of paediatrics were added as were any top 5 general medical journals ranked by JIF according to the JCR 2002 if not already included.

Analysis of the survey of psychiatrists indicated that it would be informative to understand whether journals were important as an information source to clinicians relative to other information sources. Therefore, I included an additional question in the surveys of surgeons and paediatricians that had not been included in the survey of psychiatrists.

Professional informed guidance was sought for each specialty on the overall research question, the individual survey questions and the structure of each questionnaire. The overall aims were clearly stated on the first page of the survey and in the accompanying letter posted to recipients. To maximise response rates anonymity was ensured for recipients and respondents and short, clear questions requiring simple unambiguous answers were included. The guarantee of anonymity has, however, resulted in uncertainty around the representativeness of our data with regard to geographical spread, to each of the sub-specialties and to the age and sex of respondents. Some of this uncertainty could have perhaps been reduced by the inclusion of additional questions, but a longer questionnaire may have had a consequential reduction in response rates.

Although response rates were lower than those often achieved for more clinical surveys, the response rates received for the surveys were not out of line with other similar surveys (Schein et al., 2000) and as, in order to maintain anonymity, no reminders were distributed this may have further limited the response rates. Cull (2005) previously commented on declining response rates to surveys by paediatricians, and response rates to clinician surveys appear to be declining at least partly due to office based policies of not participating in surveys (Wiebe et al., 2012). This must create uncertainty over how representative these findings may be of the whole population. Nevertheless, as large numbers of specialists had initially been contacted, the numbers of respondents were considered sufficiently large for each sub-specialty to allow relatively simple data analysis.

To maintain transparency, the types of questions included, response rates for the surveys, concerns about potential biases and generalisability of the findings due to selection procedures or response rates were discussed within each paper. As some of the data used were available from the SCI and JCR published under licence, permission for the publication of the findings was sought from Thomson ISI (See Acknowledgements).

Details of the data analyses are included in Table 2. Our finding of the importance of the general medical journal to inform clinical practice showed similar trends across all three selected specialties and is explored further in paper P4. Findings combined, analysed and discussed in P4 are subject to the same risks of bias as the original three surveys but have the potential to add weight to the key observations of those surveys. We also used P4 to publish some details comparing JIF scores with readership and importance of particular journals to paediatricians. This is because our intended separate publication drawing on these data was not accepted.

Study of an indirect pathway: Investigating the role of successive generations of citations for indirect societal impact

For the second strand of work, we developed a mixed quantitative and qualitative approach to assessment of citations in order to understand, and inform assessment of, the indirect impacts of that research over many citation generations. The method was piloted on four selected key mental health research papers (in social psychiatry and neuroscience). In this methodological research it was considered to be more important to focus on developing, testing and piloting the novel method on a few key papers from two areas of biomedical research first before considering other areas.

Paper P5 describes the extensive literature search that I conducted in order to inform the development of the methodology described in P6.

Paper P5 - The literature review

I conducted a wide and systematic search, striking a balance between the search's sensitivity and specificity. Although the research question was clear, specific search terms were difficult to define precisely. To cover a broad base, I searched eight

databases, including two large general international bibliographic databases, Scopus and Web of Science (WoS), and six more specialised databases. I hand searched four journals that were considered to be most relevant to the subject from their inception to the date of searching, and examined the reference lists of eight key papers.

Using set criteria, I systematically reviewed the papers identified in the searches by examining first the title, then the abstract and then the full text and excluded articles when sufficient evidence of their irrelevance became apparent. Remaining papers were studied for details of potentially useful indicators of the importance of a citation to the citing paper. A number of indicators were selected for testing.

Limitations of the review included our lack of resources to review any papers not published in English, and non-inclusion of those papers not identified by my search strategy or not available either from Brunel University Library or by Inter Library Loan within the project's time-frame. Some potentially relevant published research that was missed could have further informed the development of our method. However, given the numerous publication platforms for research and the extensive number of languages that could be used for publication, it would be very difficult for any search to find all potentially relevant articles and we believe that the search strategy was robust and inclusive. In P5, I describe the search in detail for others to reproduce, should they choose to do so.

Paper P6 – Development of a novel citation categorisation procedure to explore the wider societal impacts of research.

Using a prototype template, we tested potential indicators of the importance of a reference to the citing paper before deciding which to include in the pilot. My colleagues and I sought to build-in ways of reducing uncertainties and errors as the methodology developed. Below, I discuss the precautionary steps taken when working through the test and pilot phases in order to achieve as good an outcome as possible.

Expert guidance

As the questions that we were trying to answer concerned the pathway from biomedical research to clinical practice, we sought the views of experts (Penfield et al., 2013, Internet citation:, 2012) including: researchers in the biomedical field; practising clinicians; policy advisors; and researchers with expertise in the application of research impact assessment methods and bibliometrics. We invited six experts to participate in the project in a paid advisory capacity. Paying the experts helped ensure their continued involvement throughout. I maintained communication with the experts including at two all day meetings in Central London. My colleague and I sought their advice on various aspects, including development of the test and pilot assessment templates, selection of the key papers for inclusion in our pilot study, interpretation of the findings from the application of both assessment templates, and analysis of the wider impact of the key papers studied. Opinions of experts can vary and therefore inclusion of a different group of experts may have resulted in different outcomes for the development work.

Testing

I recruited and trained a group of eight post-graduate assessors who were not experts in the field to conduct the majority of the assessments in the testing and piloting of the template (Haslam et al., 2008, Moriarty et al., 2009, Peritz, 1983).

From the literature review I identified some potentially useful quantitative indicators of the importance of a citation to the citing article, as well as data on the qualitative categorisation of the citations, and, by consulting with my colleague, decided on which indicators to test in the prototype template. We based our qualitative categorisation procedure on earlier work (Hanney et al., 2005) where my colleague was a team member, modified according to published recommendations and informed by findings from the literature.

Eight assessors and the key researchers (i.e. TJ and SH) applied the test template to a batch of 96 research articles from mental health research. The experts also applied the test template to all 96 articles for comparison across all three groups (i.e. six experts, eight assessors and two researchers).

Data for each indicator, collected using the test template, showed the level of agreement between assessors as well as the speed and ease of application.

The disadvantages of the test procedure included the relatively small number of assessments (96) on which to base the choice of indicator - the results may have differed if citations to a larger number had been conducted. The non-expert assessors tended to include more citations as Central than experts and this was a matter of concern, so I provided further training for the assessors before the pilot stage. Nevertheless, this tendency to include more papers is unlikely to have been completely overcome and may have resulted in some overestimation of the numbers of papers assessed as Central. A further disadvantage was that the pilot was limited to two areas of mental health research which may have different characteristics to citations in other areas.

Minimisation of error

Analysis of the data from the test phase was used to refine and simplify the methodology for the pilot. For example, a filter was introduced so that only articles containing three or more citation occasions, and only reviews with two or more citation occasions, were automatically included in the qualitative step of the assessment process. A randomly selected 20% sample of excluded papers was assessed as a check on the filter. The large amount of data collected through this 20% filter allowed the numbers of Central papers that were missed by use of the filters to be estimated.

The qualitative assessment step in the pilot was discussed at length at a meeting with the group of experts. The conclusion was that a single, informed, carefully worded subjective question for the assessors to answer, in order to determine the Centrality of the citation to the citing paper, would facilitate the required judgement. To help with decision making, I provided the assessors with guidance notes which also asked them to adopt a default position of Not Central.

The assessment process for the pilot was conducted via a specifically constructed electronic application with automated distribution of prepared assessment sheets to each assessor via a secure, password protected electronic route and automated central collection of assessment results. This reduced the time required for the

assessment process as well as minimising data entry errors. Disadvantages of this system included the time involved in the preparation of the papers before uploading.

I provided more training for our assessors to help them to: understand and practice the assessment procedure; enable them to discuss the procedures as a group to minimise differences in understanding; and allow them to feed their concerns into the discussion (Hanney et al., 2005, Moriarty et al., 2009). The assessors' lack of expertise in the research area being studied may have had a significant effect on their assessments. However, the level of agreement in the pilot phase for groups of four assessors was good with just 6% of citations requiring additional assessment by others.

I provided familiarisation sessions for the experts to help them understand the procedures that the assessors faced, and also to prepare them for conducting a small batch of assessments for comparison. Nevertheless, opinions vary and even experts do not always agree (Allen et al., 2009).

Upon completion of the citation analyses and creation of the citation streams of Central papers (as described in Paper 6), my colleagues and I searched for citations to any of those Central papers in clinical guidelines or other documents that showed some evidence of impact on policy or practice, such as case reports. This step was included to illustrate the potential impact that could be identified, rather than being an exhaustive search. We examined all citations on the Web of Science (WoS) and a straightforward search of the internet using the Google search engine. Identified clinical guidelines and case reports were checked in order to confirm the inclusion of the citation. A citation in a clinical guideline has been suggested as an example of impact on policy without the need for assessment of the importance of the citation (Grant et al., 2000) but some citations could be more important to the guideline than others.

As this was a study to develop a new methodology, inevitably some question marks over the methods used, for example in relation to addressing problems of attribution, are substantive matters considered in the following chapters.

Summary

The methods can be summarised as follows:

Direct pathway: Investigating the importance of journals to clinicians

- Postal questionnaire surveys of UK psychiatrists, surgeons and paediatricians to inform more widely on the importance of journals to clinical practice and the appropriateness of using JIF. Steps were taken to minimise bias but inevitably some bias may remain.

Indirect pathway: Investigating the role of successive generations of citations for indirect societal impact:

- Methodological development to identify Central citations to a key research article and use of the method to trace across up to six citing generations and identify wider impacts. An extensive literature search and expert advice informed the development, but some aspects of the method would benefit from further consideration.

Chapter 3 - Contribution to knowledge

In this chapter I discuss the existing knowledge at the start of the work and how the findings of this research have advanced the knowledge in the field.

Study of a direct pathway: Investigating the importance of journals to clinicians.

Before this research was conducted limited information was available on the information sources that specialists used to inform their clinical practice. Dawes and Sampson (2003) in their review had found that the number of published studies of information seeking behaviour of clinicians was surprisingly small and generally of poor quality; the majority of studies had, however, found printed materials to be favoured.

On setting out with this work, our intention was to go further than the existing studies of which my colleagues and I were aware and to cover the full range of clinicians in each of a number of diverse UK medical specialties in order to build a body of work that would help to inform the issue more widely. We made this intention clear in our first 2004 survey of psychiatrists (Paper P1, questionnaire): "Our research is attempting to identify a more realistic way to assess publications for clinical practitioners. The intention is to extend the study to other medical fields in the future."

Table 3.1 summarises the knowledge preceding our studies that we were aware of as well as how our findings add to this knowledge in ways that focus on gaps we identified. The data are arranged by topic and summarised at the end of the chapter.

Table 3.1 - The contribution that papers included in Pathway 1 provide to existing knowledge: What was known from previous research; gaps and scope for additional knowledge; knowledge contributed by my portfolio

What was known from previous research	Gaps and scope for additional knowledge	Knowledge contributed by my portfolio	Paper number
<p><i>Which journals are most widely read?</i></p> <p>Many groups are interested in the readership and perceived importance of different journals (Blecic, 1999, Lewison, 2002, Traynor and Rafferty, 2001, Council for Medical Sciences, 2002).</p> <p><i>British Journal of Surgery</i> and <i>BMJ</i> were read most widely by general surgeons passing the UK Intercollegiate Board exam in 1997 (Macleod, 1998).</p> <p>Norwegian doctors spend on average 3.4 hours per week reading medical literature. 2/3 of this time is spent on medical journals (Nylenna, 1990).</p> <p>US surgeons dedicate an average of 14 hours per month to reading medical literature. This rises to 23 hours per month for surgeons who have published more than 10 papers. The most popular surgical journals for US surgeons are <i>Annals of Surgery</i>, <i>Journal of the American College of Surgeons</i> and the <i>Archives of Surgery</i>. The most popular general medical journals are <i>NEJM</i> and</p>	<p>Which research publications reach UK clinicians?</p> <p>What similarities and differences exist between the journals read and considered important by different groups of UK medical specialists?</p>	<p>For psychiatrists, a small number of journals are very important for dissemination. <i>BMJ</i> and <i>British Journal of Psychiatry</i> are very important across all sub-specialties.</p> <p>Substantially more surgeons read and rank first <i>BMJ</i>, <i>Annals of the Royal College of Surgeons of England</i> and <i>British Journal of Surgery</i> than any other journal. No one specialty journal is important across all sub-specialties.</p> <p>A few journals are important for dissemination to paediatricians, <i>Archives of Disease in Childhood</i> and <i>BMJ</i> are the most widely read across sub-specialties.</p> <p>The <i>BMJ</i> is read widely across all three specialties, by academics and non-academics, and is one of a few journals that are widely read in each specialty. The <i>BMJ</i> comes second or third most important to inform clinical practice within each specialty.</p> <p>There is a statistically significant difference in the number of journals read by academics compared</p>	<p>P1, P2, P3, P4</p>

<p><i>JAMA</i> (Schein et al., 2000).</p>		<p>to non-academics for all three specialties.</p> <p><i>The Lancet</i>, a UK based non-membership journal, is more important to academic surgeons and academic paediatricians than it is to other groups.</p>	
<p><i>How readership compares with JIF</i></p> <p>In professions allied to medicine there was virtually no correlation between JIF and the perceived relative importance of journals to researchers and a small group of users (nursing practitioners) of research (Lewison, 2002).</p> <p>Research evaluation can affect research publication behaviour (Butler, 2003, Croxson et al., 2001, Walford, 2000).</p> <p>JIF was not a consideration for US surgeons when selecting journals to read (Schein et al., 2000).</p>	<p>How journals read by UK medical specialists compare with JIF.</p>	<p>The relationship between JIF and perceived importance of a journal to clinicians in psychiatry is complex and varied. Journals with the highest JIF tend to be more important to academic than non-academic psychiatrists</p> <p>As the relationship between JIF and journal readership by surgeons is complex, caution is required in their use for research assessment.</p> <p>There is a clear mismatch between JIF and importance of <i>Archives of Disease in Childhood</i> to paediatricians' clinical practice.</p>	<p>P1, P2, P4</p>
<p><i>Comparison of the journals containing clinical publications and those read by clinicians</i></p> <p>Seven journals (four general medical journals, two from the UK) contained the best paediatric evidence, sourced from citations in the <i>Cochrane Database of Systematic Reviews</i>, The American Academy of Pediatrics policy statements and the Canadian Paediatric Society statements. All seven were available in 80% of UK paediatric or neonatal hospitals (Birken and Parkin, 1999).</p> <p>One dominant journal in nursing contained 46% of</p>	<p>Do UK medical specialists access the journals that publish most UK biomedical research?</p>	<p>Six of the seven journals containing best paediatric evidence, (Birken and Parkin, 1999), are the most widely read by UK paediatricians, >40% hospital based paediatricians read all 6, >25% based in the community read 2 or more.</p>	<p>P3</p>

<p>the total publications in that field, far more than any other (Rafferty et al., 2000).</p> <p>As well as publication in specialist journals, many important articles in internal medicine, general/family practice, general care nursing and mental health are published in four general medical journals (McKibbon et al., 2004).</p>			
<p><i>Nationality of journals</i></p> <p>Authors of UK clinical guidelines cite UK publications preferentially (Grant et al., 2000).</p> <p>American surgeons are only interested in American journals. The two general medical journals most widely read by American surgeons (<i>JAMA</i> and <i>NEJM</i>) are both US based (Schein et al., 2000).</p> <p>Publications in national professional journals are considered to be very important in communication of research findings to applied health care practitioners in the Netherlands (Council for Medical Sciences, 2002).</p> <p>The proportion of nationally produced papers published in the top rated UK and American surgical journals declined from 1983 to 1998 (Tompkins et al., 2001).</p>	<p>Do UK clinicians prefer local journals to international journals?</p>	<p>Journal nationality and the availability of journals as part of membership are overlapping issues.</p> <p>UK psychiatrists show considerable nationality bias in their perceptions of the most important journals to clinical practice.</p> <p>The two general medical journals most important to UK clinicians are UK based and have lower JIFs than two based in the USA.</p> <p>For surgeons, journal nationality is more consistently linked to readership than importance for clinical practice.</p> <p><i>Archives of Disease in Childhood</i> and <i>BMJ</i> are the journals read most widely by UK paediatricians, both are UK journals. Three of the top six most widely read journals are UK based, three are USA based.</p>	<p>P1, P2, P3, P4</p>
<p><i>Membership journals</i></p> <p>'Clearly, other factors than the (J)IF influence the "popularity" of journals among surgeons.</p>	<p>Are membership journals important to UK clinical practitioners?</p>	<p><i>British Journal of Psychiatry</i> and <i>BMJ</i>, both membership journals, are the most important to UK psychiatrists.</p>	<p>P1, P2, P3</p>

<p>.....members of the American Medical Association routinely receive...<i>Journal of the American Medical Association</i>. Consequently, journals of high (J)IF, which are not “enforced” on the reader may suffer in “popularity” (Schein et al., 2000).</p>		<p>Membership journals have high readership levels for surgeons.</p> <p>The two journals read most widely by UK paediatricians (<i>Archives of Disease in Childhood</i>, <i>BMJ</i>) are both membership journals.</p>	
<p><i>Importance of journals as an information source</i></p> <p>Varied results have been found across specialties for the information sources important to clinicians. Remarkably few studies have been conducted and there is little consistency in the data collected (Dawes and Sampson, 2003).</p> <p>Medical colleagues were most important to family practitioners in New Zealand (Cullen, 1997), otherwise printed materials have been found most important (Dawes and Sampson, 2003, Riordan et al., 2004, Schein et al., 2000).</p> <p>Publication in journals plays an important part in dissemination of research to US surgeons. Surgeons believe that journals are their main source of information (Schein et al., 2000).</p> <p>The majority of Norwegian physicians spent most of their reading time on journals (Nylenna, 1990).</p>	<p>Are journals an important source of information for clinicians in order to inform their clinical practice?</p>	<p>Journals are the second most important information source for surgeons.</p> <p>For paediatricians three information sources are considered to be most important: professional meetings and conferences, peer-reviewed journals and medical colleagues.</p> <p>Journals are preferred as an information source by more hospital based paediatricians than those based in the community.</p>	<p>P2, P3</p>

Study of an indirect pathway: Investigating the role of generations of citations for indirect societal impact

As part of the exploration of the wider societal benefits of research we had considered that tracing through generations of citations to journal articles could provide an additional method of studying the pathway from research to clinical practice. Kostoff's (1998) consideration that citations could be used as radioactive tracers of research, and Rousseau's work (1987) on a mathematical technique for assessing indirect impact of citations, informed this work. More recently the topic has been further discussed (Dervos and Kalkanis, 2005, Hu et al., 2011).

Studies of the qualitative assessment of citations in order to trace across generations of citations to outcomes are limited in number. Hanney et al (2005) reported that the proportion of citations of considerable importance, or essential, to a citing paper was small (only 9% in this case). The extent of their study was limited by, for example, low levels of assessor agreement on categorising citations and large volumes of citations that required processing.

Informed by these earlier findings, and by testing previously documented indicating factors of the importance of a citation, my colleague and I developed a novel combination of techniques to assess citations. This combination of techniques enables more feasible and intellectually more credible tracing of indirect impacts across many generations of citations than previously thought possible. From 4,515 papers examined, 1,796 assessments were conducted providing a large body of data for analysis. The methodology developed is described in P5 and P6 and contributes to existing knowledge. The information available prior to this work, as well as questions that remained unanswered and the knowledge that this work adds are set out in Table 3.2. A summary of the contribution to knowledge is included at the end of the chapter.

Despite all the progress, perhaps the key unresolved question is: how far can indirect citations be taken as providing evidence of wider impacts of research? I discuss this in the Limitations in Chapter 5.

Table 3.2 - The contribution that papers included in Pathway 2 provide to existing knowledge: What was known from previous research; gaps and scope for additional knowledge; knowledge contributed by my portfolio

What was known from previous research	Gaps and scope for additional knowledge	Knowledge contributed by my portfolio	Paper number
<p><i>The importance of a citation to the citing paper</i></p> <p>Most citations are of little importance to the citing paper e.g. Prabha (1983) studying business administration; Safer & Tang (2009) studying empirical psychology research.</p> <p>Kacmar & Whitfield (2000) found 9% and 6% of citations to articles in two specific journals to be important in the area of Management and Organisation.</p> <p>Hanney (2005), found 8% to be important and 1% to be essential in diabetes research.</p>	<p>What proportion of citations is important to key research articles in biomedical research?</p>	<p>For the psychiatry and neuroscience papers studied, the cited article is important for 4.4% of citing articles and 6.1% of citing reviews.</p> <p>These findings are compatible with previous studies in other fields of research rather than breaking new ground.</p>	<p>P5, P6</p>
<p><i>Use of quantitative indicators of the importance of a citation that then provide the possibility of part-automation of the assessment of importance</i></p> <p>Indicators of the importance of a citation previously suggested include: the number of citation occasions, number of references included to support one point, location of a citation in the text, first author named in the text and length of the citation (McCain and Turner, 1989, Paul, 2000, Peritz, 1983, Safer and Tang, 2009, Sombatsompop et al., 2006, Tang and Safer,</p>	<p>Which quantitative indicators of the importance of a citation can efficiently and effectively be applied?</p>	<p>The number of citation occasions is the best quantitative indicator of importance of a reference that can be reproducibly applied to provide good comparison with expert views.</p> <p>There is a strong positive correlation between number of citation occasions and importance for citing articles ($r=0.976$) and citing reviews ($r=0.947$). 20% of references cited on 3 or more occasions and 2% of references cited on less than 3 occasions are important. Similar findings are</p>	<p>P5, P6</p>

<p>2008, Zhu et al., 2015). Further details can be found in P5.</p>		<p>obtained for reviews.</p> <p>Using the number of citation occasions helps to filter out citations that are much less likely to be important to the citing paper. Still only a minority of those getting through the filter are important.</p>	
<p><i>Using qualitative analysis of citations</i></p> <p>Consistency and time required to conduct qualitative analysis of citations are major drawbacks (McCain and Turner, 1989).</p> <p>Agreement was limited when assessors were asked to categorise citations based on four definitions of their use within the citing paper (Hanney et al., 2005).</p> <p>Even experts are not in complete agreement on the importance of a citation within a citing paper (Allen et al., 2009)</p>	<p>How can the importance of a reference be effectively determined by non-expert assessors using citations?</p>	<p>In the test phase, the non-expert assessors' opinions on the types of role played by the references were too varied for use as a categorisation procedure in the pilot. Using a straightforward informed identification of those citing papers where the reference is very important (Central) is more effective.</p> <p>For a group of four non-expert assessors, and a large body of assessments, total agreement on importance of a citation is found for 75% of assessments, 3 out of 4 agree on 19% of assessments, verdicts are evenly split on 6% which go on to further assessment.</p>	<p>P5, P6</p>
<p><i>The role of self-citations in evaluation of research impacts</i></p> <p>Self-citations are usually excluded from quantitative research evaluation to avoid distortion of the assessment but some think that they could be at least as important as non-self-citations (Harzing, 2010, Safer and Tang, 2009, Tang and Safer, 2008, Cave et al., 1997, Kacmar and Whitfield, 2000).</p> <p>The number of citation occasions may not reflect the importance of a self-cite in the same way as a non-self-cite (Hanney et al., 2005, Safer and</p>	<p>Should self-citations be included in an assessment of the wider impacts of research?</p>	<p>Evidence shows that self-cites are important in qualitative citation analysis e.g. the percentage of self-citations varies from 9% to 51% across the key articles studied. Important self-citations vary from 25% to 71% across the same key articles and should perhaps at least not be excluded from qualitative citation analysis. Self-cites may have a greater level of importance than non-self-cites when tracing the influence of research.</p>	<p>P5, P6</p>

<p>Tang, 2009). Authors judge the importance of a self-cite in a different way to a non-self-cite (Safer and Tang, 2009).</p>			
<p><i>Studying the pathway from research to indirect impact using qualitative citation analysis</i></p> <p>Whether indirect citations should be included in standard bibliometric analysis has been discussed (Dervos and Kalkanis, 2005, Hu et al., 2011).</p> <p>Rousseau (1987) proposed a mathematical evaluation of the total influence of a referenced paper which included the direct as well as indirect references.</p> <p>Hanney et al developed a method of tracing influence over generations of citations but encountered legitimacy and feasibility problems that needed to be overcome.</p> <p>Technical literature can be used to trace the impacts of research. Kostoff et al (2001) used a text mining methodology to select citing papers for analysis thereby limiting the numbers requiring analysis and making the operation feasible. To go beyond the second citation generation at least part automation of the text mining was found to be necessary.</p>	<p>What methods could be used that make tracing citations across many generations in order to identify indirect impact both feasible and credible?</p>	<p>By filtering based on citation occasions, and focusing on the important ones, we found that tracing through generations of citations to indirect impacts across up to six generations of citations becomes both more feasible and intellectually more credible, than previously thought possible. We identify citations in clinical guidelines to some papers in generations 2, 3 & 4 of the citation streams. These indirect citations could provide evidence of wider impacts at national, international and global levels but attribution issues remain and are discussed in Chapter 5.</p>	<p>P5, P6</p>

Summary:

The contribution to knowledge that this portfolio of research provides is summarised below.

Direct pathway: Investigating the importance of journals to clinicians.

- Journals are read widely and considered to be important to clinicians across three UK medical specialties in order to inform their clinical practice
- Comparisons of JIF and the journals that are considered most important by psychiatrists, surgeons and paediatricians are complex. This implies a need for caution in their use for the assessment of biomedical research outputs.

Indirect pathway: Investigating the role of successive generations of citations for indirect societal impact

- By filtering based on number of citation occasions and focusing on important citations, tracing indirect impacts across many generations of citations becomes more feasible and intellectually more credible but questions remain about attribution.

Chapter 4 – Evaluation of impact

In this chapter, I draw on several categories of impact from Buxton and Hanney's Payback Framework (1996) to help analyse the impact from my portfolio of papers. The first two categories are traditional academic impacts i.e. knowledge production; and targeting of future research; and the third category is a wider societal impact i.e. impacts on policy/decision making. However, the Payback Framework was developed principally for the assessment of the impact of health research. Its categories of impact can take on different meanings when assessing the impact of research on research. For example, in this current analysis the policies and practices that might be informed are those of groups involved with the transfer and assessment of research knowledge, including journal editors and medical libraries.

This chapter includes, first, a description of the four-step method used to assess the impacts from the six papers. Then, a separate account for each strand of work of how I apply this method to analyse the contribution to knowledge (overlapping with Chapter 3), and examine the impacts on follow-on research and impacts on policy.

The methods used to analyse impacts

A traditional simple method of citation analysis is applied in Step 1. In Step 2 I use a standard impact assessment approach of examining citations to find evidence of impact on policy, etc. For the third and fourth steps I draw on one of the aims of the body of work itself: to develop a novel methodology for collecting further data by citation analysis that may add to the impact information collected by traditional methods. I use the method that we developed in P5 and P6 to extend the impact analysis of my portfolio of papers i.e. P1-P6. Below, I provide an account of each of the four steps.

1. Using Google Scholar (GS) a brief, simple bibliometric analysis of the citations to papers P1-P6, by strand of work.
2. Using GS, citations to papers P1-P6 (and Central papers if they have progressed through Steps 3 and 4) are examined to identify evidence of impact on policy etc.

3. P1 to P6 together form Generation 1. All citing articles containing three or more citation occasions, and all citing reviews with two or more citation occasions, to a Generation 1 paper are assessed using the respective HERG Assessment of Citations Templates (HACT) that we describe in P6. Those papers assessed as important (Central) form Generation 2.
4. Citations to papers in Generation 2 are similarly selected based on the number of citation occasions and assessed as Central or not, using the relevant template, to create Generation 3. This procedure is similarly used to create Generation 4 and Generation 5. GS citations to all papers included in Generations 2-5 are examined for evidence of impact as in Step 2 above.

Further details of the procedures described in Steps 3-4 above are included in Papers P5 and P6. There are various differences in the methodology used here in comparison to that described in P6. I used GS to source citations, whereas in P6 the WoS was used. Advantages of using GS include:

- The expected types of impacts from this area of research arise in a broad range of documents eg official reports and other grey literature (Prins et al., 2016, Sibbald et al., 2015).
- All six portfolio papers are covered in GS instead of three papers in WoS. The three not included in WoS are either published in relatively new open access journals not covered by WoS at the time of publication, but covered since that time, or because the paper is published in a special issue, not included in WoS, although the parent journal is.

Disadvantages of using GS include:

- The less rigorous structure and level of organisation
- Citations may include duplications, unpublished documents and other non-peer-reviewed documents.

GS has been discussed as a tool for citation analyses in recent years (Falagas et al., 2008, Prins et al., 2016), but is relatively new. The WoS has been available for much longer, at least for bibliometricians to access, and has been more extensively

analysed and understood as a tool for citation analysis. The use of GS should therefore be treated with caution, and included citations checked carefully.

A further difference in the methodology I use is that here I have traced impacts to a portfolio of papers (P1-P6) whereas in P6 each citation stream relates to just one key research paper that forms Generation 1.

A third difference is in the identification of impacts. In the method discussed in P6, citation of the key research article or a Central paper in a clinical guideline is used as evidence of impact (Grant et al., 2000, Thelwall and Maflahi, 2016). However, as my portfolio of work has been a study of research on research, I have studied the citations to P1-P6 or to any Central paper included in the citation stream in a wider range of documents. As these citing papers are not expected to have the same level of importance as clinical guidelines, I discuss below my reasoning for considering them to provide evidence of impact.

This impact analysis is conducted by one person, myself, unlike in P6 where four post-graduate assessors (and, if necessary, the two researchers) assess each citation.

Study of a direct pathway: Investigating the importance of journals to clinicians.

Topics I discuss here include impacts related to policy and practice, and also informing further research and insights on research evaluation that contribute to the understanding of pathways and informing impact assessment. Areas covered include the differences in information seeking habits of clinicians relative to academics, and how research evaluation and the use of JIF potentially compromises the availability of relevant research to some clinicians. The final topic is quite complex with many differing but overlapping issues.

Bibliometric summary of the contribution to knowledge made by my papers studying Pathway 1

A brief bibliometric analysis of papers P1 - P4 is summarised in Table 4.1. Eighty four citing papers to the whole strand includes 100 citations when cites to more than

one paper are taken into account. The highest cited paper (P1) has received 47 citations. The earliest citations were received in 2004 and the latest in 2017. The geographical spread of the citations for the portfolio of six papers (including P1-P4), either due to the location of the first author or the source of the data included in the study, is displayed in Figure 4.1 and includes countries in Europe, North America, South America, Asia and Australasia. Languages of publication include Croatian, German, Iranian, Portuguese and Spanish.

Table 4.1: Bibliometric analysis of papers studying Pathway 1 using data collected from Google Scholar

<i>Parameter</i>		<i>Number</i>	<i>Cites/year</i>
Citations to	Papers studying Pathway 1	100	-
	Paper P1 (2004)	47	3.6
	Paper P2 (2006)	23	2.1
	Paper P3 (2007)	23	2.3
	Paper P4 (2008)	7	0.8
Citing papers		84	-
Citing papers not available for detailed analysis*		28	-
Papers citing a body of research (citing more than 1 paper from P1-P4)		12	-
Locations** for citing papers (excluding the UK)		23	-
Languages of publication for citing papers (excluding English)		5	-
Citing reviews/discussions in Generation 2 passing the initial filter of 2 citation occasions		2	-
Citing papers in Generation 2 passing the initial filter of 3 or more citation occasions		5	-

*Including those not published in English, those not available from Brunel Library or via the internet and PhD theses

**Location of first author or source of data

- Not applicable

Scrutiny of citations to papers P1-P4 (Step 2 of the method) is possible as the numbers involved are relatively small. However, additional information identified using Steps 3 and 4 of the method has been used to inform the selection of impacts discussed below. Details from some citing papers (See Table 4.1) where more than one of the papers P1-P4 has been cited (citing a body of knowledge) have also been discussed as Greenhalgh et al (2016) noted “the impact of programmes of research may be greater than the sum of its parts”. Selected papers that do not conform to the usual scientific article or review type or structure e.g. editorials have also been noted and discussed where they have been considered to be particularly important.

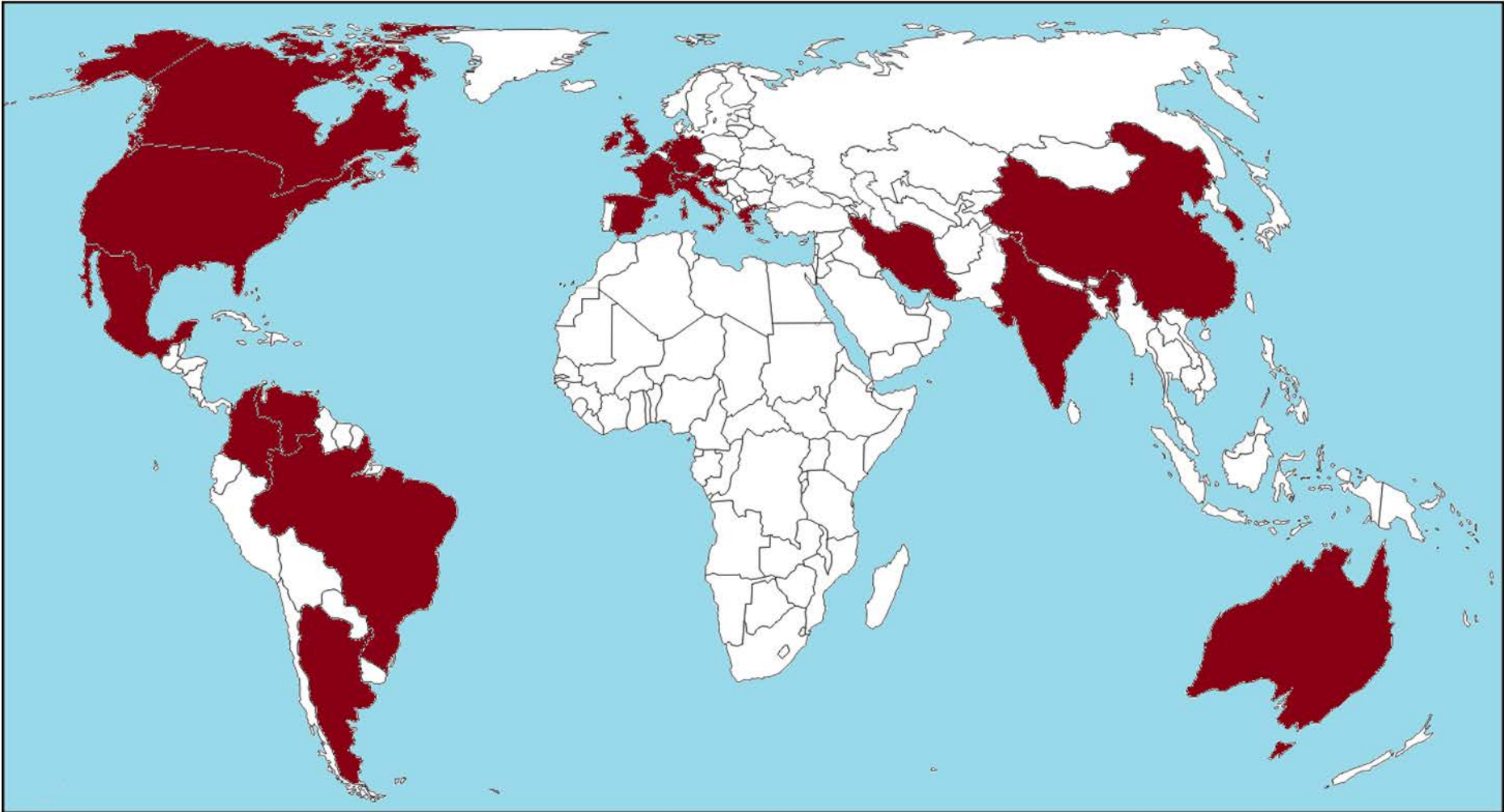


Figure 4.1: World map illustrating the distribution of citations to the six papers (P1 – P6) included in my portfolio (by location of the first author or the source of the data included in the study)

Application of Step 3 of the method to the 84 citing papers identifies two reviews/discussion articles with two or more citation occasions to P1-P4 (Weiss, (2007); Escudero-Gomez et al, (2008)) and five articles that contain three or more citation occasions, including one self-cite, (Gehanno et al, (2011); Sambunjak et al, (2009); Rutters et al, (2010); Herbella et al, (2010) and Jones et al, (2008)). These are considered in Step 4 of the analysis. The self-cite, P4 - Jones et al 2008, as noted previously is based on data collected in the surveys described in each of P1, P2 and P3. Papers P1, P2 and P3 are each cited in P4 on three or more occasions and would be classified as Central. Citing review, Escudero-Gomez et al (2008) and citing article Herbella et al (2010) are not considered to be Central and therefore are not discussed below.

Figure 4.2 displays the citation stream for papers studying Pathway 1 against year of publication of the citing paper. Figure 4.2 contains the four G1 papers (P1-P4) plus the Central citations in generations G2-G5 and those citing papers that are probably Central but the language of publication restricts fuller analysis. The nomenclature I use in the figure to label each paper provides the citation generation, after G1, in which Centrality is identified (eg G2, G3, G4, and G5), followed by the name of the citing paper's first author and, last, the name of the first author of the cited paper (e.g. 'G3 Ovseiko cites Weiss', located approximately in the centre of the figure, refers to a paper published in 2012 from Generation G3, with first author Ovseiko, that contains a Central citation to a G2 paper by Weiss). For the papers that are from my portfolio, the names P1-P4 have been used rather than Jones to help clarify which of the four papers is cited.

This citation stream provides both an illustration of the progress of the research from publication of P1 - P4 onwards to the current time and also an opportunity to identify further impacts across generations of citations. The impact analysis I describe in the narrative below focuses on targeting of future research and impacts on policy and practice.

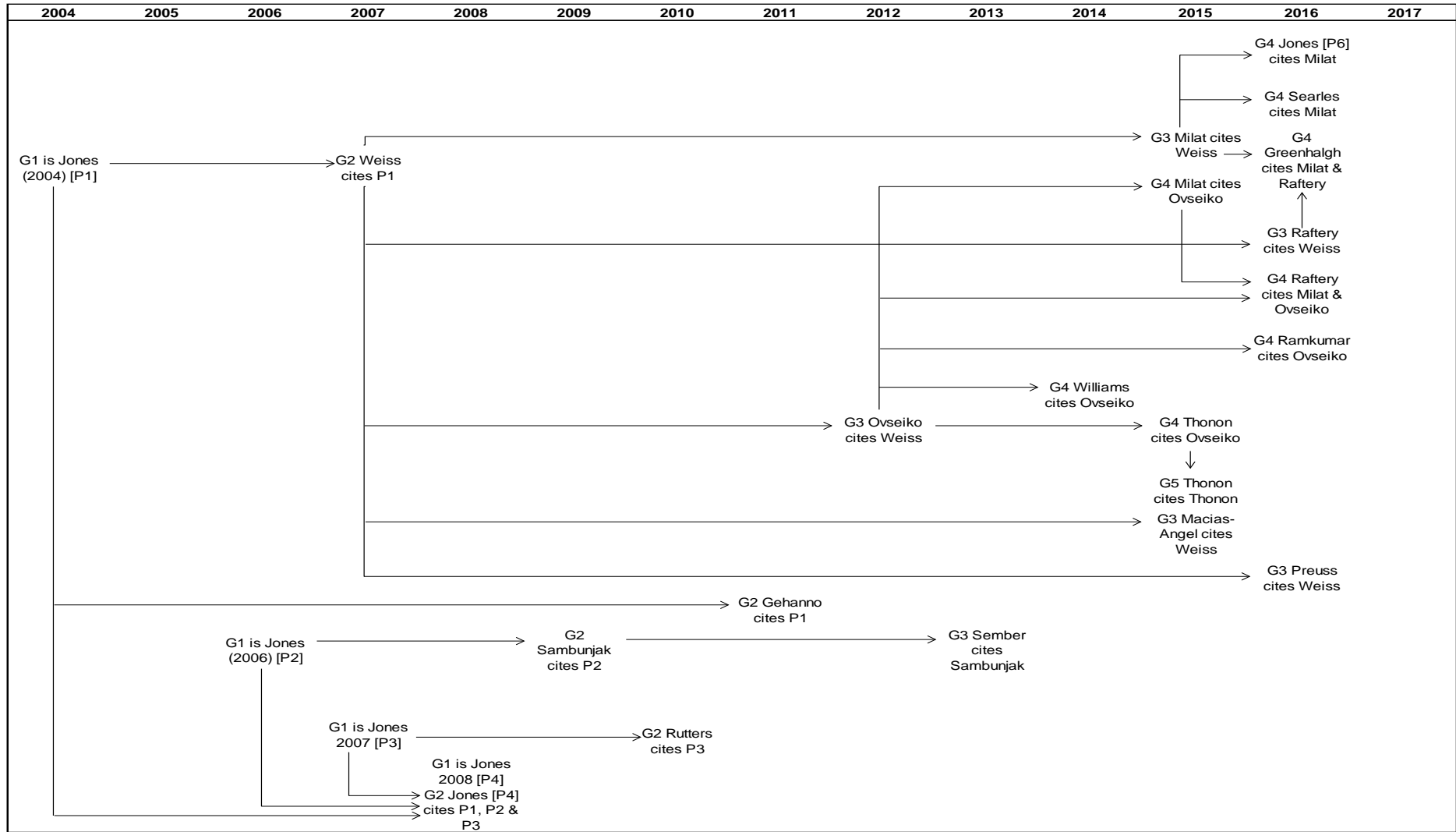


Figure 4.2 Citation stream produced by application of the novel method of tracing impacts across numerous citation generations to papers P1-P4

The effect of the research on the targeting of future research

As noted in Chapter 1, Weiss's review (2007) of methods of research impact measurement suggests a structure for this measurement based on outputs and outcomes. P1 is cited on two occasions in Weiss (2007) and my analysis using Step 3 indicates that the reference could be considered to be important, fulfilling the stated requirements for classification as being Central, as Weiss cites P1 along with others to help him to develop his argument (See Figure 4.2). P1 was reference 54 in Weiss's work, he wrote:

“Studies of the reading habits of psychiatrists (54) and surgeons (55) show that the most widely read journals in these fields do not all have high impact factors....Surveys indicate that clinicians have only a few hours per week to read the literature and that they tend to read only a handful of the 15,000 biomedical journals currently in publication (53–55, 59–64). It is therefore not surprising that clinicians may turn to secondary and tertiary channels of information to learn about recent scientific evidence (59, 65). The journal impact factor alone is unlikely to capture the degree to which these multiple channels transmit scientific information to clinicians and decision makers. Measuring the penetration of research into the clinical domain is thus a complex but important first step in assessing the impact of science on patient health.” (Weiss, 2007)

Then, applying Steps 3 and 4, a considerable portion of the citation stream in Figure 4.2 develops by tracing through Central citations from P1 through Weiss's review and onward for a total of five citing generations. Weiss is cited 71 times (on 10th May 2017) and this stream becomes quite complex from 2012. It includes Central citations in numerous studies and reviews including in generations G3 and G4, a Health Technology Assessment (HTA) report (Raftery et al., 2016) on measurement of research impact (See Figure 4.2).

Whilst any contributions from P1 in Raftery et al (2016) are possibly small they may be important pieces of information contributing to impacts. We previously found attribution very difficult to assign (P6), as others have (Kostoff, 1998, Rousseau, 1987). But Raftery et al's study (2016) relates to research evaluation and perhaps it is reasonable to assume that the important issue progressing via the citation stream at least relates to the citation of P1 in Weiss (2007) which, as set out in the quotation, also relates to research evaluation. I discuss attribution more fully later.

Many citations to P1-P4 (and Central papers in the citation stream for P1-P4) relate to issues, often overlapping, that affect uptake of research findings, particularly in relation to the information needs of clinicians. Some citing papers discussing these topics are published in languages other than English, limiting the level of assessment that I can reasonably undertake.

Gehanno et al G2 (2011) cite P1 (3 citation occasions) and P2 (2 citation occasions) illustrating how psychiatrists and surgeons rely on a few journals to inform their clinical practice. They found varied coverage of general and internal medicine sub-specialties in the top four general medical journals. They conclude that if practitioners are not aware of, or are not considering, this varied coverage when deciding which journals to read that they risk missing much relevant information and also may not be aware that they are doing so. Although this citation is identifiable using Steps 1 and 2, application of Step 3 shows that it is probably Central (See Figure 4.2).

Sambunjak et al G2 (2009) are concerned that the influence of JIF is driving editors of general medical journals to change from publishing in the national language, Croatian, to English to give broader appeal to the journal and potentially widen readership. This change of practice does not serve the needs or reading habits of local medical practitioners. Sambunjak et al cite P2 (4 citation occasions) and P3 (1 citation occasion), and would be Central (See Figure 4.2) as P2 makes significant contributions providing evidence of the few journals that clinical practitioners read and that importance to clinicians does not necessarily correlate with a high JIF, particularly for national journals. They also cite P2 in the discussion as evidence supporting their similar findings of academics spending more time reading journals than non-academics, and that journal availability as part of membership influences readership.

Further discussion by Sambunjak et al (2009) refers to language of publication as a confounding issue in journal publication that is very important to Croatian clinicians. De la Portilla Geada G2 (2014), editor of *Salud Mental*, cites P1 (identifiable with Steps 1 and 2, not Central) in combination with many other citations in an impassioned piece about the need to recognise languages other than English, such as Spanish, in science publication. He argues this will benefit authors and readers

for whom English is not their first language as well as be of benefit to science. Six further articles citing at least one of our papers (none in English, all identifiable using Steps 1 and 2 and individually probably not Central) discuss language of publication.

Use of impact analysis Steps 3 and 4 on Sambunjak et al (2009) identifies a citing article, G3 Sember cites Sambunjak (2014), where Sambunjak et al is cited on three occasions in a paper discussing Croatian as the language chosen for publication by medical students (See Figure 4.2). Sember et al found the percentage of papers published in Croatian fell considerably from 2000 to 2010. As Sember et al's article is published in Croatian I am unable to determine Centrality.

Hoffman et al G2 (2012) study the scatter of research that relates to the diseases with the highest burden. They consider RCTs and Systematic Reviews to be accessible forms of information for clinicians. Hoffman et al cite P1, P2 and P3 (not Central unless considered as a body of knowledge) to inform their findings. Our findings are used as evidence informing Hoffman et al's conclusions that the scatter of published reports of RCTs and Systematic Reviews mean that medical specialists are not accessing all potentially relevant information for their clinical practice. This citation is identifiable using Steps 1 and 2 and is not included in Figure 4.2.

The impacts of the research on policy/decision making and practice

Some issues in the previous section are also important to journal editors and editorial policy. I applied impact analysis Steps 1-4 to citing papers in this category as much as possible. The discussion below includes citations to 'bodies of knowledge' and editorials. Impact assessment findings from such citations are not included in Figure 4.2.

De Dios et al's G2 (2011) article examines reading habits of primary care physicians in Spain connecting the role of journal editors with the need to consider language of publication. De Dios et al found similar results to ours (citing P1, P2 and P3), and also that the readers' preferred language is an important consideration. These citations to our papers, identifiable with Steps 1 and 2, are significant using Step 3 if assessed as a body of knowledge as they are used to inform the background to the

research and to support their conclusions. A supporting editorial response highlighted De Dios et al's conclusions.

Tyrer G2 (2004) cites P1 in his *British Journal of Psychiatry* editorial as our study shows how it is the only specialty journal widely read across the whole specialty, and he spells out the policy implications for the journal itself in terms of coverage of the whole specialty.

“Jones et al (pp. 251–257) reveal the results of a questionnaire survey of UK psychiatrists. I was surprised to find that the *British Journal of Psychiatry* and the *BMJ* were so far ahead of the rest of the field. This emphasises the responsibility of the *Journal* towards its readers. If no old age psychiatrists read the *Journal of Child Psychology and Psychiatry and Allied Disciplines*, and no child psychiatrists read *Age and Ageing*, then we must make sure that the major advances in each subject are reflected in some way in the *Journal*.” (Tyrer, 2004)

As editor, Tyrer was very concerned that the JIF was not suitable for an assessment of value to clinicians. He wrote letters to the *Canadian Journal of Psychiatry* G2 (2005) and *Epidemiologia e Psichiatria Sociale* G2 (2007) about their journals' progress and citing Paper P1 to illustrate his comments about the mismatch between JIF and the preferences of the reader.

Tyrer, G2 (2013) when stepping down as editor, comments on his aims when he first took up office and the changes that had occurred since. For his measure of the appeal of the journal to clinicians and researchers, Tyrer quotes P1 as the only real evidence when he took up office. Bhui, G2 (2013) on taking up the editorial role from Tyrer, provides some insight on his ideas for taking the journal forwards and again voices concern that the value of the journal is not expressed well for all readers by JIF, citing P1 as evidence.

Taylor G2 (2007), as editor of the *Annals of the Royal College of Surgeons of England*, lays out his role as he sees it to provide a 'clinical, practical and technical surgical journal'. He includes a single reference, P2, as evidence of the high readership of the *Annals*.

Other policy considerations in citations to papers studying Pathway 1 include policies of provision by medical libraries. Rutters et al G2 (2010) describe the development of

the German Medical eLibrary portal as a source of evidence-based high quality information in a quick, easily accessible manner to clinicians. The authors include three citation occasions to P3 describing the information needs of paediatricians (See Figure 4.2). However, as the paper is published in German, I am unable to determine the importance of the reference.

Bardyn et al G2 (2009) describe the construction of a tool to help inform the development of an effective medical library collection. Their aim is to develop a tool that can be easily adapted for use by other specialty areas within medical libraries. They value direct input from clinicians and cite P1, P2 and P3 (body of knowledge but probably not Central as they are cited with others in making the same point) as evidence of the importance of journals to clinicians as well as the few core journals read within each speciality and sub-specialty.

Analysis using Step 1 includes Steele et al's G2 (2011) review and rationalisation of journal subscriptions provided by a mental health trust that is used to inform their subscription service in 2010 - impact on practice - and is also intended to inform the Trust's future policy and practice. They cite P1, amongst others, as evidence that JIF does not well reflect the value of journals in a clinical setting. Steele et al consider the opinions of users to be more helpful in informing journal subscription choices than the 'quality' of the journals or those most cited.

Some findings from the P1-P4 surveys are beginning to be used in practice as part of assessments of research impact, for example ones using the Payback Framework, where it is suggested articles in widely read journals are likely to have been seen by many practitioners (Hanney et al., 2007). P2 has been cited in a case study to illustrate why the specific piece of research is likely to have been widely read by clinicians.

Study of an indirect pathway: Investigating the role of successive generations of citations for indirect societal impact

The impacts made by this strand are mostly insights on research evaluation. These include a methodological development for assessment of a specific aspect of research impact, proposed new sources of citation that could indicate clinical impact

and also an example of how our methodology, once developed, could have extended a research evaluation case study.

Bibliometric summary of the contribution to knowledge made by papers studying Pathway 2

Results of the brief bibliometric analysis are included in Table 4.2. There are 13 citations in total to date most citing P5. The earliest citation was in 2013 and the latest in 2016. One citing paper is published in Portuguese; all others are published in English. The locations of the first authors or the sources of the data analysed in the study include: Brazil, Canada, Iran, Netherlands and the USA as well as the UK (See Figure 4.1).

Table 4.2: Bibliometric analysis of papers studying Pathway 2 using data collected from Google Scholar

<i>Parameter</i>		<i>Number</i>	<i>Cites/year</i>
Citations to	Papers studying Pathway 2	13	-
	Paper P5 (2012)	12	2.4
	Paper P6 (2016)	1	1.0
Citing papers		13	-
Citing papers not available for detailed analysis*		2	-
Papers citing a body of research (citing more than 1 paper from P5-P6)		0	-
Locations** for citing papers (excluding the UK)		6	-
Languages of publication for citing papers (excluding English)		1	-
Citing reviews/discussions in Generation 2 passing the initial filter of 2 citation occasions		0	-
Citing papers in Generation 2 passing the initial filter of 3 citation occasions		1	-

*Including those not published in English, those not available from Brunel Library or via the internet and PhD theses

**Location of first author or source of data

- Not applicable

As the two papers included in this strand are relatively recent publications, Step 4 of the impact analysis to trace across generations of citations is not necessary. One citation is cited on three or more occasions. This self-cite (P6 citing P5) is Central as the study in P6 is directly based on the literature search in P5. (It also illustrates why self-cites might be extremely important in tracing the impact of research through generations of citations.)

The impact of the research on the targeting of future research

Citations include a paper by Wathen et al G2 (2013) discussing their new methodology developed to search for evidence of the translation of trial findings on screening for intimate partner violence. The authors consider that a new methodology is required to investigate the processes of knowledge transfer as the expected processes had not occurred. P5, our literature search, informs their new methodology.

“we created a comprehensive search and analysis strategy, which we call a ‘modified citation analysis’, to capture both scholarly and grey literature..... using aspects of the method described by Jones et al.” (Wathen et al., 2013)

The majority of the remaining citations to papers in Pathway 2 study or discuss research evaluation. Some citing papers examine citations in various documents as potential evidence of clinical impact. Turner et al, G2 (2015) study the impact of the National Institute for Health Research (NIHR) HTA programme using citations to its research in the National Institute for Health and Care Excellence (NICE) clinical guidelines. They cite P5 to support their comment on how useful and important they consider it to be to track research output. Thelwall & Kousha, G2 (2016) look at citation in clinical trials as a method of collecting evidence of impact and a way of addressing the bias that citation analysis has towards the academic researcher. They cite P6 as an illustration of the often lengthy pathways for tracing impact from biomedical research to clinical practice as measured by clinical guidelines. In an earlier paper, Mohammadi & Thelwall G2 (2013) propose the use of F1000 papers as a new potential tool in collection of evidence, citing P5 in their description of the motivations for citations.

Others use our research to illustrate how their research impact evaluation work can be expanded. For example, in their impact study of the Public–Private Center for Translational Molecular Medicine (CTMM) in the Netherlands, Steuten et al G2 (2016) comment that a full research assessment as indicated in our paper P5 could reveal more impacts.

Summary

The main impacts of my portfolio of papers as I describe in this chapter are analysed using a 4-step method. This includes a traditional bibliometric analysis, supplemented by information found by applying the novel method of exploring the wider impacts of research across numerous generations of citations described in P6. Identified impacts include:

Direct pathway: Investigating the importance of journals to clinicians

- A Central citation taken through to G4: a HTA report on measurement of impact. This impact of my work is identifiable by application of the novel method I describe in P6.
- Impact on research studying how local journals becoming more international results in relevant research being less available to local clinicians. Language of publication is a confounding issue.
- Impact on journal editorial policy and on medical library provision that aims to ensure as much relevant research as possible reaches clinicians.

Indirect pathway: Investigating the role of generations of citations for indirect societal impact

- Impact on new methodological developments, on the study of the impact of the NIHR HTA programme and on studies of potential new sources of impact for inclusion in assessment of biomedical research.

Chapter 5 – Discussion

In this critical review I have examined my portfolio of six published papers and discussed the coherence of the research described. I have provided a critique of the methodologies used and the additional knowledge that the research has provided, and I examined the impacts from that work. My overall findings from the work are that:

- Access of journals by clinicians can play a direct role in informing clinical practice, but only a few journals are widely read in each specialty;
- Tracing through important papers across numerous generations of citations can increase understanding of the indirect impacts of biomedical research and further inform research assessment.

Strengths of this thesis

In preparing this thesis I have increased understanding of two translational pathways - Pathways 1 and 2 – that are built on sophisticated, respected and long-standing data sources.

The work that I conducted over the last six months in the construction of this critical review has enabled me to conduct research on ‘research on research’. I reflected on the methods used to study the two pathways and examined the contributions that my portfolio of articles had made to understanding of those two pathways.

An additional strength of this critical review is that it has allowed me to apply further our novel method (developed in P5-P6) and, in doing so, to identify the impacts of the work. I have also been able to set my work - originally started in 2002 - in the continuously evolving and current contexts, and examine its limitations.

To the best of my knowledge, no one has conducted such an extensive study of these two pathways previously, and in doing so, this thesis has contributed to the discussion on research evaluation by providing additional ways of understanding pathways from research to clinical practice.

By focusing in the Pathway 1 study on systematic surveys of clinicians from three diverse medical specialties - psychiatry, surgery and paediatrics - my colleagues and I expanded the knowledge base about the views of clinicians on the journals (including general medical journals) that they read and that they considered to be important to their clinical practice. As far as I am aware, we have taken this area of work further than has been done previously in order to inform medical specialties more widely.

Identifying the apparent importance of the role that certain specific journals play for clinicians is informative not just to journal editors, but also to others including readers of research, authors of research articles, medical library managers and those interested in research evaluation (Blecic, 1999, Council for Medical Sciences, 2002, Lewison, 2002, Traynor and Rafferty, 2001, Weiss, 2007). By examining the impact of my papers, I became aware of the particular strength of this aspect of my work. I was able to identify examples of impact on the development of research impact measurement methodology (Weiss, 2007), and on the policies of some journal editors (Tyrer, 2004, Taylor, 2007) and medical library managers (Bardyn et al., 2009, Rütters et al., 2010, Steele, 2011). Citations to my work also indicate that it adds to the discussion on the need for effective transmission of research findings to clinicians. My work has increased understanding about various overlapping issues including language of publication, publication in national versus international journals, the role of membership journals and the relevance of JIF (de la Portilla Geadá, 2014, Sambunjak et al., 2009). Some of these issues particularly affect clinicians in many non-English speaking countries and, perhaps more noticeably, in less wealthy and developing countries (Hicks et al., 2015, Sambunjak et al., 2009). I also found some evidence of the impact of my work on practice in an impact study of the NHS HTA programme (Hanney et al., 2007) where paper P2 had been cited in a case study to illustrate why the specific piece of research was likely to have been widely read by clinicians.

Study of Pathway 2 includes the development of a novel methodology for citation analysis that involves both quantitative and qualitative elements. Impacts of four chosen key research articles were assessed by identifying citations of Central importance and studying the development of the research across six generations of

citations. The citation streams produced (See P6) illustrate the pathways from those research publications to citation, often many generations later, in clinical guidelines.

In P6, a few findings at the prototype stage helped with the development of a novel method of citation analysis that could be applied across numerous citing generations. My colleague and I found that usually just a small proportion of references were important to a research paper (Chapter 3), in agreement with other research findings (Hanney et al., 2005, Kacmar and Whitfield, 2000, Prabha, 1983, Safer and Tang, 2009), and that the number of occasions when a reference was cited in a paper correlated well with the importance of that reference (McCain and Turner, 1989, Peritz, 1983, Safer and Tang, 2009, Sombatsompop et al., 2006, Tang and Safer, 2008). These findings, well supported by data (Chapter 3, p35), justified the application of a filter of three citation occasions for research articles to be included in the method. The combination of the identification of Central papers, and the use of the filter, enhanced both the legitimacy and feasibility of the assessment process. Discussion in the literature, described in P5, about the inclusion of self-citations in citation analysis has been inconclusive. Therefore, the role of self-citations in qualitative assessment of impact was also investigated in P6 and findings indicated at least the same level of importance as for non-self-citations. Our findings concur with Kacmar and Whitfield's (2000).

A major strength of my analysis of this pathway lies in the development of this novel methodology and the findings from the large body of data collected, including the citation streams for each key research article studied.

The impacts of this strand of work have been limited so far, partly due to the date of publication of the methodology paper (2016). However, in Chapter 4 I showed that the literature review published in paper P5 has been used by others to inform their knowledge transfer methodological work (Wathen et al., 2013) and research evaluation studies (Mohammadi and Thelwall, 2013, Steuten, 2016, Thelwall and Kousha, 2016, Turner et al., 2015). Given the illustrative citation streams that have been produced by the application of the new mixed method citation analysis, this method could potentially be useful for revealing impact in interdisciplinary areas and areas of research far from those of the authors of the original papers studied.

Limitations

In Chapter 2 I provide a justification of the methods used in both strands of the work, and include some details on the limitations at the time that the work was conducted. Here I will discuss the limitations of the findings more in the context of the current state of research and research evaluation.

My colleagues and I conducted the three surveys in Pathway 1 over a decade ago now. Therefore, the picture may have changed given that the volume of information available and the ways for clinicians to access information have continued to expand. Accessing a research article via the hard copy of the journal issue is no longer the only, or indeed usual, method of access. Journal issues as well as individual articles can be easily accessed via the internet. The expansion of the Open Access movement may have resulted in changes to the behaviour of clinicians as many more journal articles are free for the reader to access (Björk, 2017, Tennant et al., 2016). These developments may have had an effect on the preferences for membership journals that we, and Schein (2000), had found. This might increase the need for an update to the surveys. Conducting updates to these surveys would allow comparisons with the baseline information provided in P1-P4. Perhaps expanding coverage to other medical specialities and other countries would also be informative (Lewison, 2002). Tyrer (2003) suggested that it would be relatively simple for journals to run their own studies of individual journal usage as he had done. However, a more comprehensive exploration of journal readership and importance to clinicians would perhaps benefit from independent study.

Recent published research of a similar nature, but each examining one specific group of clinicians, includes the work of Le et al (2016) studying the information seeking habits of primary care physicians in Denmark, and Marques (2016) studying the variations in information available to psychiatric trainees across Europe. These studies found that journals played a significant, if not consistent, part in information provision and provide some updated data to our studies although for different groups. This perhaps gives an indication that, currently, journals are still of importance to some clinicians and possibly may be of similar importance in other specialties.

The work described in the papers studying Pathway 2 is more recent. To my knowledge, this new methodology has so far only been pilot tested in our own studies on a few research papers in two small areas of mental health research, and also used in the impact study of my portfolio of six papers included in Chapter 4. The methodology would benefit from further studies on more key research articles in order to provide additional data on the strengths and weaknesses of the HACT.

Attribution remains a complex issue facing impact assessment. Considerable progress has been made by focussing this analysis on citations that are Central to the citing paper but, attribution concerns are probably even more relevant when considering indirect impact through generations of citations. If, as previously discussed, determining the reason why a reference is included in a research article is difficult, then determining whether that reason is then what is transferred forwards into citations to the article, and then further on to later generations of citations, is increasingly more difficult. Previous work has also discussed how two citations to a paper may interpret the contents in quite different ways (Donovan, 2006) which further complicates issues of attribution. A further limitation has been the lack of resources to analyse citing papers published in languages other than English.

Other considerations include the specific journal article that is chosen as the G1 paper on which the impact analysis is conducted. As all research can be said to be somewhat based on earlier research, should an earlier article be selected, should a single article be the focus of a research assessment or would a body of papers from the same research group or project be more appropriate (Meagher et al., 2008)? The credit for research work should be appropriately assigned for research evaluation to be meaningful and although we have made some progress, attribution is complex and further work in this area would be beneficial. However, analysis described in the next section in relation to the REF might possibly suggest this problem is not necessarily as great as feared.

Implications and looking forwards

When the surveys were conducted we found journals were both widely read and considered to be important to clinicians. Updating the surveys and broadening their coverage to other specialties and clinicians would provide more current data for

comparison with our baseline. In the Leiden Manifesto, Hicks et al (2015) laid out guidance for best practice when conducting metrics-based research evaluation. One of their ten principles for research evaluation was that while quantitative indicators were very useful for supporting peer-review and reducing any potential for bias, they should not be used alone. If, as we had found, JIF seems to be an inappropriate or insufficient indicator of the importance of a journal to clinical practitioners, then it would seem to be important to either supplement its use with that of other indicators or to use alternatives (Lewison et al., 2001). Hicks et al (2015) also call for assessment of research that is of local importance to include reward for publication locally i.e. in the language of the community to which it is most relevant, rather than necessarily in journals with high JIF. My portfolio of papers has produced relevant findings on this issue which have subsequently informed further research and analysis.

Recently, according to the UK Clinical Research Collaboration, research spending has focussed more on the translation of research (2015). Furthermore, UK research evaluation has moved further towards the inclusion of assessment of societal impacts (Grant, 2014, HEFCE, 2015), a requirement that would seem to be increasing in complexity:

“We have recommended that impact should be interpreted much more subtly and broadly to link bodies of work and disciplinary or collaborative activity to outcomes understood from a more nuanced and deeper perspective.” (Stern, 2016)

In the context of a rapidly expanding knowledge base about research impact assessment it might be thought that there is less need for further approaches such as those developed in my portfolio of papers. However, as the quote from the Stern report shows, there is also increasing recognition of the complexities involved. Therefore, keeping track of the importance of journals as an information source to clinicians, and assessment of impacts many generations of citations later by use of the novel methodology developed in P5 and P6, may provide additional methods of informing the evaluation process by indicating further impacts.

An example of how this could perhaps be undertaken comes from a paper by Kuipers et al (1997) which had been included both in the UK REF 2014 as part of an

impact case study (<http://impact.ref.ac.uk/CaseStudies/CaseStudy.aspx?Id=41192>) and also in P6 as one of the key research articles studied i.e. a first generation paper in that study. A preliminary triangulation of the data collected from both sources has indicated potential additional impacts that can be identified by application of the HACT over six generations of citations, but fuller analysis of how far the problem of attribution could be overcome would also be important. Then further studies using the HACT could be conducted on topics known to have been the focus of REF 2014 case studies, and further triangulation conducted.

Another issue raised in the analysis of the REF 2014 was whether the length of time allowed for impact to have arisen was adequate. It was suggested that the 20 year period was not insufficient (Rosenberg, 2015). This might suggest, in turn, that it was not generally thought necessary to go too far back in order to find a reasonable starting point for impact assessment. Although, of course, tracing through the generations, may require longer to reach clinical outcomes.

Whilst the novel methodology developed in P5 and P6 has provided some interesting data, there could be significant benefit to using the method to study the wider impacts from further research articles. Building up a larger body of data would contribute to understanding the findings more fully. The workload involved in conducting the assessments could potentially be reduced by the introduction of automation or part-automation for some of the included processes. Studies on content analysis (Zhang et al., 2013) and electronic study of semantics (Knoth and Herrmannova, 2014) within a paper potentially could offer at least partial automation of the qualitative assessment stage of the method.

The novel methodology that I, together with my colleagues, developed remains resource intensive and, whilst the method may provide further understanding of the impacts of research over many generations of citations, use of the method would necessarily need to be decided on an individual case basis.

Conclusions

My work reveals how issues and approaches linked to journals, which were previously analysed very much in the context of academic assessment of quality, can also provide understanding of pathways from research to clinicians and how this impact could be assessed. But my portfolio of papers also helps to set out an agenda for future studies to make further progress and a baseline for additional studies of clinician readership of journals.

By revealing the importance of journals in informing UK clinical practitioners this research has provided input to the discussion on, and perhaps need for, research evaluation to take more account of direct impact on clinical practice. In addition, analysis through a series of generations of citing papers, with both qualitative and quantitative input, can help to illuminate the pathways from biomedical research to clinical practice and add to existing research evaluation methodology. There seems to be an increasing need to expand assessment of societal impacts of biomedical research. I have investigated two pathways from research to clinical practice with colleagues using (and in the study of Pathway 2 building on) existing well-organised and well respected data sources – journals, published articles and citations. Here I have critically reviewed this work. This research could be of interest to those many groups involved in biomedical journals as a form of communication and interested in biomedical research evaluation.

Appendix 1 - Author's Declaration

Summary of Teresa Jones's contribution to the published papers included in her submission towards a PhD by Publication

	Paper 1	Paper 2	Paper 3	Paper 4	Paper 5	Paper 6
Number of authors	4	3	3	3	3	2
Conception	25	30	30	40	45	40
Design	50	60	65	60	70	50
Execution/Data acquisition	90	90	90	90	95	65
Data analysis/ interpretation	75	80	80	90	85	85
Publication	40	45	45	70	90	85

Table: Estimated percentage contribution* by THJ to multi-authored papers submitted as part of her PhD by Publication

*The percentage contribution analysis is based on the guidance provided by the International Committee of Medical Journal Editors (ICMJE) 2017 on definition of authorship as well as the requirements of each publishing journal for the articles listed. Further details for the ICMJE definition can be found at: <http://www.icmje.org/recommendations/browse/roles-and-responsibilities/defining-the-role-of-authors-and-contributors.html>.

Paper 1 - Jones, T. , Hanney, S. , Buxton, M. and Burns, T. (2004) 'What British psychiatrists read: Questionnaire survey of journal usage among clinicians'. *British Journal of Psychiatry*, 185(1); pp.251-257 <http://bjp.rcpsych.org/content/185/3/251>

TJ's findings in the early stages of her NHS Research Fellowship identified the requirement for and informed the changes to the lines of investigation from the originally proposed project plan towards surveying about the journal read to inform clinical practice. TJ, MB, SH and TB were involved in the conception, planning, preparation and approval of the consequent survey questionnaire. TJ conducted and managed the questionnaire survey and data collection, including preparation of the first draft of the questionnaire and preparation of the list of names of recipients from the data supplied by the Royal College of Psychiatry. TJ carried out the data analyses, including preparation and presentation for discussion and publication, with additional intellectual input from MB, SH and TB. TJ wrote the first draft of the paper and all authors read and revised the text and approved the final manuscript. TJ liaised closely on the paper with TB who was based at the Warneford Hospital, University of Oxford. TJ was first and corresponding author.

The list of papers above includes all of the papers that are proposed to be submitted by Teresa Jones as part of the requirements for a PhD by Publication at Brunel University London and where I was a co-author.

I substantiate the contribution that Teresa Jones provided to each of the papers listed as portrayed in the descriptions and table of percentage contributions above.

Signature..... 

Name (Please print)..... TOM BURNS

Date..... 27. 01. 2017

Comments..... This is my clear recollection of what was a very thoroughly conducted piece of work lead effectively by T.J.

Summary of Teresa Jones's contribution to the published papers included in her submission towards a PhD by Publication

	Paper 1	Paper 2	Paper 3	Paper 4	Paper 5	Paper 6
Number of authors	4	3	3	3	3	2
Conception	25	30	30	40	45	40
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Paper 2 - Jones TH, Hanney S, Buxton MJ. The journals of importance to UK clinicians: a questionnaire survey of surgeons. *BMC Medical Informatics and Decision Making*. 2006;6:24. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1559602/>

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Paper 3 - Jones TH, Hanney S, Buxton MJ. The information sources and journals consulted or read by UK paediatricians to inform their clinical practice and those which they consider important: a questionnaire survey. BMC Pediatrics. 2007;7:1.

<http://bmcpediatr.biomedcentral.com/articles/10.1186/1471-2431-7-1>

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Paper 4 - Jones TH, Hanney S, Buxton MJ. The role of the national general medical journal: surveys of which journals UK clinicians read to inform their clinical practice. Medicina Clínica. 2008;131:30-5. www.elsevier.es/es-revista-medicina-clinica-2-pdf-13134418-S300

TJ, MB and SH were involved in the conception, planning and preparation of the work using data collected predominantly in the surveys reported in papers 1, 2 & 3. TJ carried out the data analyses, including preparation and presentation for discussion and publication, with additional intellectual input from MB and SH. TJ wrote the first draft of the paper and all authors read and revised the text and approved the final manuscript. TJ was first and corresponding author.

The list of papers above includes all of the papers that are proposed to be submitted by Teresa Jones as part of the requirements for a PhD by Publication at Brunel University London and where I was a co-author.

I substantiate the contribution that Teresa Jones provided to each of the papers listed as portrayed in the descriptions and table of percentage contributions above.

Signature..... *M J Buxton*

Name (Please print)..... *Professor Martin J Buxton*

Date..... *23rd January 2017*

Comments.....

As far as I can judge the nature and extent of Teresa Jones' contribution to the 4 papers for which I was a co-author as described above seems fair and accurate.

Summary of Teresa Jones's contribution to the published papers included in her submission towards a PhD by Publication

	Paper 1	Paper 2	Paper 3	Paper 4	Paper 5	Paper 6
Number of authors	4	3	3	3	3	2
Conception	25	30	30	40	45	40
Design	50	60	65	60	70	50
Execution/Data acquisition	90	90	90	90	95	65
Data analysis/ interpretation	75	80	80	90	85	85
Publication	40	45	45	70	90	85

Table: Estimated percentage contribution* by THJ to multi-authored papers submitted as part of her PhD by Publication

*The percentage contribution analysis is based on the guidance provided by the International Committee of Medical Journal Editors (ICMJE) 2017 on definition of authorship as well as the requirements of each publishing journal for the articles listed. Further details for the ICMJE definition can be found at: <http://www.icmje.org/recommendations/browse/roles-and-responsibilities/defining-the-role-of-authors-and-contributors.html>.

Paper 5 - Jones TH, Donovan C, Hanney S. Tracing the wider impacts of biomedical research: a literature search to develop a novel citation categorisation technique. *Scientometrics*. 2012; 93(1):125-34. <http://link.springer.com/article/10.1007/s11192-012-0642-8>

TJ and SH were involved in the conception and preparation of grant submissions for a project to explore the use of journals in the study of the impact of research on clinical practice using bibliometrics as a tool. TJ was named researcher on the project as she was not Brunel staff at that time. TJ and SH were involved in the planning and preparation of the project. TJ designed and conducted the extensive literature search, with additional intellectual input from SH. TJ analysed the findings with additional intellectual input from SH and CD. TJ presented the findings at an international conference in Istanbul, Turkey and following an offer from *Scientometrics*, a leading bibliometrics journal, wrote the first draft of the paper. All authors read and revised the text and approved the final manuscript. TJ was first and corresponding author.

The list of papers above includes all of the papers that are proposed to be submitted by Teresa Jones as part of the requirements for a PhD by Publication at Brunel University London and where I was a co-author.

I substantiate the contribution that Teresa Jones provided to each of the papers listed as portrayed in the descriptions and table of percentage contributions above.

Signature.....*Clare Donovan*.....

Name (Please print).....*DR CLARE DONOVAN*.....

Date.....*31/01/17*.....

Comments.....

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Summary of Teresa Jones's contribution to the published papers included in her submission towards a PhD by Publication

	<i>Paper 1</i>	<i>Paper 2</i>	<i>Paper 3</i>	<i>Paper 4</i>	<i>Paper 5</i>	<i>Paper 6</i>
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<http://bmcpediatr.biomedcentral.com/articles/10.1186/1471-2431-7-1>

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Paper 6 - Jones TH, Hanney S. Tracing the indirect societal impacts of biomedical research: development and piloting of a technique based on citations. *Scientometrics*. 2016; 107(3):975-1003. <http://link.springer.com/article/10.1007/s11192-016-1895-4>

TJ and SH were involved in the conception and preparation of grant submissions for the project. TJ and SH were involved in the planning and preparation of the project and the invitation of the experts to join the advisory group. TJ recruited, selected, trained and directed the group of eight postgraduate assessors. TJ developed and managed the assessment data collection procedures for both the test template and the pilot template with additional intellectual input from SH. TJ carried out the data analyses with additional intellectual input from SH and the group of experts. TJ and SH presented the findings, including TJ's identification of the possibility of increasing the efficiency of the assessment method and the importance of self-citations in this type of analysis, to meetings of the panel of experts. TJ wrote the first draft for the paper, both authors read and revised the text and approved the final manuscript. TJ was first and corresponding author.

The list of papers above includes all of the papers that are proposed to be submitted by Teresa Jones as part of the requirements for a PhD by Publication at Brunel University London and where I was a co-author.

I substantiate the contribution that Teresa Jones provided to each of the papers listed as portrayed in the descriptions and table of percentage contributions above.

Signature.....Stephen R. Hanney.....

Name (Please print).....STEPHEN R. HANNEY.....

Date.....13/4/17.....

Comments.....This is an accurate account of the contribution made by Teresa to each paper. It might be worth noting that the strand of work in the first four papers started sometime after Teresa had been appointed to the Health Economics Research Group at Brunel as the NHS ROD Fellow, and she was, therefore, fully involved in the design and conception of the work, as well as leading the execution of the work. The reduction in Teresa's role in the execution of Paper six was because by then she was also supervising and coordinating the work of a team recruited to assist her conduct the study.

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Appendix II – Paper P1:

What British psychiatrists read

Questionnaire survey of journal usage among clinicians

TERESA JONES, STEPHEN HANNEY, MARTIN BUXTON and TOM BURNS

Background The role of journals in disseminating research to clinicians is increasingly debated. Current measures of esteem for journals (e.g. impact factors) may not indicate clinical penetration.

Aims To assess the perceived importance of different mental health journals to psychiatrists' clinical practice and compare this with impact factors.

Method Random samples of psychiatrists providing child and adolescent, adults of working age and old age services chose up to ten journals read or consulted with regard to their clinical work, ranking the top three. For these journals, comparisons were made with impact factors and importance as outlets for UK psychiatry research.

Results A total of 560 questionnaires were completed (47%). Two membership journals (the *British Journal of Psychiatry* and the *BMJ*) were most read and highest ranked. Associations between impact factors, clinicians' ratings and importance as outlets for psychiatry papers varied.

Conclusions The results could lead to reconsideration of the importance of some journals. Academic assessments of the status of journals should not be assumed to reflect their influence on clinicians.

Declaration of interest T.B. is on the editorial board of the *British Journal of Psychiatry* and *Psychological Medicine*. The National Health Service Executive, London, funded the study.

The mission of many biomedical research funding bodies is to improve health (Wellcome Trust & NHS Executive, 2001; Medical Research Council, 2002) but to achieve this the relevant research needs to be disseminated effectively to clinicians. Publication of research articles in peer-reviewed journals plays an important part in this dissemination (Schein *et al*, 2000), although concerns have been raised about the effectiveness of passive dissemination in encouraging the uptake of research (Coomarasamy *et al*, 2001). There are few incentives for researchers to engage in research utilisation activities and the status of papers aimed at practitioners is uncertain (Tomlinson, 2000). Nevertheless, there are attempts to broaden the scope of health research assessment (Buxton & Hanney, 1996) and to identify the journals that are important to practitioners (Lewison *et al*, 2001). With the current emphasis on evidence-based practice, it is critical to understand what research reaches clinicians. We undertook to obtain the views of psychiatrists on the journals that they read with regard to their clinical work and to compare these with established measures of esteem used for journals.

METHOD

Definitions for the following categories were used for psychiatrists.

- (a) Child: psychiatrists specialising in the treatment of children and adolescents.
- (b) Adult: general psychiatrists and those specialising in the treatment of adults of working age.
- (c) Old age: psychiatrists specialising in the treatment of elderly patients.
- (d) Academic: psychiatrists with any part of their contract for dedicated academic sessions (excluding routine continuing professional development).
- (e) Non-academic: psychiatrists without any part of their contract for dedicated academic sessions (excluding routine continuing professional development).

National Health Service (NHS) Research Outputs Database

The Research Outputs Database was constructed by The Wellcome Trust (Dawson *et al*, 1998) and then maintained by the Centre for Information Behaviour and the Evaluation of Research, City University. It covers the full range of research publications, including basic and clinical sciences, in the peer-reviewed journals contained in the Science Citation Index and Social Science Citation Index databases. The Research Outputs Database contains bibliographic information from biomedical papers with a UK address, including details of funding acknowledgements. The NHS Research Outputs Database, a subset of the Research Outputs Database, has been constructed and contains details of papers from England that involve some element of NHS financial support (Wellcome Trust & NHS Executive, 2001).

The NHS papers have been identified using a filter for England that identifies them via one or more of the following: characteristics of the name of the author's institution, for example 'hospital'; the institution's postcode; or the funding acknowledgements on the paper.

Journal impact factors

Journal impact factors were obtained from the 2001 edition of the on-line Journal Citation Reports from the Institute for Scientific Information. The journal impact factor is 'a measure of the frequency with which the "average article" in a journal has been cited in a particular year or period. The annual JCR impact of a journal ... is calculated by dividing the number of current year citations to the source items published in that journal during the previous two years' (Garfield, 1994). A ranking order of journals within the 'psychiatry' category based on journal impact factors was also taken from the 2001 Journal Citation Reports for each of the citation indices (i.e. the Science Citation Index and the Social Science Citation Index).

Questionnaire survey

Psychiatrists' names and addresses

A sample of 1200 registered Members and Fellows of the Royal College of Psychiatrists was provided by the College. The Royal College of Psychiatrists does not allow access to its membership lists but agreed to supply address labels for one-off use to distribute the questionnaires. The NHS consultant psychiatrists were selected randomly via the Statistical Package for the Social Sciences statistical software (SPSS version 10.1) from within three patient-age groups (child, adult and old age).

Psychiatrists providing services for these three patient-age groups were present in the College's membership list in the approximate proportions 1:3:1, but equal numbers from each group were included in the sample. This was to ensure sufficient numbers in each group to allow detailed analysis.

Selected UK psychiatrists were asked, by questionnaire survey, which journals they read or consulted on a regular basis with regard to their clinical practice. To ensure anonymity no record of the participants was kept.

Questionnaire structure

A list of journals containing psychiatric research was extracted from the NHS Research Outputs Database using a mental health filter previously developed for the Research Outputs Database (Wellcome Trust & NHS Executive, 2001). The journals were ordered according to the number of papers on psychiatric research they published. To limit the list used in the study, the top 32 journals, accounting for 60% of UK psychiatry papers in the period 1990–1999, were presented in alphabetical order on the questionnaire. The questionnaire recipients were asked to tick up to ten journals that they read or consulted on a regular basis with regard to their clinical work and to rank the top three of these. In doing this they were invited to add journals missing from the list that they considered important for mental health clinical practice. They were then asked to provide brief details of the type of NHS contract they held, the number of academic and clinical sessions they worked, which patient age-group they worked with and which disorders they covered. The questionnaire is appended as a data

supplement to the on-line version of this paper and is available from the authors on request.

Questionnaire analysis

The data from the returned questionnaires were entered into a database. There were difficulties in identifying all the journals added to the questionnaires by the respondents, particularly because of the similarity of some journal names; therefore, a member of the Health Economics Research Group at Brunel University (Avril Cook, see Acknowledgements) independently checked these and the journal names were verified using *Ulrich's International Periodicals Directory* (Bowker, 2003) or the internet.

The psychiatrists' responses were collated and tabulated according to their type of practice, and the relationships between their rankings, journal readership and impact factors were examined.

RESULTS

Survey findings

A total of 560 questionnaires (47%) were completed and returned. The return rates for psychiatrists treating each of the three groups were: child, 49%; adult, 38%; old age, 52%. Those psychiatrists with some academic commitment formed 26% of respondents.

A substantial number of recipients added more journals to the questionnaire, bringing the total number of journals from the original 32 up to 156. Those journals that were not listed on the original questionnaire but appear in the summary tables have been marked with an asterisk. The 560 respondents ticked or added journal names on 3215 occasions. Out of these, 13 (0.4%) related to 10 unverified journal names that nevertheless were included within the database.

The difference in the median number of journals read by psychiatrists with academic commitments (ten journals or more) and those without (three journals) was statistically significant (Kruskal–Wallis; $\chi^2_1=7.823$, $P=0.005$). The percentage of 'non-academic' psychiatrists reading three journals or fewer was higher across all three age groupings but especially so in the adult group where the figure was 40%. Overall, approximately twice as many academics compared with non-academics read at least ten journals.

Tables 1 and 2 detail the specific journals that psychiatrists read and have ranked first, second or third with regard to their clinical work. A striking consistency was found at the top of each table, both across all age groups and between academic and non-academic psychiatrists. The two most prominent journals across the board were the *British Journal of Psychiatry* followed by the *BMJ*.

Table 1 shows that for adult psychiatrists these two journals dominated their reading habits. Both were cited by over 90% of the sample whereas the third most commonly cited journal (the *American Journal of Psychiatry*) was read by only 50%. Although both the *British Journal of Psychiatry* and the *BMJ* were still cited by about 90% of the child and old age psychiatrists, specialised journals became more prominent.

The importance of these specialised journals for child and old age psychiatrists was even more clearly reflected in their ranking of the journals (Table 2). Within each category there were only a small number of journals (between four and seven) ranked in the top three in importance for their clinical practice by more than 10% of psychiatrists (i.e. only a few are widely viewed as important; see Table 2).

Relationship of readership to the NHS Research Outputs Database and journal impact factors

Table 3 contains the same 31 journals as those that appear in Table 1: those journals read by 10% or more of psychiatrists in any category (by patient age or academic commitments). The numbers of psychiatry papers in the journals between 1990 and 1999 were identified through the NHS Research Outputs Database. The *British Journal of Psychiatry* is clearly the journal with the largest number of papers in the psychiatry section of the NHS Research Outputs Database and also is ranked as the most important to clinical practice overall. The pattern needs to be interpreted with caution because only a relatively small proportion of *BMJ* papers are related to psychiatry and the *Archives of General Psychiatry* publishes comparatively few papers per year.

The data on journal impact factors are presented in a number of ways in Table 3, including (in the final column) their position in the Institute for Scientific Information ranking of psychiatry

Table 1 Percentage of psychiatrists reading selected journals with regard to their clinical work (all journals read by at least 10% of psychiatrists in one or more category)

Journal	Patient age-group to whom psychiatric services are provided											
	All groups			Child			Adult			Old age		
	±	+	-	±	+	-	±	+	-	±	+	-
<i>British Journal of Psychiatry</i>	97	97	97	97	97	97	99	100	98	95	93	96
<i>BMJ</i>	89	90	89	85	90	84	91	88	92	93	91	93
<i>American Journal of Psychiatry</i>	38	48	34	25	32	22	50	73	41	39	44	38
<i>Journal of Child Psychology and Psychiatry and Allied Disciplines</i>	35	41	32	96	100	94	3	5	3	0	0	1
<i>International Journal of Geriatric Psychiatry</i>	30	27	31	0	0	0	3	2	3	80	93	76
<i>Psychological Medicine</i>	29	41	25	21	36	15	36	46	31	32	44	28
<i>Lancet</i>	22	30	19	10	15	7	22	41	15	34	42	31
<i>Age and Ageing</i>	16	14	18	0	0	0	2	0	3	43	47	43
<i>Acta Psychiatrica Scandinavica</i>	15	20	13	5	10	4	20	34	15	18	19	18
* <i>Journal of the American Academy of Child and Adolescent Psychiatry</i>	14	15	14	39	37	40	1	0	1	0	0	0
<i>Journal of Neurology, Neurosurgery and Psychiatry</i>	13	19	11	3	7	1	11	22	7	24	33	22
<i>Hospital Medicine</i> (previously <i>British Journal of Hospital Medicine</i>)	12	11	12	8	10	7	9	10	9	14	14	14
* <i>Advances in Psychiatric Treatment</i>	11	6	13	14	8	16	13	2	17	7	5	8
* <i>Clinical Child Psychology and Psychiatry</i>	9	10	8	24	24	24	1	0	1	0	0	1
<i>Journal of the Royal Society of Medicine</i>	9	12	7	8	10	7	10	17	7	8	12	8
<i>Biological Psychiatry</i>	8	14	6	5	12	5	9	22	5	8	9	8
<i>Schizophrenia Research</i>	7	12	5	3	5	1	16	32	10	3	2	3
* <i>Archives of General Psychiatry</i>	6	15	3	3	7	1	14	41	4	3	0	4
<i>Journal of Affective Disorders</i>	6	12	3	1	3	0	11	32	3	6	9	6
<i>Journal of Psychopharmacology</i>	6	10	5	3	5	2	9	20	6	6	7	6
<i>International Journal of Eating Disorders</i>	5	5	4	11	14	9	5	0	6	0	0	0
* <i>Journal of Family Therapy</i>	5	7	4	13	15	12	0	0	0	0	2	0
* <i>Psychiatric Bulletin</i>	5	7	4	3	0	4	9	10	8	4	14	2
<i>Psychopharmacology</i>	5	6	4	2	2	1	5	10	3	7	7	7
<i>International Clinical Psychopharmacology</i>	4	5	4	1	0	1	6	15	3	5	2	6
* <i>Child Abuse and Neglect</i>	3	4	2	7	10	5	0	0	0	0	0	0
* <i>Journal of Adolescence</i>	3	3	3	9	7	10	0	0	0	0	0	0
<i>Social Psychiatry and Psychiatric Epidemiology</i>	3	4	2	0	0	0	7	12	4	2	2	1
* <i>International Psychogeriatrics</i>	2	4	1	0	0	0	0	0	0	5	14	3
* <i>Ageing and Mental Health</i>	1	4	0	0	0	0	0	0	0	3	14	1
* <i>Journal of the American Geriatrics Society</i>	1	3	0	0	0	0	0	0	0	3	12	1

±, With and without academic commitments; +, with academic commitments; -, without academic commitments; *, journal not listed on the original questionnaire.

journals, which does not include general medical journals such as the *BMJ* or the *Lancet*.

DISCUSSION

The response rate of 47% to a non-clinical questionnaire survey with no reminder is somewhat better than Schein *et al's* (2000) response of 42% to a similar survey of American surgeons. Although this level of response indicates an interest among psychiatrists in the issue of the assessment of journals, it is possible that

the non-respondents might have very different views from those discussed here.

Few key journals

For respondents, it appears that a small number of journals are very important for the dissemination of information with a bearing on clinical practice. Furthermore, the numbers of psychiatrists who read three journals or fewer are most marked in the adult group, which is approximately three times as large as the other two categories in the membership of the Royal College of Psychiatrists.

Adjustment for this factor would give overall figures for psychiatrists reading three journals or fewer of 27%, with 11% for academics and 34% for non-academics. If a small number of journals are of greatest importance to clinicians, then research findings published in these journals have greater potential to result in benefit to patients.

The journals that were found to be the most important to clinical psychiatrists – the *British Journal of Psychiatry* and the *BMJ* – are both available as part of membership to the Royal College of Psychiatrists and the British Medical Association,

Table 2 Percentage of psychiatrists ranking selected journals first, second or third with regard to their clinical work (all journals ranked by at least 10% of psychiatrists in one or more category)

Journal	Patient age-group to whom psychiatric services are provided											
	All groups			Child			Adult			Old age		
	±	+	-	±	+	-	±	+	-	±	+	-
<i>British Journal of Psychiatry</i>	81	76	83	71	73	70	89	78	93	85	79	86
<i>BMJ</i>	56	50	58	38	42	36	66	54	71	64	53	66
<i>Journal of Child Psychology and Psychiatry and Allied Disciplines</i>	28	32	27	78	78	78	3	2	3	1	0	1
<i>International Journal of Geriatric Psychiatry</i>	26	23	27	0	0	0	2	0	3	69	79	66
<i>American Journal of Psychiatry</i>	15	20	13	9	12	7	27	46	20	13	12	14
* <i>Journal of the American Academy of Child and Adolescent Psychiatry</i>	10	12	9	27	29	26	1	0	1	0	0	0
* <i>Advances in Psychiatric Treatment</i>	7	5	8	6	5	7	11	2	15	6	5	6
* <i>Clinical Child Psychology and Psychiatry</i>	6	2	7	16	5	20	0	0	0	0	0	0
<i>Age and Ageing</i>	5	4	5	0	0	0	1	0	1	13	14	13
<i>Psychological Medicine</i>	5	7	5	4	5	3	10	12	9	2	2	3
* <i>Archives of General Psychiatry</i>	3	10	1	2	5	0	9	29	2	1	0	1
<i>Biological Psychiatry</i>	2	5	1	1	2	1	5	15	2	1	2	1
<i>Journal of Psychopharmacology</i>	2	3	1	0	0	0	5	10	3	1	0	1

±, With and without academic commitments; +, with academic commitments; -, without academic commitments; *, journal not listed on the original questionnaire.

respectively. Most psychiatrists, therefore, will receive them without subscription. Because our sample was provided by the Royal College of Psychiatrists from lists of its Members and Fellows, then all will receive the *British Journal of Psychiatry*. Approximately 80% of practising doctors are members of the British Medical Association and therefore automatically will receive the *BMJ*. In addition, the *BMJ* is freely accessible via the internet. These two journals were noticeably ahead of all the other journals in terms of readership. The *British Journal of Psychiatry* also contained a significant proportion of the total papers in the whole NHS Research Outputs Database mental health field. It published more than three times as many articles funded in some way by the NHS as the *International Journal of Geriatric Psychiatry* in second place. Rafferty *et al* (2000) found that one dominant journal in the field of nursing contained far more publications than any other (46% of the total), followed by a second containing 6.5%.

Comparisons with journal impact factors

The journal impact factor has been used as an indicator of the quality of research published within journals (Schwartz & Lopez Hellin, 1996). However, our study

shows that the correlation between the perceived importance attributed by clinical practitioners in the field of psychiatry and the journal impact factor is neither a simple nor a consistent relationship (see Fig. 1). This was found for clinicians both with and without academic commitments.

The journal impact factor scores of the *British Journal of Psychiatry* and the *BMJ* are reasonably high. The *British Journal of Psychiatry* was positioned eighth out of 81 within the field of psychiatry, and the *BMJ*, although obviously not listed in the psychiatry journals, had a journal impact factor that would have put it in third position. Of the top ten journals in the field of psychiatry, according to journal impact factors, only four (*Archives of General Psychiatry*, *Biological Psychiatry*, the *American Journal of Psychiatry* and the *British Journal of Psychiatry*) were found in the 31 journals with a clinical readership of 10% or more in any one category (by patient age-group or academic commitments) and the first three of these were found to be of significantly greater importance to academics in the adult group than to any other category of psychiatrist.

In this discussion an inevitable limitation has to be considered. As discussed later, national bias has been found in both publication trends and readership of journals (Grant *et al*, 2000; Schein *et al*, 2000), therefore it was felt that a standard

list of journals that were most important as outlets for UK psychiatry publications would seem an appropriate starting point for this survey. Including a comparatively small number of such journals enabled a manageable list to be included in the questionnaire, but allowing clinicians to add journal names inevitably created two populations of journals. It would seem reasonable to assume that those journals included within the questionnaire were more likely to be ticked as read than those not included. The *Archives of General Psychiatry*, which has the highest journal impact factor in the field of psychiatry, was not one of the journals listed on the questionnaire owing to the small number of UK papers published in it. This absence from the questionnaire might have reduced the numbers of psychiatrists referring to the *Archives of General Psychiatry* but would not account for the marked differences found between academics and non-academics and between the adult group compared with the other two patient age categories. It is possible of course that papers in journals such as this have an important indirect, rather than direct, influence on clinical practice in the UK through their impact on guidelines, etc.

The *Journal of Child Psychology and Psychiatry and Allied Disciplines* is widely read and the most highly rated by child psychiatrists, but its journal impact factor

Table 3 All 31 journals read by at least 10% of psychiatrists in one or more category and ranked by the percentage of psychiatrists that read them, their journal impact factors (JIFs) and various ranking methods of JIF

Journal	% Psychiatrists (all categories) reading the journal	NHS (England) psychiatry publications 1990–1999	JIF 2001	Ranking of the 31 journals by JIF	Position in ISI ranking of the 81 psychiatry journals in SCl by JIF
<i>British Journal of Psychiatry</i>	97	1049	4.1	6	8
<i>BMJ</i>	89	168	6.6	4	–
<i>American Journal of Psychiatry</i>	38	41	6.9	3	2
<i>Journal of Child Psychology and Psychiatry and Allied Disciplines</i>	35	64	2.8	13	9 ¹
<i>International Journal of Geriatric Psychiatry</i>	30	335	1.8	19	38
<i>Psychological Medicine</i>	29	299	3.1	9	15
<i>Lancet</i>	22	74	13.3	1	–
<i>Age and Ageing</i>	16	52	1.7	20	–
<i>Acta Psychiatrica Scandinavica</i>	15	136	2.1	16	29
* <i>Journal of the American Academy of Child and Adolescent Psychiatry</i>	14	15	3.6	7	11
<i>Journal of Neurology, Neurosurgery and Psychiatry</i>	13	101	3.0	11	16
<i>Hospital Medicine (previously British Journal of Hospital Medicine)</i>	12	79	0.3	27	–
* <i>Advances in Psychiatric Treatment</i>	11	N/A	N/A	N/A	N/A
* <i>Clinical Child Psychology and Psychiatry</i>	9	N/A	N/A	N/A	N/A
<i>Journal of the Royal Society of Medicine</i>	9	69	0.7	24	–
<i>Biological Psychiatry</i>	8	61	5.5	5	4
<i>Schizophrenia Research</i>	7	75	3.6	7	12
* <i>Archives of General Psychiatry</i>	6	29	12.0	2	1
<i>Journal of Affective Disorders</i>	6	114	1.9	17	36
<i>Journal of Psychopharmacology</i>	6	63	2.6	14	20
<i>International Journal of Eating Disorders</i>	5	100	1.9	17	35
* <i>Journal of Family Therapy</i>	5	12	0.5	26	–
* <i>Psychiatric Bulletin</i>	5	N/A	N/A	N/A	N/A
<i>Psychopharmacology</i>	5	51	3.1	9	14
<i>International Clinical Psychopharmacology</i>	4	126	2.3	15	26
* <i>Child Abuse and Neglect</i>	3	1	1.2	21	–
* <i>Journal of Adolescence</i>	3	14	0.8	23	–
<i>Social Psychiatry and Psychiatric Epidemiology</i>	3	79	1.2	21	33 ¹
* <i>International Psychogeriatrics</i>	2	N/A	N/A	N/A	N/A
* <i>Ageing and Mental Health</i>	1	32	0.6	25	–
* <i>Journal of the American Geriatrics Society</i>	1	4	2.9	12	–

ISI, Institute for Scientific Information; SCl, Science Citation Index; *, journal not listed in original questionnaire; –, journals not included in the ISI's rankings of psychiatry journals in either the SCl or the Social Science Citation Index; N/A, journals without a JIF.

1. Position of journal based on JIF in ISI ranking of the 77 psychiatry journals in the Social Science Citation Index.

would put it in 17th position if it were included in the Science Citation Index listing for psychiatry in the Journal Citation Reports. The *International Journal of Geriatric Psychiatry* is similarly widely read within its patient age-group of psychiatrists but is poorly rated by journal impact factor, being positioned 38th in the psychiatry list. *Clinical Child Psychology and Psychiatry* and *Advances in Psychiatric Treatment* feature quite prominently in the results of this survey but neither was included in the original questionnaire

because neither is listed by the Science Citation Index.

Survey findings in context

Previous research has raised several relevant issues, including the significance of country of publication and the relevance of journal impact factor to readership patterns. Grant *et al* (2000) examined UK clinical guidelines to determine the flow of information from basic research to clinical practice and the nationality of papers cited

in UK clinical guidelines. They found that UK authors of clinical guidelines cite UK publications in a greater proportion (25%) than is found in world biomedical literature (10%). Schein *et al* surveyed 1000 Fellows of the American College of Surgeons and found that they were only interested in American journals, despite the fact that an international survey by e-mail had found a UK journal, the *British Journal of Surgery*, to be the 'best' general surgical journal in the world (Schein *et al*, 2000). Furthermore, journal impact factor was

not a consideration for these surgeons when selecting journals to read. Lewison (2002) examined the relationship between the importance of journals to researchers and to the users of research in a series of medical sub-fields. He found significant variations. In the more clinical subjects such as nursing there was virtually no correlation between their perceived relative importance and the citation score of the journal.

The findings of this survey indicate that in terms of nationality of journals read, and ranked first, second or third, although some of the American journals are of considerable significance there is a clear bias towards journals published in the UK. This bias may, however, have been exaggerated by the choice of journals listed in the original questionnaire.

The study examines what psychiatrists read and perceive as important to their clinical practice, and it covers a large number of publications. Adopting a broad approach in a brief questionnaire inevitably means that some issues were not explored. The term 'read' has not been examined, just as the different sections and article types in the journals have not been analysed individually. Further studies, possibly on a journal-by-journal basis, would provide more information in this area (Tyrer, 2003). Also, there may have been some differences in the respondents' interpretation of the questions asked, which possibly will have had some effect on the findings. A further limitation

CLINICAL IMPLICATIONS

- Researchers aiming to inform clinical practice should consider targeting their findings to journals widely read by clinicians.
- The incentives to researchers to disseminate research to clinicians should be increased.
- Journals should be concerned with identifying ways to enhance their perceived clinical relevance.

LIMITATIONS

- The two journals ranked highest for readership were 'subscription' journals that are routinely received by most respondents.
- The response rate was only 47%.
- The study is cross-sectional and therefore is unable to track associations between reading habits and changes in journal impact factors.

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that has not been examined here involves the variation in journal availability to psychiatrists, with expensive ones available only to some psychiatrists. Research on

these issues would provide additional information on the factors involved in translating biomedical research into clinical practice.

By itself, transmission through journals is not seen as a major way of securing the implementation of research findings (Coomarasamy *et al*, 2001) but clinicians do believe that journals are their main source of information (Schein *et al*, 2000). Assessment of the impact of journals is an important part of a wider stream of work being developed to examine the value of research (Buxton & Hanney, 1996) and, in turn, such analysis (Hanney *et al*, 2003) is being linked to work on how best to implement research findings (Grimshaw *et al*, 2001). Perhaps greater recognition should be given to researchers who publish in the journals that are of greatest importance in disseminating research, irrespective of their journal impact factors.

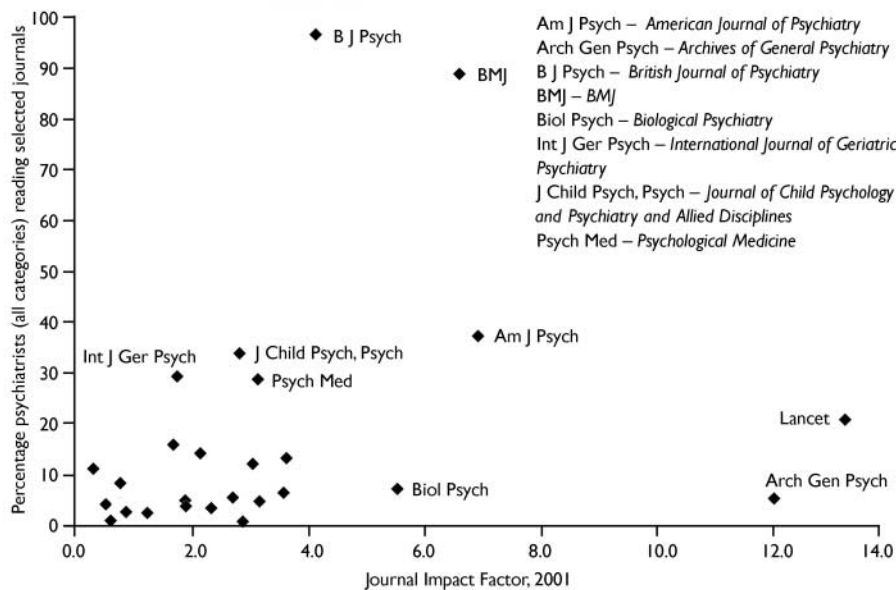


Fig. 1 Percentage of psychiatrists reading selected journals v. journal impact factor 2001 (all journals read by at least 10% of psychiatrists in one or more category, as in Table 3). Note that the *Archives of General Psychiatry* was not listed on the original questionnaire.

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abcdefgh

A study of which peer reviewed journals are read and perceived as important by clinical practitioners in the field of mental health

This questionnaire can be completed in about 5 minutes. Your answers will be entirely anonymous: there is no identification number on the questionnaire.

Please return the questionnaire to us within two weeks in the pre-paid envelope provided.

Thank you for your time and co-operation.

Further details about the background to the project are supplied on the last page but if you have any questions about the survey please contact:

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HERG
Health Economics Research Group

1. Please tick up to 10 journals in total that you read or consult on a regular basis with regard to your clinical work and then rank the top three of these (i.e. 1,2 or 3). Please add any journals you feel are of importance in the context of mental health clinical practice.

Name of Journal	Tick up to 10	Rank top 3
ACTA PSYCHIATRICA SCANDINAVICA		
AGE AND AGEING		
AMERICAN JOURNAL OF MEDICAL GENETICS		
AMERICAN JOURNAL OF PSYCHIATRY		
BEHAVIOUR RESEARCH AND THERAPY		
BIOLOGICAL PSYCHIATRY		
BRITISH JOURNAL OF CLINICAL PSYCHOLOGY		
BRITISH JOURNAL OF GENERAL PRACTICE		
BRITISH JOURNAL OF HOSPITAL MEDICINE		
BRITISH JOURNAL OF MEDICAL PSYCHOLOGY		
BRITISH JOURNAL OF PSYCHIATRY		
BRITISH MEDICAL JOURNAL		
HUMAN PSYCHOPHARMACOLOGY-CLINICAL AND EXPERIMENTAL		
INTERNATIONAL CLINICAL PSYCHOPHARMACOLOGY		
INTERNATIONAL JOURNAL OF EATING DISORDERS		
INTERNATIONAL JOURNAL OF GERIATRIC PSYCHIATRY		
IRISH JOURNAL OF PSYCHOLOGICAL MEDICINE		
JOURNAL OF ADVANCED NURSING		
JOURNAL OF AFFECTIVE DISORDERS		
JOURNAL OF CHILD PSYCHOLOGY AND PSYCHIATRY AND ALLIED DISCIPLINES		
JOURNAL OF FORENSIC PSYCHIATRY		
JOURNAL OF NEUROLOGY NEUROSURGERY AND PSYCHIATRY		
JOURNAL OF PSYCHOPHARMACOLOGY		
JOURNAL OF PSYCHOSOMATIC RESEARCH		
JOURNAL OF THE ROYAL SOCIETY OF MEDICINE		
LANCET		
MEDICINE SCIENCE AND THE LAW		
NEUROSCIENCE LETTERS		
PSYCHOLOGICAL MEDICINE		
PSYCHOPHARMACOLOGY		
SCHIZOPHRENIA RESEARCH		
SOCIAL PSYCHIATRY AND PSYCHIATRIC EPIDEMIOLOGY		

2. What type of NHS contract do you have?

- Whole time
- Maximum part time
- Part time
- Honorary
- Other

3. How many clinical sessions per week do you work?

4. How many academic sessions per week do you work?

5. In which sub-group do you work? (Please tick as many as necessary)

- Childhood & adolescence
- Adults of working age
- Old age psychiatry
- Liaison psychiatry

6. With which disorders do you work? (Please tick as many as necessary)

- Anxiety disorders
- Bipolar disorders
- Conduct disorders
- The dementias
- Depression
- Eating disorders
- Obsessive-compulsive disorder
- Phobias
- Schizophrenia
- Suicide and self-harm
- Alcohol, drug or substance abuse
- Learning difficulties
- Other

(Please specify.....)

Background: Clinical research generally does not command the same level of citation as basic research. The assessment of research quality often uses the journal impact factor, based on the average citation rate of the journal, but clinical research is less likely to appear in a journal with a high impact factor. Too often the result is the *apparent* poor performance of establishments involved in clinical research relative to those concentrating on research of a more basic nature. Our research is attempting to identify a more realistic way to assess publications for clinical practitioners. The intention is to extend the study to other medical fields in the future.

Journals: The list of journals has been taken from the Research Outputs Database (ROD) that was constructed by The Wellcome Trust and based on the Science Citation Index (SCI). It is now maintained by the Department of Information Science at City University. A subset of ROD (NHS ROD) has been constructed containing details of publications from England that involve some element of NHS financial input and this is being studied by the NHS-funded Fellowship at the Health Economics Research Group, Brunel University. For this questionnaire a list of journals has been extracted from the NHS ROD covering 60% of mental health publications over the period 1990-1999. It covers all levels of research publications, from basic to clinical, found in the peer reviewed journals contained on the SCI database.

BJPpsych

The British Journal of Psychiatry

What British psychiatrists read: Questionnaire survey of journal usage among clinicians

Teresa Jones, Stephen Hanney, Martin Buxton and Tom Burns

BJP 2004, 185:251-257.

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Material**

Supplementary material can be found at:
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Appendix III – Paper P2:

Research article

Open Access

The journals of importance to UK clinicians: a questionnaire survey of surgeons

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Abstract

Background: Peer-reviewed journals are seen as a major vehicle in the transmission of research findings to clinicians. Perspectives on the importance of individual journals vary and the use of impact factors to assess research is criticised. Other surveys of clinicians suggest a few key journals within a specialty, and sub-specialties, are widely read. Journals with high impact factors are not always widely read or perceived as important. In order to determine whether UK surgeons consider peer-reviewed journals to be important information sources and which journals they read and consider important to inform their clinical practice, we conducted a postal questionnaire survey and then compared the findings with those from a survey of US surgeons.

Methods: A questionnaire survey sent to 2,660 UK surgeons asked which information sources they considered to be important and which peer-reviewed journals they read, and perceived as important, to inform their clinical practice. Comparisons were made with numbers of UK NHS-funded surgery publications, journal impact factors and other similar surveys.

Results: Peer-reviewed journals were considered to be the second most important information source for UK surgeons. A mode of four journals read was found with academics reading more than non-academics. Two journals, the *BMJ* and the *Annals of the Royal College of Surgeons of England*, are prominent across all sub-specialties and others within sub-specialties. The *British Journal of Surgery* plays a key role within three sub-specialties. UK journals are generally preferred and readership patterns are influenced by membership journals. Some of the journals viewed by surgeons as being most important, for example the *Annals of the Royal College of Surgeons of England*, do not have high impact factors.

Conclusion: Combining the findings from this study with comparable studies highlights the importance of national journals and of membership journals. Our study also illustrates the complexity of the link between the impact factors of journals and the importance of the journals to clinicians. This analysis potentially provides an additional basis on which to assess the role of different journals, and the published output from research.

Background

The increasing importance of evidence-based practice in medicine highlights the desirability of clinical practitioners keeping in touch with clinical research. The growing volume of information is available in many different forms, but Schein et al[1] found that the traditional, peer-reviewed journals were the information source considered most important by American surgeons. Many groups have an interest in knowing about the perceived importance and readership of the various journals, including researchers, the users of research and those who determine how researchers should best be assessed as well as those involved in journal publication [2-5].

The issue is complicated by the increasing availability of journals via the internet and also by the sheer number of journals available, for example there were 139 journals in the 2001 'Surgery' category of the Science Citation Index (SCI, from Thomson Scientific, 2004) and many other journals also include papers on surgery.

The introduction of the journal impact factor by the Institute for Scientific Information (ISI, now Thomson Scientific) provided a quantitative shorthand method to assess scholarly journals that was of particular interest to researchers considering where to submit their articles. There is, though, criticism when the use of journal impact factors is extended to cover the assessment of the output of researchers [6-8]. One concern is that different fields have different average journal impact factors. For example clinical specialties, such as surgery, tend to have lower scores than other more basic fields and risk losing out. Research assessments can affect the publication behaviour of authors [9-12] and hence, the more important impact factors are perceived to be, the greater the pressures on researchers to submit papers to journals with high impact factors. At the same time there are attempts to broaden the scope of research assessment by, for example, considering the impact of research on clinical practice[2,13,14].

It is relevant, therefore, to explore the extent of journal readership by clinicians and, as the term 'read' can have many interpretations, to identify the individual journals they rank important for informing their clinical practice. This can only effectively be examined at the level of specific specialties and sub-specialties, though similar patterns may emerge from different specialties. The survey by Schein et al [1] of the reading habits of American surgeons is one of the few studies of these issues in any discipline although there was also a survey of general surgeons passing the UK Intercollegiate Board exam in 1997 [15]. In this context we attempted to provide a comprehensive analysis of the journals read and perceived as important by UK clinicians in a series of specialties, starting with psychiatry [16] and continuing here with surgery.

We conducted a questionnaire survey to identify the relative importance of journals as an information source to UK surgeons, the individual journals of importance to them, further to explore the issues emerging from the previous surveys and the potential implications of these for the assessment of clinical research.

Methods

Ethics approval was not required for this study as the survey was conducted anonymously using a list of names and addresses taken from the Medical Directory (see below) which is available in the public domain. Prior to the release of the Medical Directory, those listed are given the opportunity to exclude their names from external surveys. All researchers involved are independent of the funders of the project.

Questionnaire construction

Using the methods we have described elsewhere [17] we constructed a questionnaire containing a list of 39 journals including general medical, specialty and sub-specialty journals either if they contained a large number of NHS-funded surgery papers or if they had a high impact factor relative to other similar journals[18] (See Table 1). Thus the list was derived from two sources:

- *The National Health Service (NHS) Research Outputs Database (ROD)* – The ROD was constructed by the Wellcome Trust[19] and then maintained by the Centre for Information Behaviour and the Evaluation of Research (ciber), City University. It covers the full range of UK biomedical research publications, including basic and clinical sciences, in the peer-reviewed journals contained in the Science and the Social Science Citation Indices from Thomson Scientific. It also includes details of funding acknowledgements. NHS ROD is a subset of ROD which contains details of publications from England with evidence of some element of NHS financial support[20]. A ROD surgery filter, constructed at ciber, was used to extract a list of the leading journals covering 70% of surgery publications on the NHS ROD over the period 1990–1999.

- *Journal Citation Reports 2002 – The Journal Citation Reports® on the Web (JCR® Web)* is a resource from Thomson Scientific for journal evaluation which 'covers more than 7,500 of the world's most highly cited, peer-reviewed journals'. Coverage is both multidisciplinary and international[18]. From the 2002 version we combined the top 20 journals from the specialty of surgery and the UK published journals in the top 20 from the general medical category, both rankings by impact factor.

Surgeons' names and addresses were taken from the Medical Directory 2003/4 CD-ROM (produced by Informa

Table 1: Journal names as presented to surgeons in the questionnaire.

Please tick up to ten journals in total that you read or consult on a regular basis to *inform your clinical practice*. If necessary add any that are not listed. From those you have ticked please rank the top three journals (i.e. 1,2 or 3).

Journal	Tick up to 10 Rank top 3
Acta Orthopaedica Scandinavica	
Acta Oto-Laryngologica	
American Journal of Surgical Pathology	
American Journal of Transplantation	
Annals of Surgery	
Annals of Surgical Oncology	
Annals of the Royal College of Surgeons of England	
Annals of Thoracic Surgery	
Archives of Surgery	
British Journal of Oral & Maxillofacial Surgery	
British Journal of Plastic Surgery	
British Journal of Surgery	
British Journal of Urology	
BMJ	
Clinical Orthopaedics and Related Research	
Clinical Otolaryngology	
European Journal of Pediatric Surgery	
International Journal of Oral & Maxillofacial Surgery	
Journal of Bone & Joint Surgery – British Volume	
Journal of Endovascular Therapy	
Journal of Internal Medicine	
Journal of Neurology, Neurosurgery & Psychiatry	
Journal of Neurosurgery	
Journal of Pediatric Surgery	
Journal of the American College of Surgeons	
Journal of the Royal Society of Medicine	
Journal of Thoracic and Cardiovascular Surgery	
Journal of Urology	
Journal of Vascular Surgery	
Lancet	
Lasers in Surgery and Medicine	
Liver Transplantation	
Neurosurgery	
Obesity Neurosurgery	
Shock	
Surgery	
Transplant International	
Transplantation	
Transplantation Proceedings	

Healthcare, UK in association with the Royal Society of Medicine, London). In this database the names and addresses of surgeons are held under the sub-specialties of surgery which has resulted in some duplication where surgeons are entered as specialising in more than one sub-specialty. Hence 4,400 names were reduced to 2,660 after removal of duplicates and in line with the privacy policy. In addition the sub-specialty divisions were not always the same as the sub-specialty classification described by the Royal College of Surgeons of England and therefore we considered it to be more accurate and informative to ask the surgeons in the questionnaire for details of their sub-specialty/sub-specialties. All consultant surgeons

listed with full registration and not retired were included in the questionnaire. We asked the questionnaire recipients to tick up to 10 journals in total that they read or consulted on a regular basis to inform their clinical practice (see Table 1) and invited them to add and tick any that were not listed and from those ticked to rank the top three journals. We also asked them to rank various information sources, including peer-reviewed journals, surgical colleagues and professional meetings and conferences for their role in informing their clinical practice. Responses to the survey were collected over a four-month period early in 2004. The survey was carried out anonymously with no

means of identification included on the questionnaires and no reminders were distributed.

Questionnaire analysis

We transferred the data, using a double-entry procedure to ensure its integrity, from the returned questionnaires into a database for analysis. To verify the names of journals added to the questionnaires we consulted Ulrich's International Periodicals Directory[21] and the internet.

We collated and tabulated the surgeons' responses according to their sub-specialty and academic responsibility and examined the importance of journals as an information source and the relationships between readership, journal rankings, impact factors and numbers of publications. The journal impact factor is 'a measure of the frequency with which the "average article" in a journal has been cited in a particular year or period.' [22] Journal impact factors were obtained from the 2001 edition as the most relevant for analysis of data taken from the NHS ROD 1990–1999 and for numbers of publications an updated, more accurate version of the ROD surgery filter was used.

Results

2,660 questionnaires were distributed and a total of 1,003 questionnaires were completed and returned (a 38% response rate). Due to some surgeons specialising in more than one discipline the total number of responses to the question concerning sub-specialty (Q4 on questionnaire) was 1,046 (104%). Those surgeons with some academic responsibilities formed 29% of respondents.

A substantial number of surgeons added more journals to the list that had been included in the original questionnaire. The respondents ticked the 39 journals originally listed 4,336 times and the 224 added journal names on 1,316 occasions. Those included in the original questionnaire appear in italics in Tables 2 and 3.

Peer-reviewed journals were considered important by 72% of surgeons and were the second highest information source after professional meetings and conferences at 92%, the third highest being surgical colleagues at 64%. All three of these information sources were consulted by at least 95% of respondent surgeons. Internet sources were considered important by 10% of respondents but were used by 64%.

Further results of the survey are presented in Tables 2 and 3 and illustrated in Figures 1, 2, 3. The modal number of journals read by respondent surgeons was 4 though for those with academic responsibilities this rose to 6 (Figure 2). A statistically significant difference was found between the number of journals read by academics and non-academics ($t = -2.90$, $p = 0.010$). There was some variation in

readership across sub-specialties with urologists reading the least (mode 3, with 35% reading 3 or less journals and 3% reading 10+ journals) and oral and maxillofacial surgeons reading the most (bimodal 4 and 6, 9% reading 3 or less journals and 13% reading 10+ journals).

In Table 2 we have presented the data on journal impact factors in a number of ways including (in the last column) their position in the ISI ranking of 139 surgery journals, which does not include either general medical journals or some sub-specialty journals which appear in different rankings.

Discussion

As found by Schein et al, journals were considered to be one of the most important information sources to inform the clinical practice of surgeons. Nevertheless, with mode of 4 for journals read by surgeons overall, and with 20% of 'non-academic' surgeons reading three journals or less, many surgeons are exposed to just a few journals.

The data in Tables 2 and 3 address the issue of a few key journals and show the same three journals being read, and rated most highly, by substantially more surgeons than any other journals. The three are: *BMJ*, a general medical journal, the *Annals of the Royal College of Surgeons of England*, a specialty journal, and *British Journal of Surgery* which traditionally has published papers in breast, upper and lower GI, vascular, endocrine and surgical sciences. The *British Journal of Surgery* is ranked by the greatest number of surgeons overall but, as with its readership, this is based on its importance for three sub-specialties: general surgery (the largest number of respondents), paediatric surgery and vascular surgery. The *BMJ* and the *Annals of the Royal College of Surgeons of England* are ranked as important by surgeons in all sub-specialties, though to varying degrees. Our findings are broadly in line with the small survey of 1997 candidates for the general surgery examination which showed that they read the *British Journal of Surgery* most widely, followed by the *BMJ* [15]. This suggests that at least across the board there are just a few key journals; and beyond the three above, the only journals of importance to more than 20% in any of the nine surgery sub-specialties are sub-specialty journals. Within each sub-specialty between three and five individual journals are considered important by more than 20% of surgeons. This gives a total of 26 journals that are important to at least 20% of any one sub-specialty, a figure which represents a small proportion of the total number of journals read by surgeons.

Consideration of the nationality of the most widely read and highly rated journals introduces a further dimension into the analysis. UK based journals feature prominently amongst those general medical and specialty journals

Table 2: Percentage surgeons reading selected journals with regard to their clinical work (all journals read by at least 10% of surgeons in one or more of the listed categories).

Journals read	Sub-specialties %					NHS (England) surgery publications 1990-99	JIF 2001	24 listed journals ranked by JIF	139 surgery journals from SCI's ranking by JIF
	Largest								
	All	General surgery	Otolaryngology	Urology	Vascular surgery				
<i>BMJ (UK)</i>	77.9	81.1	77.8	80.5	87.3	263	6.6	3	-
<i>Annals of the Royal College of Surgeons of England (UK)</i>	61.0	77.1	48.9	48.0	72.5	838	0.5	21	103
<i>British Journal of Surgery (UK)</i>	48.0	97.2	1.5	14.6	93.1	1510	3.5	4	5
<i>Lancet (UK)</i>	30.8	48.0	11.9	23.6	49.0	211	13.3	1	-
<i>Annals of Surgery</i>	24.7	47.2	5.9	10.6	29.4	18	6.7	2	1
<i>Journal of the Royal Society of Medicine (UK)</i>	18.6	21.2	29.6	15.4	14.7	308	0.7	19	-
<i>Surgery</i>	16.7	31.6	3.7	7.3	23.5	37	2.6	8	14
<i>BJU International (British Journal of Urology) (UK)</i>	14.6	0.0	0.0	98.4	2.0	458	1.4	12	-
<i>Clinical Otolaryngology (UK)</i>	14.3	0.0	97.0	0.0	0.0	123	0.7	19	-
<i>Journal of Urology</i>	12.3	1.1	0.0	87.0	0.0	54	3.2	5	-
<i>British Journal of Plastic Surgery (UK)</i>	10.7	1.7	3.7	0.0	0.0	372	0.8	17	67
<i>Journal of Vascular Surgery</i>	8.3	9.3	0.0	0.8	76.5	76	3.1	6	7
<i>Archives of Surgery</i>	8.1	18.6	0.7	0.0	10.8	19	2.8	7	11
<i>Journal of Laryngology and Otology (UK)</i>	8.0	0.0	58.5	0.0	0.0	323	0.5	21	-
<i>Journal of the American College of Surgeons</i>	7.2	15.8	1.5	0.8	4.9	17	2.4	9	16
<i>Acta Oto-Laryngologica</i>	6.3	0.0	42.2	0.0	0.0	80	0.8	17	-
<i>European Journal of Vascular and Endovascular Surgery (UK)</i>	6.1	8.2	0.0	0.0	56.9	0	1.5	11	40
<i>European Journal of Surgical Oncology (UK)</i>	5.0	12.7	0.0	0.0	2.0	2	1.3	14	45
<i>Colorectal Disease (UK)</i>	4.6	11.9	0.0	0.0	0.0	N/A	N/A	N/A	-
<i>Laryngoscope</i>	4.0	0.0	28.1	0.0	0.0	18	1.4	12	-
<i>Archives of Otolaryngology – Head and Neck Surgery</i>	2.2	0.0	15.6	0.0	0.0	25	1.1	16	52
<i>Journal of Endovascular Therapy (Journal of Endovascular Surgery)</i>	2.2	1.7	0.0	0.0	20.6	8	2.1	10	26
<i>Otology & Neurotology (American Journal of Otology)</i>	1.4	0.0	10.4	0.0	0.0	56	1.2	15	-
<i>Phlebology (UK)</i>	1.4	2.8	0.0	0.0	12.7	64	0.5	21	114

Journal titles in italics were included in the original questionnaire; SCI, Science Citation Index from Thomson Scientific; -, Journals not included in Thomson Scientific's surgery rankings in the SCI; N/A, Journal without a JIF

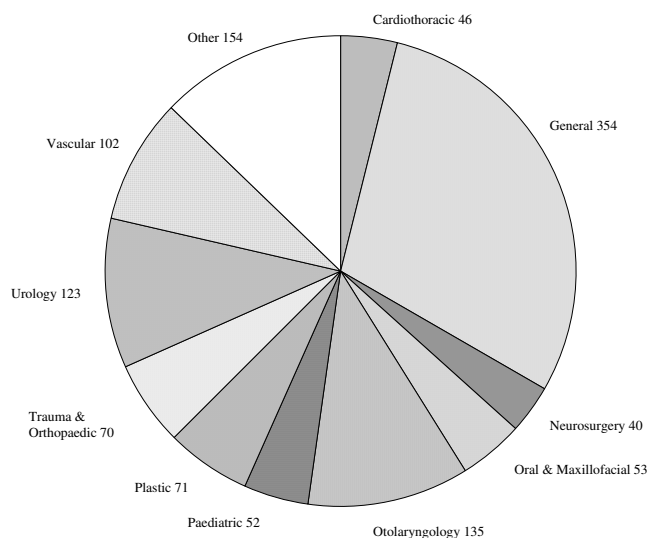


Figure 1
Number of respondents within each surgical sub-specialty.

most widely read by surgeons overall (Table 2) but at sub-specialty level, for journals ranked as important, the picture is more varied (Table 3). For example, in the two sub-specialties with least respondents (neurosurgery and cardiothoracic surgery), the journals read most widely are not UK based and yet they are read by at least 80% of surgeons within their respective sub-specialties. These findings of bias, above sub-specialty level, towards local journals are consistent with Schein et al's [1] survey of American surgeons where the top three general medical journals, and the top five surgical journals, were all found to be American. The *British Journal of Surgery* was rated as one of the three most popular journals by only 0.5% of

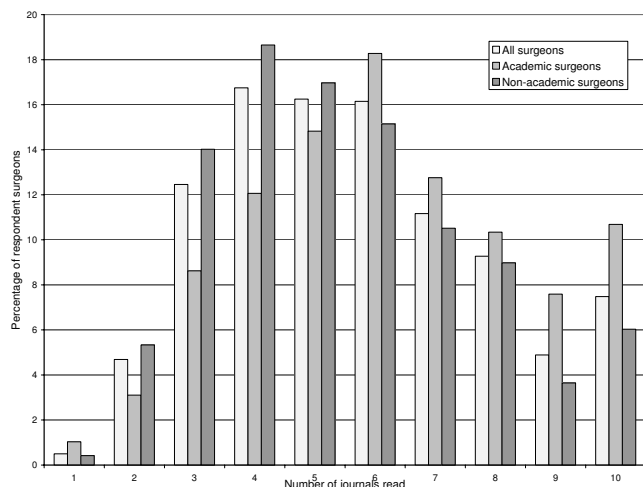


Figure 2
The number of journals read by respondent surgeons.

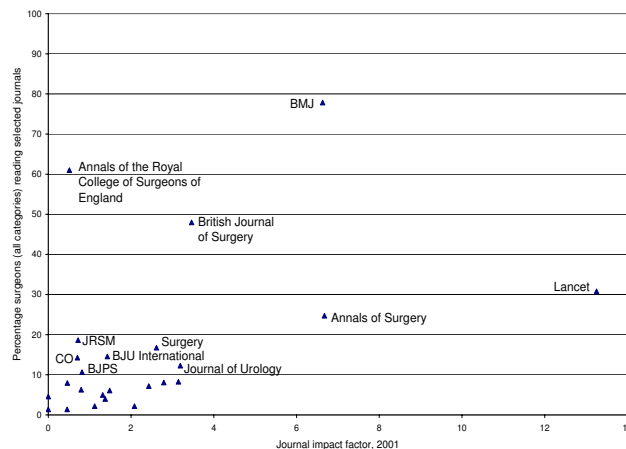


Figure 3
Percentage respondent surgeons reading selected journals v. journal impact factor 2001 (all journals listed in Table 1).
Abbreviations :
BJPS: British Journal of Plastic Surgery
CO: Clinical Otolaryngology
JRSM: Journal of the Royal Society of Medicine

American surgeons. Yet Schein et al also reported the results of an international e-mail audit of general surgeons where 33% of respondents considered the *British Journal of Surgery* the 'best' general surgical journal in the world – a higher figure than for any other journal [1], even the *Annals of Surgery* which has the highest impact factor for any surgical journal and is rated highest by the most US surgeons. In the Netherlands, national journals were similarly reported to be very important for the dissemination of research findings to clinicians [2]. The apparent importance of national journals to surgeons is interesting in light of the increasing availability of journals and bibliographic databases over the internet and also Tompkins et al's findings that the proportion of nationally produced papers published in the highest rated British and American journals had decreased over the period 1983 to 1998 as the journals became more international [23]. In US journals this decrease was from 87.5% to 68.8% and in the one British journal included in the analysis (*British Journal of Surgery*) from 74.8% to 47.1%. Tompkins et al found the sources of the greatest increases in article numbers were European and Asian authors. Nationality of publications had previously been found to play an important part in the flow of information from research to clinical practice via UK clinical guidelines [24].

There are many professional organisations within the UK for surgeons, either generally or within the sub-specialties, and many of these organisations produce or support specific journals. Similarly, many journals are supported by professional organisations based in the USA. These jour-

Table 3: Percentage surgeons ranking selected journals 1, 2 or 3 in importance with regard to their clinical work (all journals ranked by at least 20% of surgeons in one or more sub-specialty).

Journals ranked	Sub-specialties %										
	All	Cardio thoracic surgery	General surgery	Neuro surgery	Oral & Maxillo facial surgery	Otolary ngology	Paediatr ic surgery	Plastic surgery	Trauma & Ortho paedic surgery	Urology	Vascular surgery
<i>British Journal of Surgery (UK)</i>	40	2	91	0	0	0	48	4	3	5	79
BMJ (UK)	36	39	37	15	38	44	29	30	17	50	32
<i>Annals of the Royal College of Surgeons of England (UK)</i>	24	11	38	13	15	22	27	28	13	15	26
BJU International (British Journal of Urology) (UK)	13	0	2	0	0	0	15	0	1	94	1
<i>Clinical Otolaryngology (UK)</i>	13	0	0	3	6	90	10	4	0	0	0
Journal of Urology	10	0	1	0	0	0	8	0	0	81	0
<i>British Journal of Plastic Surgery (UK)</i>	7	0	0	0	15	2	2	82	0	0	0
Journal of Laryngology and Otology (UK)	6	0	0	0	0	47	2	3	0	0	0
<i>Journal of Bone & Joint Surgery – British Volume (UK)</i>	6	0	0	3	0	0	0	0	87	0	1
British Journal of Oral & Maxillofacial Surgery (UK)	5	0	0	0	89	0	0	7	0	0	0
<i>European Journal of Vascular and Endovascular Surgery (UK)</i>	5	0	7	0	0	0	2	0	0	0	51
Journal of Vascular Surgery	5	0	6	0	0	0	2	0	0	0	49
<i>Journal of Thoracic and Cardiovascular Surgery</i>	4	96	0	0	0	0	4	0	1	0	0
Annals of Thoracic Surgery	4	89	0	0	0	0	4	0	0	0	0
<i>Plastic and Reconstructive Surgery</i>	4	0	0	0	11	0	0	48	0	0	0
Journal of Neurosurgery	3	0	0	83	0	0	4	0	0	0	0
<i>Neurosurgery</i>	3	0	0	63	0	1	2	0	0	0	0
International Journal of Oral & Maxillofacial Surgery (UK)	3	0	0	0	55	0	0	0	0	0	0
<i>Journal of Pediatric Surgery</i>	3	0	0	0	0	0	44	0	0	2	0
Journal of Hand Surgery (British and European) (UK)	3	0	0	3	0	0	0	20	14	0	0
<i>Journal of Bone and Joint Surgery (American)</i>	3	0	0	0	0	0	0	0	37	0	0
European Journal of Cardiothoracic Surgery	2	30	0	0	0	0	4	0	0	0	0
<i>British Journal of Neurosurgery (UK)</i>	2	0	0	40	0	0	2	0	0	0	0
Clinical Orthopaedics and Related Research	2	0	0	0	0	1	0	0	23	0	0
<i>Journal of Neurology, Neurosurgery & Psychiatry (UK)</i>	1	0	0	28	0	0	0	0	0	0	0
European Journal of Pediatric Surgery	1	0	0	0	0	1	21	0	0	0	0

Journal titles in italics were included in the original questionnaire.

nals are usually available to members of the organisations either as part of their membership or at a significantly reduced rate. The percentage of surgeons likely to subscribe to a journal and the level of rate reduction applied to the journal result in a complicated picture overall with regard to readership. Membership journals could perhaps, be expected to have relatively high readership levels but not necessarily high rankings of importance. The *Annals of the Royal College of Surgeons of England*, a membership journal for the Royal College, illustrates this with very high readership levels but more modest numbers of surgeons ranking it as important. *British Journal of Surgery* is a membership journal of the Association of Surgeons of Great Britain and Ireland, the professional association for general surgeons, and is perhaps more of a sub-specialty journal for the largest sub-specialty of general surgery rather than a specialty surgery journal. It has a relatively high readership level overall, though not the highest, and is considered the most important journal by the largest number of surgeons. The issue of membership journals adds a further level to the analysis by nationality.

The final issue is a comparison of the journals read most widely by surgeons and journal impact factor (Figure 3). Here a complex picture emerges with no clear consistent relationship as was found previously.

The issue of journal impact factor in this survey is complicated by several considerations including the apparent preference of UK surgeons for UK journals, which generally have lower impact factors than US journals, and the issue of membership journals. Looking just at the journals included in the ISI surgery list from Thomson Scientific, only three of the top ten appear among the 24 journals listed on Table 2 as having the highest readership by UK surgeons. Indeed the *Annals of the Royal College of Surgeons of England*, is second on the list for readership (and third on the list for importance to clinical practice – see Table 3) but in position 103 out of 139 when ranked by impact factor. When the general medical journals are brought into the analysis, however, a rather different picture emerges because, as noted, two of the most read journals are the *BMJ* and the *Lancet* and they have relatively high impact factors. Therefore, apart from the *Annals of the Royal College of Surgeons of England*, the five most read journals have the highest impact factors of all 24 journals in Table 2. With its many different facets, the complex relationship between readership by clinicians and impact factors confirms the need for caution in their use in the assessment of outputs from individual researchers.

Including a list of journals in the questionnaire automatically introduces bias against those not listed. Although attempts were made to reduce this to a minimum by using precise inclusion criteria some element of bias is to be

expected and the names of the journals that were included in the questionnaire have been identified in the tables to allow consideration to be made. The response rate to our survey of 38% is comparable to Schein's analysis of American surgeon's with 37% of questionnaires suitable for analysis. This response level suggests caution should be exercised in extrapolating the findings to the whole body of UK surgeons as the opinions of non-respondents may differ from those of the respondents. Given the anonymity of the survey, our knowledge about the representativeness of the responders is limited with regard to, for example, geographical distribution of respondents across the UK, response rates within each of the sub-specialties, age and sex of respondents. Furthermore, we recognise that the situation is liable to change particularly as electronic access to journals becomes more widespread and this survey is cross-sectional and therefore unable to track changes in readership levels or journal impact factors over time. Nevertheless, overall, the findings presented here related to each of the issues provide a firmer evidence base than previously existed and should help inform the decisions made by researchers and those who assess them, and by the readers and editors of journals. They can be used to address the issues raised earlier.

Overall, the evidence potentially provides an additional basis on which to assess the role of different journals and the published output from research. Furthermore, the importance of the nationality of journals to clinicians suggests the type of survey being reported here could usefully be extended to other countries.

Conclusion

UK surgeons consider peer-reviewed journals to be an important information source. The mode for journals read is four with academics reading more than non-academics. For UK surgeons a few journals are key across all sub-specialties and others within sub-specialties. UK journals are generally preferred by UK surgeons and readership patterns are influenced by membership journals. Some key journals do not have high impact factors.

Competing interests

The author(s) declare that they have no competing interests.

Authors' contributions

MB and SH prepared grant submissions for the project, TJ, MB and SH were involved in the planning, preparation and approval of the original questionnaire. TJ conducted the questionnaire survey and data collection. TJ carried out the data analysis with additional intellectual input from MB and SH. All authors read and approved the final manuscript.

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A study of which peer reviewed journals and other information sources are perceived as important by surgeons.

This questionnaire can be completed in about 5 minutes. Your answers will be entirely anonymous: there is no identification number on the questionnaire or the reply-paid envelope.

Please return the completed questionnaire to us in the envelope provided or to the address below.

Thank you for your time and co-operation.

Further details about the background to the project are supplied on the last page but if you have any questions about the survey please contact:

Teri Jones or Dr Steve Hanney
Health Economics Research Group
Brunel University
Uxbridge, Middlesex. UB8 3PH
Telephone 01895 274000 ext. 5430 or 3709
Email: teresa.jones@brunel.ac.uk, stephen.hanney@brunel.ac.uk



1. What type of NHS contract do you have?

- Whole time
- Maximum part time
- Part time
- Honorary
- Other

2. How many clinical sessions per week do you work?

3. How many academic sessions per week do you work?

4. In which sub-groups do you work? (Please tick as many as necessary)

- | | | | |
|------------------------|--------------------------|------------------------|--------------------------|
| Cardiothoracic | <input type="checkbox"/> | Trauma and orthopaedic | <input type="checkbox"/> |
| General | <input type="checkbox"/> | Urology | <input type="checkbox"/> |
| Neurosurgery | <input type="checkbox"/> | Vascular | <input type="checkbox"/> |
| Oral and Maxillofacial | <input type="checkbox"/> | Other | <input type="checkbox"/> |
| Otolaryngology | <input type="checkbox"/> | <i>Please specify</i> | |
| Paediatric | <input type="checkbox"/> | | |
| Plastic | <input type="checkbox"/> | | |

5. In terms of their importance in informing your clinical practice, please rank any of the following information sources that you consult or attend.

Information Sources	Rank (1,2,3,4 etc)
Surgical colleagues	
Professional meetings/conferences	
Continuing Professional Development	
Other medical education courses	
Internet sources	
Audio/video cassettes	
Peer-reviewed journals	
Textbooks	
Commercial/industrial literature	
Newspapers and magazines	
Others - please name	

6. Please tick up to ten journals in total that you read or consult on a regular basis *to inform your clinical practice*. If necessary add any that are not listed. From those you have ticked please rank the top three journals (i.e. 1,2 or 3).

Journal	Tick up to 10	Rank top 3
Acta Orthopaedica Scandinavica		
Acta Oto-Laryngologica		
American Journal of Surgical Pathology		
American Journal of Transplantation		
Annals of Surgery		
Annals of Surgical Oncology		
Annals of the Royal College of Surgeons of England		
Annals of Thoracic Surgery		
Archives of Surgery		
British Journal of Oral & Maxillofacial Surgery		
British Journal of Plastic Surgery		
British Journal of Surgery		
British Journal of Urology		
BMJ		
Clinical Orthopaedics and Related Research		
Clinical Otolaryngology		
European Journal of Pediatric Surgery		
International Journal of Oral & Maxillofacial Surgery		
Journal of Bone & Joint Surgery - British Volume		
Journal of Endovascular Therapy		
Journal of Internal Medicine		
Journal of Neurology, Neurosurgery & Psychiatry		
Journal of Neurosurgery		
Journal of Pediatric Surgery		
Journal of the American College of Surgeons		
Journal of the Royal Society of Medicine		
Journal of Thoracic and Cardiovascular Surgery		
Journal of Urology		
Journal of Vascular Surgery		
Lancet		
Lasers in Surgery and Medicine		
Liver Transplantation		
Neurosurgery		
Obesity Neurosurgery		
Shock		
Surgery		
Transplant International		
Transplantation		
Transplantation Proceedings		

Thank you for your time and co-operation.

Background: Clinical research generally does not command the same level of citation as basic research. The assessment of research quality often uses the journal impact factor, based on the average citation rate of the journal, but clinical research is less likely to appear in a journal with a high impact factor. Too often the result is the *apparent* poor performance of establishments or units involved in clinical research relative to those concentrating on research of a more basic nature. Our research is attempting to identify the information sources that are important to clinical practitioners and, where appropriate, compare the findings with journal impact factors.

Derivation of list of journals: Two sources were drawn upon to produce the single list of journals presented in Question 6 in alphabetical order:

- *Journal Citation Reports 2002 (JCR) from ISI:* The top 20 journals from the field of surgery, ranked by journal impact factor, were combined with those journals published in the UK from the 20 ranked top in the general medical category.
- *The Research Outputs Database (ROD) that was originally constructed by The Wellcome Trust:* A subset of ROD (NHS ROD) was compiled containing details of publications from England that involve some element of NHS financial input. A list of journals was then extracted covering 75% of publications on the NHS ROD related to surgery over the period 1990-1999.

Appendix IV – Paper P3

Research article

Open Access

The information sources and journals consulted or read by UK paediatricians to inform their clinical practice and those which they consider important: a questionnaire survey

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Abstract

Background: Implementation of health research findings is important for medicine to be evidence-based. Previous studies have found variation in the information sources thought to be of greatest importance to clinicians but publication in peer-reviewed journals is the traditional route for dissemination of research findings. There is debate about whether the impact made on clinicians should be considered as part of the evaluation of research outputs. We aimed to determine first which information sources are generally most consulted by paediatricians to inform their clinical practice, and which sources they considered most important, and second, how many and which peer-reviewed journals they read.

Methods: We enquired, by questionnaire survey, about the information sources and academic journals that UK medical paediatric specialists generally consulted, attended or read and considered important to their clinical practice.

Results: The same three information sources – professional meetings & conferences, peer-reviewed journals and medical colleagues – were, overall, the most consulted or attended and ranked the most important. No one information source was found to be of greatest importance to all groups of paediatricians. Journals were widely read by all groups, but the proportion ranking them first in importance as an information source ranged from 10% to 46%. The number of journals read varied between the groups, but *Archives of Disease in Childhood* and *BMJ* were the most read journals in all groups. Six out of the seven journals previously identified as containing best paediatric evidence are the most widely read overall by UK paediatricians, however, only the two most prominent are widely read by those based in the community.

Conclusion: No one information source is dominant, therefore a variety of approaches to Continuing Professional Development and the dissemination of research findings to paediatricians should be used. Journals are an important information source. A small number of key ones can be identified and such analysis could provide valuable additional input into the evaluation of clinical research outputs.

Background

If medicine is to be evidence-based then health research findings need to be implemented appropriately in the clinical setting. However, there is an ever-expanding wealth of biomedical knowledge to be assimilated and used by clinicians [1,2]. The range of potentially available information sources is large and even for one of them, peer-reviewed journals, the choice within a specialty is enormous.

A review of the information sources used and favoured by clinicians from many different medical specialties, as well as some nursing groups, found results varied from one study to another [3]. Overall, however, other medical colleagues were the preferred source, for example Cullen found that family practitioners referred most frequently to medical specialists [4]. In contrast, others found printed materials to be the favourite source [5-7]. Even studies on the implementation of a specific clinical advance show that a wide range of sources can all play a role [8].

Despite some doubts [9], journals continue to be considered an important information source by many clinicians. Journals are also still the principal medium used to publish research findings. Assessment of both research and journals can be contentious [10-15] and in the UK, there are moves within research assessment towards giving some recognition to the impact made by research [16,17]. A key issue for researchers wishing to make their findings known to clinicians might be "Which information sources and journals are clinicians most likely to access and take notice of?"

These issues may well differ between specialties. Even within one specialty there are likely to be differences between different groups. The availability of different information sources, as reported by trainees-on-call, has been studied in relation to paediatric and neonatal units in UK hospitals [7]. The survey reported here covers the general use of information sources by paediatricians, at consultant and non-consultant career grades (NCCG) within both hospital and community environments. We aimed to determine which sources are consulted or attended by UK paediatricians to inform their clinical practice and which are considered important. We also aimed to identify how many and which specific journals were read by clinicians. This allows comparisons with the journals containing the best paediatric evidence identified by Birken et al [18] and potentially provides information that could contribute to the assessment of research outputs.

Methods

Ethics approval was not required for this study as the survey was conducted anonymously using a list of names and

addresses taken from the Medical Directory (see below) which is available in the public domain. Prior to the release of the Medical Directory, those listed are given the opportunity to exclude their names from external surveys.

The method used involved a questionnaire survey followed by analysis, comparisons within the specialty and further comparisons with other similar or related studies.

Questionnaire recipients

Paediatricians' names and addresses were taken from the Medical Directory 2003/4 CD-ROM (produced by Informa Healthcare, UK in association with the Royal Society of Medicine, London) if they had full registration and were not retired. All doctors with a UK address specialising in paediatrics were included in the questionnaire survey unless they had excluded their names under the Medical Directory's privacy policy.

Questionnaire structure [see Additional file 1]

The questionnaire focused first on information sources in general and then concentrated on journals.

A list of 11 information sources was presented in the questionnaire. In compiling this list, advice was sought from members of the Royal College of Paediatrics and Child Health to ensure the inclusion of information sources likely to be available to community-based or hospital-based paediatricians. Questionnaire recipients were asked to tick any information sources that they consulted or attended to inform their clinical practice. They were invited to add and tick any that were not listed and from the complete list to rank the top three.

A list of journals was constructed including general medical, paediatric and sub-specialty journals either if they contained a large number of NHS funded paediatrics papers or if they scored highly on the impact factors developed by the Institute of Scientific Information (ISI, now part of Thomson Scientific). Thus the list was derived from two sources. Firstly from the Research Outputs Database (ROD) [19] and secondly from the Journal Citation Reports (JCR) 2002 from ISI [20] [see Additional file 1]. After overlaps were removed, the two sources resulted in a total of 39 journals that were listed in the questionnaire.

The questionnaire recipients were asked to tick up to ten journals in total that they read or consulted on a regular basis to inform their clinical practice. They were invited to add any that were not listed.

Further questions related to the position they held, the number of academic and clinical sessions they worked and their predominant role.

Questionnaire analysis

The data from the questionnaire survey were entered into a database for analysis using a double-entry procedure to ensure the integrity of the data. The names of journals added to the questionnaires by respondents were verified using Ulrich's International Periodicals Directory [21] or the internet.

The paediatricians' responses were collated and tabulated according to three criteria:

- their position (i.e. consultant or non-consultant career grade)
- whether or not they had academic responsibilities
- their predominant role (i.e. community-based, District General Hospital-based (DGH), working at the tertiary level)

A statistical analysis was undertaken to investigate the null hypotheses that the information sources accessed and the number of journals read were independent of the paediatrician's characteristics.

Results

2,330 questionnaires were distributed and 993(43%) paediatricians responded. Paediatricians who had ticked more than one predominant role out of the three options totalled less than 3% in all cases and were included in both groups for analysis. The characteristics of the respondents can be found in Table 1.

Information sources consulted or attended by respondent paediatricians to inform their clinical practice and those considered important

Figure 1 shows the results for paediatricians overall by giving three numbers for each information source: the percentage consulting or attending it; the percentage ranking it either first, second or third; and the percentage ranking it first. Overall, the information sources perceived to be of greatest importance to paediatricians' clinical practice are professional meetings & conferences, peer-reviewed journals and medical colleagues. This picture is repeated in all three of the measures used.

The percentage of paediatricians in different groups ranking information sources first in importance to their clinical practice is presented in Figure 2. The data are arranged to allow comparisons between: those holding different positions (the numbers with NCCG status based in hospitals were too small for analysis); those with and those without academic responsibilities; and those with different predominant roles. When comparing the distributions

across the most prominent three information sources, significant differences were found at the 95% confidence level for: academics versus non-academics (Chi-square test: $\chi^2_2 = 16.12$, $p = < 0.001$); and for community-based consultants, DGH-based consultants and those with a tertiary role (Chi-square test: $\chi^2_4 = 17.29$, $p = 0.002$).

Focusing specifically on peer-reviewed journals as an information source, Figure 3 shows the percentage reading them, the percentage ranking them first, second or third, and the percentage ranking them first for each of seven groups of paediatricians based on position held, academic responsibility and predominant role. Although journals are widely read by all groups the percentages of paediatricians within the groups who consider them first in importance show considerable variation. For community-based paediatricians at NCCG level the proportion is 10% but for academic, tertiary paediatricians, journals were considered first in importance by 46%.

Journals read and considered important to clinical practice

For the number of journals read, the results reflect the greater importance of journals to academics than non-academics. 21% of respondents overall read three journals or less and 16% read 10 journals or more. Comparisons found significant differences at the 95% confidence level for the number of journals read by: consultants (mode 10+, median 6) versus NCCGs (mode 3, median 4, Chi-square test: $\chi^2_9 = 97.85$, $p = < 0.001$); academics (mode 10+, median 8) versus non-academics (mode 6, median 6, Chi-square test: $\chi^2_9 = 70.43$, $p = < 0.001$); and hospital-based consultants (mode 10+, median 7) versus community-based consultants (mode 3, median 5, Chi-square test: $\chi^2_9 = 56.55$, $p = < 0.001$).

Table 2 shows individual journals read by at least 20% of respondents in listed categories focusing on whether or not the respondents have academic responsibilities and their predominant role. *JAMA* is also included to allow comparisons across the seven journals included in the study by Birken et al. Whilst some journals e.g. *Archives of Disease in Childhood* and *BMJ*, are important across all groups, others are much more important to some than to others. For example, *Lancet* is read by 71% academics but only 39% non-academics and *Developmental Medicine and Child Neurology* is read by 69% community based paediatricians, excluding NCCGs, but only 16% of those with a tertiary role.

Table 1: The characteristics of respondent paediatricians in the questionnaire survey.

Position and academic responsibility	All (n = 993)	Community-based (n = 294)	DGH-based (n = 412)	Tertiary (n = 279)
Consultants	84%	60%	96%	96%
Non-consultant career grades	12%	34%	4%	1%
Other positions	4%	6%	1%	4%
With academic responsibility	18%	9%	10%	36%

Discussion

Preferred information sources

In terms of the three measures used the overall picture across all respondent paediatricians indicated no one dominant source of information, but instead three were important. Furthermore, across all groups of paediatricians and for all situations studied, the picture was complex with no one source of information being the most important. Such findings highlight the need for careful analysis in terms of how to improve the flow of 'best evidence' to paediatricians.

The position of electronic databases perhaps highlights their potential for becoming increasingly important. They are down in sixth place for being consulted but, by both ranking measures used, they are placed fourth for importance. This might suggest that as their availability is increased, especially for paediatricians in the community, they will become an increasingly important source of information.

Riordan et al's study of information sources used by paediatricians-on-call in hospital units, mostly in training,

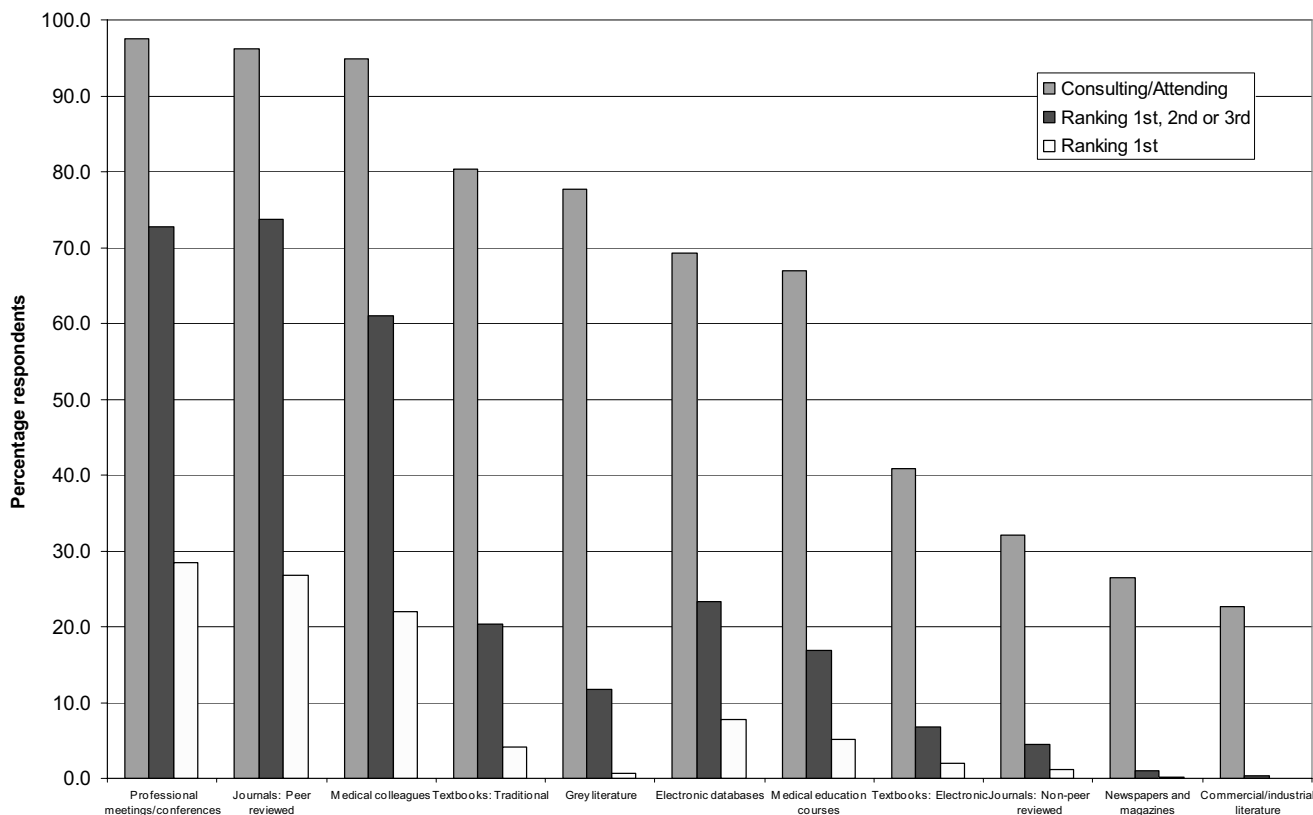


Figure 1
The importance of selected information sources. The percentage of respondent paediatricians consulting or attending selected information sources and ranking them for importance in informing their clinical practice.

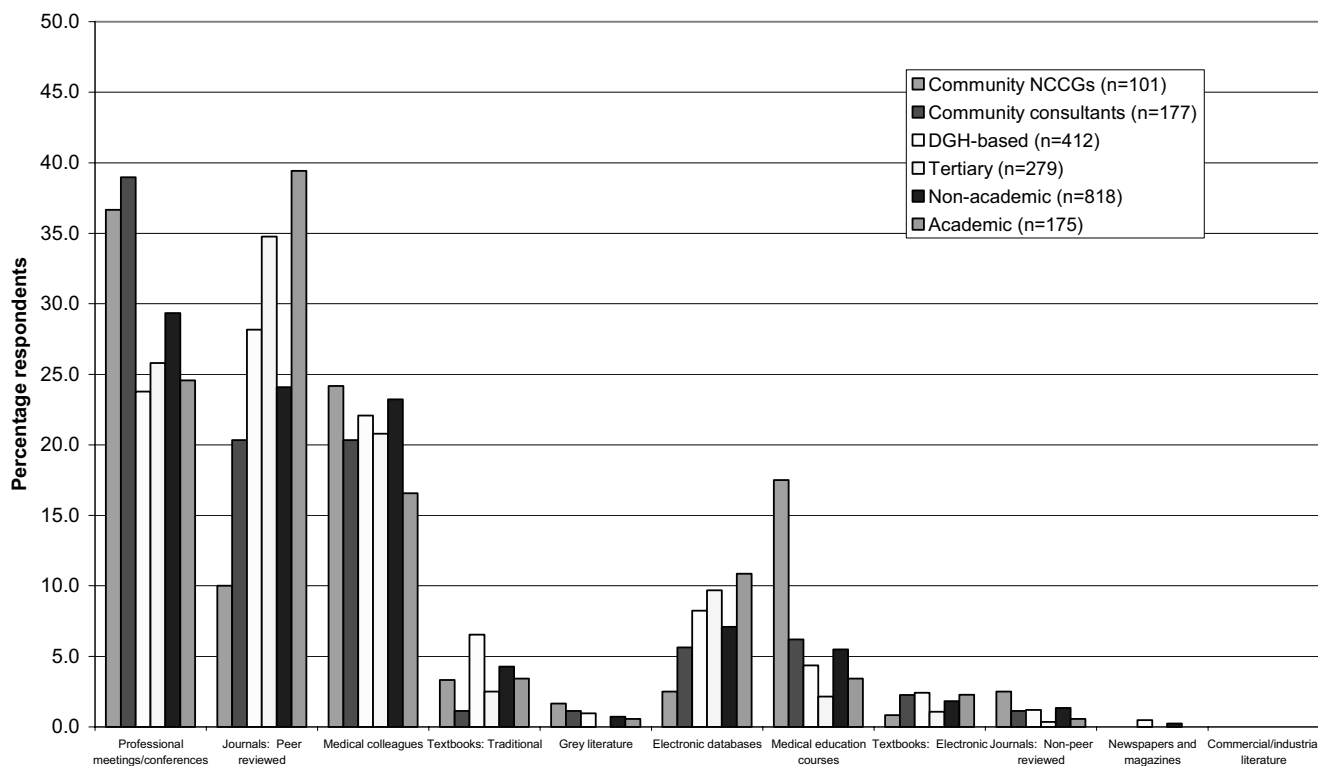


Figure 2
Respondent paediatricians (%) ranking selected information sources first in importance to inform their clinical practice. Position, academic responsibility and predominant role.

found that guidelines and textbooks were most widely used and a few used the internet or journals. In our survey of the general use of information sources by consultants and NCCGs, journals were identified as, overall, the source ranked first, second or third most important by the highest number of paediatricians. In terms of being ranked first, however, 10% of non-academic community NCCGs ranked journals first, compared with 46% of tertiary academics doing so. Community NCCGs are also the only group for which medical education courses are ranked first by more paediatricians than are peer-reviewed journals (Figure 2). Clearly different dissemination strategies are likely to be most appropriate for the different groups and for different situations, but we have found that journals are confirmed as still being of considerable importance.

Individual peer-reviewed journals

There was a significant difference between the numbers of individual journals read by hospital-based paediatricians and by those based in the community. This finding reflects the preference for peer-reviewed journals as a general information source and may reflect the greater availability of journals to clinicians in hospitals. Two membership journals, *Archives of Disease in Childhood* and

BMJ, were the most widely read by all three groups (community-based, DGH-based and tertiary) and only one other – *Pediatrics* – is read by more than 20% of all three groups. It therefore appears that there are a small number of key journals for dissemination.

Birken et al [18] also suggested a large proportion (~40%–60%) of the best evidence for paediatric clinical practice was found in a small number of journals. They listed seven journals that they found to be in the top ten most cited by all three different sources of best evidence for paediatric clinical practice and Riordan et al found that all seven of these 'best-evidence' journals were available at 80% or more of the UK paediatrics and neonatal hospital units studied [7]. Overall, six out of these seven journals were the most widely read journals in our study (See Table 2) though in a different order to that suggested by Birken et al. A detailed analysis of the readership of the top six journals by different groups of paediatricians, reveals that all six journals are read by at least 40% of those who are DGH-based or tertiary, with or without academic commitments, but only two, *Archives Of Disease In Childhood* and *BMJ*, are read by more than 27% of any category of paediatricians based in the community. It appears then, that the variation in readership patterns for these seven journals

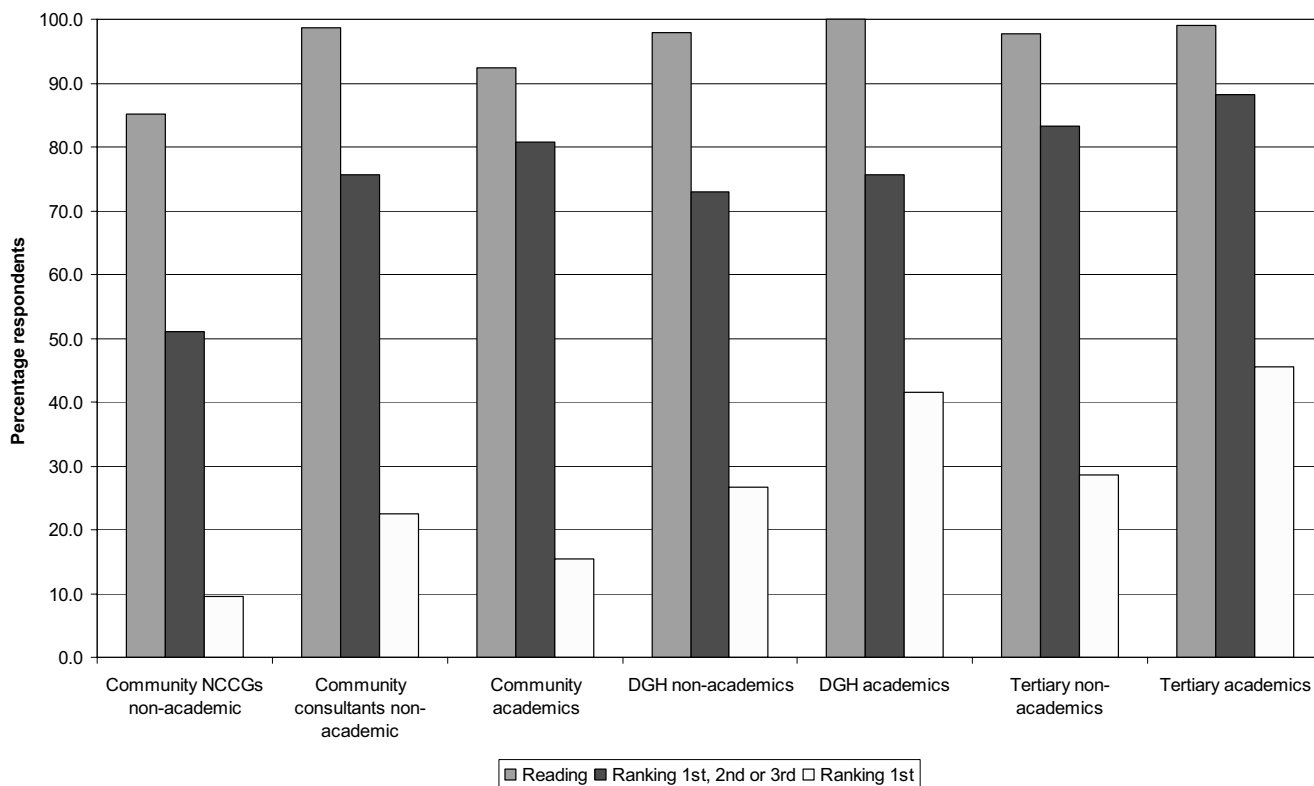


Figure 3
Journals read by paediatricians and their importance to clinical practice. The percentage of respondent paediatricians reading peer-reviewed journals and ranking them as important to inform their clinical practice.

Table 2: The journals most widely read by different groups of respondent paediatricians

Journals read ^a	All paediatricians (n = 993)			Tertiary (n = 279)	DGH-based (n = 412)	Community-based (n = 294)	
	All	academic (n = 175)	non-academic (n = 807)	All	All	All, without NCCGs (n = 193)	^b NCCGs (n = 101)
<i>Archives of Disease in Childhood (UK)</i>	96	97	96	95	99	97	92
<i>BMJ (UK)</i>	84	80	85	81	85	88	87
<i>Lancet (UK)</i>	45	71	39	62	50	22	13
<i>Pediatrics (USA)</i>	44	51	42	47	56	25	14
<i>Journal of Pediatrics (USA)</i>	43	55	40	53	54	24	7
<i>New England Journal of Medicine (USA)</i>	37	61	31	56	43	10	6
<i>Developmental Medicine & Child Neurology (UK)</i>	32	22	34	16	26	69	33
<i>Current Opinion in Pediatrics (USA)</i>	26	23	26	16	41	19	8
<i>Pediatric Clinics of North America (USA)</i>	21	17	21	13	33	13	7
<i>Child Care, Health & Development (UK)</i>	9	5	10	1	2	28	24
JAMA ^c	4	7	3	4	4	2	2

The table contains details of all journals read by at least 20% of paediatricians in one or more of the listed categories to inform their clinical practice.

^aJournal names in italics indicate those included in the list on the original questionnaire;

^bNCCGs, non-consultant career grades. NCCGs have been included separately for the Community-based paediatricians as they formed a large minority of the group (34%) whereas the numbers in the two hospital based groups were too small for separate analysis and have been included in the figures for all tertiary and all DGH-based paediatricians.

^cJAMA is included to provide a complete picture for the seven journals viewed as containing the 'best evidence' for paediatricians.

containing 'best evidence' [18] is much greater than the variation in availability found in hospital units [7] and indeed the availability in the community is uncertain.

There was an even split (5:5) for the journals most widely read between those that are based in the UK and those that are based in the USA, with the top three based in the UK. This suggests a possible nationality bias but the issue of membership journals is a confounding factor.

Comparison of the findings from this survey of UK paediatricians with the survey of UK psychiatrists reveals many similarities [22]. These include: the importance of a small number of journals; the dominance of the main membership journal from the respective royal colleges; and the apparent prominence of UK-based journals.

This study, with a response rate of 43% and a mailing list restricted by the Medical Directories privacy policy, may not reflect the opinions of all paediatricians and the picture may be changing over time. Nevertheless, the survey was large and the response rate is comparable to rates previously obtained from similar studies of UK psychiatrists (47%) [22] and USA surgeons (38%) [6]. The findings add insight to the roles played by different information sources and journals, and could inform the debate on whether the assessment of clinical research should include some evaluation of the impact, or potential impact, made on clinicians. Further research investigating the information sources considered important by other professionals specialising in paediatrics and child health would widen the picture, thus providing information for a more comprehensive analysis.

Conclusion

No one information source is dominant, therefore a variety of approaches to Continuing Professional Development should be used. Furthermore, given the variations different dissemination strategies for research findings are likely to be most appropriate for different groups of paediatricians. Overall, journals are an important information source for paediatricians and a small number of key journals can be identified, but the readership of specific ones varies within the specialty. By identifying the journals most read by clinicians to inform their clinical practice the findings could provide valuable additional input into the evaluation of clinical research outputs.

Competing interests

The author(s) declare that they have no competing interests.

Authors' contributions

MB and SH prepared grant submissions for the project, TJ, MB and SH were involved in the planning, preparation

and approval of the original questionnaire. TJ conducted the questionnaire survey and data collection. TJ carried out the data analysis with additional intellectual input from MB and SH. All authors read and approved the final manuscript.

Additional material

Additional File 1

A study of which peer reviewed journals and other information sources are read or consulted on a regular basis and perceived as important by paediatricians to inform their clinical practice. The questionnaire distributed to UK paediatricians as part of the survey.

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A study of which peer reviewed journals and other information sources are read or consulted on a regular basis and perceived as important by paediatricians to inform their clinical practice.

This questionnaire can be completed in about 5 minutes. Your answers will be entirely anonymous: there is no identification number on the questionnaire or the reply-paid envelope.

Please return the completed questionnaire to us in the envelope provided or to the address below.

Thank you for your time and co-operation.

Further details about the background to the project are supplied on the last page but if you have any questions about the survey please contact:

Teri Jones or Dr Steve Hanney
Health Economics Research Group
Brunel University
Uxbridge, Middlesex. UB8 3PH
Telephone 01895 265445 or 265444



Email: teresa.jones@brunel.ac.uk, stephen.hanney@brunel.ac.uk

1. What position do you hold?

Consultant

Other

Non-Consultant Career Grade

Please specify.....

2. How many sessions per week do you work?

Clinical Academic

3. Is your role predominantly:

Community based Tertiary
 District General Hospital Other
 based *Please specify*.....

4. In which sub-specialties do you work? (Please tick as many as necessary)

Clinical genetics Paediatric nephrology
 Community child health Paediatric neurology
 Neonatal medicine Paediatric oncology
 Paediatric cardiology Paediatric respiratory
 Paediatric endocrinology medicine
 Paediatric gastroenterology Paediatric rheumatology
 Paediatric immunology & Other
 infectious diseases *Please specify*

5. Please tick any information sources that you consult or attend to inform your clinical practice. If necessary add any that are not listed. From those you have ticked, please rank the top three (i.e. 1 for first, 2 for second or 3 for third) in terms of their importance in informing your clinical practice.

Information Sources	Tick	Rank Top 3
Medical Colleagues		
Professional meetings/conferences		
Medical education courses		
Journals: Peer-reviewed		
Journals: Non peer-reviewed		
Textbooks & Compendia: Traditional book form		
Textbooks & Compendia: Electronic form		
Grey literature (eg Documents from the Royal College, Medicines for Children, Handbooks eg from societies, individuals etc.)		
Commercial/industrial literature		
Newspapers and magazines		
Electronic databases (eg Cochrane Updates)		
Others – please name		

6. Please tick up to ten journals in total that you read or consult on a regular basis to inform your clinical practice. If necessary add any that are not listed. From those you have ticked, please rank the top three journals (i.e. 1 for first, 2 for second or 3 for third) in terms of their importance in informing your clinical practice.

Journal	Tick up to 10	Rank Top 3
Acta Paediatrica		
Annals of Internal Medicine		
Annual Review of Medicine		
Archives of Disease in Childhood		
Archives of Pediatrics & Adolescent Medicine		
Birth: Issues in Perinatal Care		
British Dental Journal		
British Journal of Cancer		
British Journal of Haematology		
British Journal of Obstetrics and Gynaecology		
BMJ		
Current Opinion in Pediatrics		
Developmental Medicine and Child Neurology		
European Journal of Pediatrics		
European Respiratory Journal		
International Journal of Pediatric Otorhinolaryngology		
Journal of Adolescent Health		
Journal of Child & Adolescent Psychopharmacology		
Journal of Developmental & Behavioral Pediatrics		
Journal of Pediatric Gastroenterology and Nutrition		
Journal of Pediatric Surgery		
Journal of Pediatrics		
Journal of the American Academy of Child & Adolescent Psychiatry		
Journal of the American Medical Association		
Journal of the Royal Society of Medicine		
Lancet		
Medical and Pediatric Oncology		
Mental Retardation & Developmental Disabilities Research Reviews		
New England Journal of Medicine		
Paediatric and Perinatal Epidemiology		
Pediatric Allergy and Immunology		
Pediatric Clinics of North America		
Pediatric Infectious Disease Journal		
Pediatric Pulmonology		
Pediatric Research		
Pediatrics		
Prenatal Diagnosis		
Seminars in Perinatology		
Ultrasound in Obstetrics & Gynecology		

Thank you for your time and co-operation.

Background: Clinical research generally does not command the same level of citation as basic research. The assessment of research quality often uses the journal impact factor, based on the average citation rate of the journal, but clinical research is less likely to appear in a journal with a high impact factor. Too often the result is the *apparent* poor performance of establishments or units involved in clinical research relative to those concentrating on research of a more basic nature. Our research is attempting to identify the information sources that are important to clinical practitioners and, where appropriate, compare the findings with journal impact factors.

Derivation of the list of journals: Two sources were drawn upon to produce the single list of journals presented in Question 6 in alphabetical order:

- *Journal Citation Reports 2002 (JCR) from ISI:* Ranked by journal impact factor, the top 20 journals from the field of paediatrics were combined with the top 5 from the general medical category.
- *The Research Outputs Database (ROD) that was originally constructed by The Wellcome Trust.* A subset of ROD (NHS ROD) was compiled containing details of publications from England that involve some element of NHS financial input. The top 20 journals were extracted containing the most publications on the NHS ROD related to paediatrics and neonatology over the period 1997-2001.

Appendix V – Paper P4:

The role of the national general medical journal: surveys of which BMJ journals UK clinicians read to inform their clinical practice

Teresa H. Jones, Stephen Hanney and Martin J. Buxton

Health Economics Research Group, Brunel University, Uxbridge, Middlesex, UK.

BACKGROUND: For biomedical research findings to contribute toward health gains they must reach clinicians. Academic journals have historically been considered important information sources. Birken and Parkin found seven journals to most consistently contain the best pediatric evidence and, of these seven, four were general medical journals.

METHODS: We surveyed clinicians in three UK medical specialties (psychiatry, surgery and pediatrics), asking which journals they read and which they considered important to inform their clinical practice.

RESULTS: The readership of general medical journals, in comparison to specialty and sub-specialty journals, is widespread across the three UK medical specialties, although the importance of general medical journals varies widely. The *BMJ* is the most prominent general medical journal in terms of readership and importance but a dominant specialty or sub-specialty journal was usually more important for most groups. *The Lancet* is less widely read and less important, although more academics than non-academics consider it important.

CONCLUSIONS: Overall, key general medical journals play an important role. Journal availability and cost, particularly in relation to membership for UK clinicians, and the position of academics and non-academics have to be considered in any analysis. Three of the four general medical journals containing the best pediatric evidence were found to be widely read by UK pediatricians and two UK-based general medical journals, the *BMJ* and *The Lancet*, were also considered important in our survey. Further investigation of the reasons for the importance of a journal and studies that would allow international comparisons would provide greater input to the discussion.

Key words: Questionnaire survey. General medical journal. Clinical practice. Consultants. Psychiatry. Surgery. Pediatrics.

Papel de las revistas nacionales de medicina general: encuesta sobre qué revistas leen los médicos del Reino Unido para informarse sobre la práctica clínica

FUNDAMENTO: Para que los hallazgos de la investigación biomédica contribuyan a mejorar la salud, es preciso que lleguen a los médicos. Históricamente, las revistas académicas se han considerado fuentes de información importante. Birken y Parkin encontraron que siete revistas contienen con más regularidad la mejor evidencia pediátrica y, de ellas, cuatro son de medicina general.

MÉTODOS: Encuestamos a médicos de tres especialidades del Reino Unido (psiquiatría, cirugía y pediatría), formulándoles preguntas sobre qué revistas leen y qué consideran importante para informarse sobre la práctica clínica.

RESULTADOS: En el Reino Unido, en comparación con las revistas de especialidades y subespecialidades, la lectura de revistas de medicina general es difundida a través de las tres especialidades citadas, aunque la importancia de estas revistas varía ampliamente. El *British Medical Journal* es la más destacada por lo que respecta a lectura e importancia, pero, en general, para los tres grupos de médicos es más importante una revista de especialidad o subespecialidad predominante.

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te. La lectura de *Lancet* es menos difundida y se considera menos importante, aunque un mayor número de académicos que de no académicos la consideran importante.

CONCLUSIONES: En conjunto, las revistas de medicina general clave desempeñan un papel relevante. En cualquier análisis, es preciso considerar la disponibilidad y el coste de la revista, en particular en relación con el hecho de ser miembro de la sociedad o asociación para médicos del Reino Unido. Se encontró que los pediatras de este país leen ampliamente tres de las cuatro revistas de medicina general que contienen la mejor evidencia pediátrica, y, en la encuesta, también se consideraron importantes dos revistas de medicina general del RU, *BMJ* y *Lancet*. Una investigación adicional de las razones de la importancia de una revista y estudios que permitieran comparaciones internacionales proporcionarían mayor información para una discusión.

Palabras clave: Encuesta por medio de un cuestionario. Revistas de medicina general. Práctica clínica. Consultores. Psiquiatría. Cirugía. Pediatría.

Introduction

For biomedical research findings to contribute towards improved health they must reach practitioners who are in a position to use the findings appropriately in the clinical setting. Peer-reviewed journals were traditionally seen as an important source of primary information for clinicians¹. The precise importance of journals compared to other sources of information is now the matter of considerable debate. Some question their importance², but other surveys, including one of surgeons in the USA, claim journals are still an important source of information³.

It is important for readers to be selective in their choices of peer-reviewed journals as there are a large number available and the level of demands made on clinicians' time is high. There have been a few studies of which journals are most read in particular specialties, including the study of surgeons in the USA³ and comparisons between the journals within specialties most favoured by researchers and by users⁴. The readership of general medical journals has not been extensively studied but Schein et al found that the two general medical journals most widely read by American surgeons were *JAMA* and *NEJM*⁵ though comparisons were not made between the readership and importance of the individual journals to the readers. UK surgeons sitting the Intercollegiate examination in general surgery⁶ were also surveyed about the journals they read and the *BMJ*, a general medical journal, was found to be the second most regularly read journal. An early study in Norway found most Norwegian doctors read two of the local general medical journals: 90% read the *Journal of the Norwegian Medical Association* and 67% read the *Nordic Medical Journal*⁶. A fifth of those surveyed read at least one of the four leading international general medical journals: *BMJ*, *JAMA*, *The Lancet* and *NEJM*. Readership is important for exposure of research findings to the target audience but there are many reasons why clini-

icians may read one journal rather than another, such as availability or cost. On both grounds it is likely that the more popular journals will include ones that are supplied free, or at reduced cost, as a result of membership of a relevant professional body. There are also various meanings of the term 'read' that have not been explored here.

For clinicians, the journals which contain the best medical evidence would seem to be appropriate choices for reading and a number of studies have tried to identify the journals that contain the best evidence within different specialties. McKibbon et al examined four different specialties (internal medicine, general/family practice, general care nursing and mental health) looking for articles suitable for abstraction in EBM journals and found that, as well as the papers in specialty journals, many important articles for all four disciplines were published in broad-based healthcare journals such as *BMJ*, *JAMA*, *The Lancet* and *NEJM*⁷. Birken and Parkin studied the specialty of paediatrics and, using three different sources, found seven journals provided the best evidence⁸. Of these seven journals, four were general medical journals, the same four as McKibbon had identified.

A further issue increasingly discussed is how far the criteria used for the assessment of health research should be expanded to include the impacts on health policy and practice and health and economic gains⁹. In this context, there could potentially be a role for giving credit to authors whose work is published in journals that are widely read and viewed as important by clinicians. This might challenge, or at least complement, the increasing emphasis given, despite the criticisms¹⁰, to journal impact factors as a way of assessing health research. It raises particularly important issues in countries, such as the Netherlands, where publications in national professional journals, both peer-reviewed and non-peer reviewed, are thought to play a very important role in the communication of the results of applied health research conducted by local researchers¹¹.

To address these and related issues we conducted surveys in the UK in three separate specialties: psychiatry, surgery and paediatrics. An outline of the methods used is described below, more details together with previously published findings can be found elsewhere¹²⁻¹⁵.

In our studies of surgeons and paediatricians, professional meetings and conferences and peer-reviewed journals stand out as the two most important sources of information^{13,14}. In terms of readership all three studies showed that a very small number of journals were widely read across the specialty. Also in each case at least one general medical journal, the *BMJ*, was read widely and for surgery the *BMJ* was more widely read than any other journal¹³.

In the psychiatry and surgery studies, further analysis revealed that by combining the clinicians' ratings of first, second and third most important journal read to inform clinical practice some of the general medical journals were seen as being very important.

For the paediatric journals the picture was somewhat different because a higher proportion of UK paediatric papers are published in US general medical journals, *NEJM* and *JAMA*, than is the case for psychiatry or surgery. Therefore, these two leading general journals from the USA were included in the journals listed in our survey (see below). This meant that for the paediatrics paper we were able to compare the readership for the seven journals listed by Birken and Parkin as comparing the best evidence. This showed that six out of the seven publications containing the best evidence in paediatrics were the journals most widely read by UK paediatricians. This included the four general medical journals: *BMJ*, *The Lancet*, *NEJM* and *JAMA* that were also found to be those containing the best evidence in other specialties by McKibbon.

Given the prominence of the general medical journal across the board, together with the findings of the other studies mentioned previously, further analysis of the data on general medical journals is presented here to help understand their value relative to specialist journals. First, we have combined the findings on readership for the main journals in each of the three specialties to show the overall role of the general medical journals. Second, we try to understand the exact role played by the general medical journals by presenting the data on the importance of the various journals in informing clinical practice in a disaggregated way. Third, we analyse both the importance to paediatricians and the journal impact factors of the seven journals that Birken and Parkin claim contain the best paediatric evidence — two leading UK ge-

TABLE 1

Percentage of psychiatrists, surgeons and paediatricians reading individual journals to inform their clinical practice: UK general medical journals and the most important specialised journals across three specialties

Journal name	All		Psychiatry		Surgery		Paediatrics	
	Acad	non-Acad	Acad	non-Acad	Acad	non-Acad	Acad	non-Acad
British Medical Journal	83	84	88	90	81	77	80	85
Lancet	49	27	34	17	41	27	71	39
Journal of the Royal Society of Medicine	14	12	14	8	18	19	11	9
British Journal of Psychiatry	29	29	97	97	0	0	0	0
American Journal of Psychiatry	16	11	55	36	0	0	0	0
Journal of Child Psychology & Psychiatry & Allied Disciplines	10	8	30	24	0	0	2	2
International Journal of Geriatric Psychiatry	5	6	18	21	0	0	0	0
Journal of the American Academy of Child & Adolescent Psychiatry	4	3	9	8	0	0	3	2
Annals of the Royal College of Surgeons of England	21	22	0	0	60	61	0	0
British Journal of Surgery	19	16	0	0	53	46	0	0
BJU International	5	5	0	0	14	15	0	0
Clinical Otolaryngology	5	5	0	0	14	14	0	0
Journal of Urology	5	4	0	0	13	12	0	0
Journal of Laryngology and Otology	3	3	0	0	7	8	1	0
Archives of Disease in Childhood	34	34	1	2	0	1	97	96
Pediatrics	18	15	1	0	0	0	51	42
Developmental Medicine & Child Neurology	8	12	1	1	0	0	22	34

Acad, consultants with any part of their contract for dedicated academic sessions (excluding routine continuing professional development); non-Acad, consultants with no part of their contract for dedicated academic sessions.

neral medical journals, the two leading USA general medical journals, and the three leading specialist journals in paediatrics.

Methods

A full account of the methods used in each of the surveys is provided in the three separate papers¹²⁻¹⁴. Here we provide an outline of the methods.

Consultants in each of the three specialties were asked which journals they read and which they considered important for informing clinical practice by questionnaire survey¹⁵. The questionnaires used in each of the three surveys contained lists of journal names derived from the Research Outputs Database (ROD) which was constructed by the Wellcome Trust¹⁶ and then maintained by the Centre for Information Behaviour and Evaluation of Research based at City University, London. The ROD contains details of the full range of UK basic and clinical biomedical research published in peer-reviewed journals and indexed in Thomson ISI's Science and Social Science Citation Indices. As a result of the addition of funding acknowledgement details, National Health Service (NHS) ROD was identified as a subset of ROD with evidence of some financial support from the NHS in England, UK. ROD filters were developed for the various medical specialties and were used to identify publications concerning research connected with each specialty¹²⁻¹⁴. From these lists of journals we selected those containing the most papers within each specialty that had at least some element of funding by the English NHS. These papers were deemed to be broadly of clinical interest due to NHS financial involvement. For the questionnaires for the surgery and paediatrics surveys, additional journal names were added from the Journal Citation Reports 2002 from Thomson ISI of the journals with high impact factors in the respective fields. This resulted in lists containing 32 journals in the psychiatrists' survey and 39 journals in both the surgeons' and the paediatricians' surveys. There was some variations to the general medical journals included, notably that whereas *BMJ*, *Journal of the Royal Society of Medicine* and *The Lancet* were included in all three, *NEJM* and *JAMA* were listed only on the original questionnaire sent to paediatricians because it was only in this field that the journals published enough papers from the NHS in England to be included in the lists.

Recipient psychiatrists' names were provided by the Royal College of Psychiatrists and those for the surveys of surgeons and paediatricians were taken from The Medical Directory 2003/4 (produced by Informa Healthcare, UK in association with The Royal Society of Medicine). When conducting the survey of psychiatrists, equally sized samples of names and addresses from each of the three major categories identified by the Royal College (those providing services to children and adolescents, adults of working age and the elderly) were taken to ensure sufficient responses were received for statistical analysis. To ensure the three separate datasets were comparable, for this paper the data from the survey of psychiatrists were adjusted before analysis to reflect the original membership more closely. For the surveys of surgeons and paediatricians, all consultants within each specialty, with full membership and not retired were surveyed, not including those that had chosen to be excluded from surveys via The Medical Directory's privacy policy. The resultant numbers of respondents used for this comparative analysis from within each specialty were: psychiatry, 954 after adjustment from a membership of 2231 (based on 551 respondents out of 1200 recipients); surgeons, 1003 from an available mem-

bership of 2660; and paediatrics, 996 from an available membership of 2330.

Journal ratings across the three specialties were compared in terms of 1st, 2nd, and 3rd in importance. Within each specialty, the importance across the sub-specialties was also examined.

Findings

Readership of individual journals

Table 1 shows the readership figures across the three specialties studied for each of the three most prominent general medical journals in the UK (*BMJ*, *The Lancet* and *Journal of the Royal Society of Medicine*). The readership of the specialty and sub-specialty journals are included for those journals viewed as important by 20% or more in one or more of the main sub-specialties within each specialty. For each

TABLE 2

The percentage of psychiatrists who consider individual journals 1st, of the listed categories

Journal	Readership	All sub-specialties			
		1.2+3	1	2	3
		British Journal of Psychiatry	97	83	45
BMJ	89	58	15	26	17
American Journal of Psychiatry	38	14	4	4	5
Journal of Child Psychology & Psychiatry & Allied Disciplines	35	20	8	6	5
International Journal of Geriatric Psychiatry	30	16	6	5	5
Journal of the American Academy of Child & Adolescent Psychiatry	14	6	3	2	1

Child, psychiatrists specialising in the treatment of children and adolescents; Adult, general psychiatrists and those

TABLE 3

The percentage of surgeons who consider individual journals 1st, of the listed categories

Journal	Readership	All sub-specialties			
		1.2+3	1	2	3
		BMJ	77.9	35.9	4.1
Annals of the Royal College of Surgeons of England	61.0	24.4	3.0	9.0	12.5
British Journal of Surgery	48.0	39.9	23.3	10.0	6.6
Clinical Otolaryngology	14.3	12.6	8.3	2.4	1.9
BJU International	14.6	13.0	8.7	3.4	0.9
Journal of Urology	12.3	10.4	2.9	5.3	2.2
Journal of Laryngology and Otology	8.0	6.3	1.2	3.4	1.7

TABLE 4

The percentage of paediatricians who consider individual journal 1st, of the listed categories

Journal	Readership	All sub-specialties			
		1.2+3	1	2	3
		Archives of Diseases in Childhood	95.9	85.9	65.1
BMJ	83.8	51.0	7.2	28.2	15.6
Lancet	54.6	12.7	2.6	3.4	6.6
Journal of Pediatrics	42.8	10.8	0.9	5.2	4.6
Pediatrics	43.5	16.5	2.0	5.4	9.1
Developmental Medicine & Child Neurology	31.6	18.8	2.7	8.1	8.1
New England Journal of Medicine	38.7	7.8	1.5	3.0	3.3
JAMA	3.7	0.2	0.0	0.1	0.1

group the figures are broken down into academics, ie those clinicians who reported that they had at least one academic session a week, and non-academics. The results show not only that the general medical journals are widely read across the three UK specialties examined, but also that the *BMJ*, in particular, is widely read within each of them. Even though, the readership figures for *NEJM* and for *JAMA* were not included in Table 1, comparison between the figures for *NEJM* and for *JAMA* within the specialty of paediatrics are noteworthy: the figures for paediatricians reading *JAMA* are very low (7% academics, 3% non-academics) in comparison to *NEJM* (61% academics, 31% non-academics). Apart from the *Archives of Disease in Childhood*, more academic paediatricians read three general medical journals, *BMJ*, *The Lancet*, *NEJM*, than the specialist paediatric journals. Conversely, apart from the *BMJ*, more non-academic paediatricians read the specialist paediatric journals than general medical journals.

Comparison of the readership and importance of the key journals

Tables 2, 3 and 4 show the journals considered important to any of the listed categories of consultants in the 3 medical specialties, psychiatry, paediatrics and surgery by more than 20% of respondents in one or more of the sub-specialties. The data for journals placed first, second and third in importance are provided separately as well as combined and readership data are supplied for comparative purposes. The journal impact factors relating to the year in which the data were collected is also included. Three sub-specialties are shown in each table, but for psychiatry this covers the whole specialty whereas for surgery and paediatrics it is just the three largest sub-specialties. In these tables the general medical journals are included only if they reach the 20% criteria. The role of the general medical journal is described in the context of each specialty.

2nd and 3rd in importance to their clinical practice: those journals considered important by 20% or more psychiatrists in any

Importance												JIF 2001
Child				Adult				Old age				
1.2+3	1	2	3	1.2+3	1	2	3	1.2+3	1	2	3	
71	28	26	17	88	55	22	11	84	42	27	16	4.1
38	10	12	16	66	16	34	16	63	18	25	20	6.6
0	0	0	0	27	7	9	11	0	0	0	0	6.9
78	32	25	21	0	0	0	0	0	0	0	0	2.8
0	0	0	0	0	0	0	0	68	25	22	22	1.8
25	12	7	5	0	0	0	0	0	0	0	0	3.6

specialising in the treatment of adults of working age; Old age, psychiatrists specialising in the treatment of elderly patients'.

2nd and 3rd in importance to their clinical practice: those journals considered important by 20% or more surgeons in any

Importance												JIF 2001
General				Otolaryngology				Urology				
1.2+3	1	2	3	1.2+3	1	2	3	1.2+3	1	2	3	
36.7	3.1	13.3	20.3	43.7	8.1	17.8	17.8	49.6	4.1	16.3	29.3	6.6
38.1	5.9	17.5	14.7	21.5	0.7	8.1	12.6	14.6	0.0	2.4	12.2	0.5
90.7	60.5	19.8	10.5	0.0	0.0	0.0	0.0	4.9	1.6	3.3	0.0	3.5
0.0	0.0	0.0	0.0	89.6	61.5	15.6	12.6	0.0	0.0	0.0	0.0	0.7
2.0	0.6	0.8	0.6	0.0	0.0	0.0	0.0	94.3	66.7	22.8	4.9	1.4
0.6	0.0	0.3	0.3	0.0	0.0	0.0	0.0	81.3	22.8	41.5	17.1	3.2
0.0	0.0	0.0	0.0	46.7	8.9	25.2	12.6	0.0	0.0	0.0	0.0	0.5

2nd and 3rd in importance to their clinical practice: those journals considered important by 20% or more paediatricians in any

Importance												JIF 2003
Community ChildHealth				Neonatology				Respiratory Medicine				
1.2+3	1	2	3	1.2+3	1	2	3	1.2+3	1	2	3	
95.1	76.6	14.2	4.3	93.1	78.2	9.7	5.2	86.0	61.4	14.9	9.6	1.72
68.9	12.6	36.0	20.3	48.0	4.8	30.2	12.9	43.9	7.0	27.2	9.6	7.21
4.9	0.6	1.5	2.8	12.9	0.4	3.2	9.3	20.2	5.3	4.4	10.5	18.32
2.5	0.0	1.2	1.2	20.2	1.6	8.1	10.5	14.0	0.0	7.9	6.1	2.91
9.2	1.2	2.8	5.2	33.5	6.0	13.3	14.1	14.9	1.8	3.5	9.6	3.78
39.1	2.5	18.5	18.2	4.0	0.0	1.6	2.4	0.9	0.0	0.0	0.9	1.9
1.5	0.3	0.3	0.9	9.3	0.4	2.8	6.0	13.2	3.5	4.4	5.3	34.83
0.0	0.0	0.0	0.0	0.4	0.0	0.4	0.0	0.9	0.0	0.9	0.0	21.46

For psychiatrists (Table 2) the *BMJ*, the only general medical journal listed, is considered second in importance overall by the greatest number of psychiatrists and this also applies at sub-specialty level for the 'Adults of working age' and 'Old age' categories but it is considered third in importance by more 'Child and adolescent' psychiatrists.

Table 3 shows the data for surgery: there is no single clearly dominant surgery journal. Here the *BMJ*, a general medical journal, is the most widely read for both academics and non-academics. When we look at importance, the sub-specialty journals are most prominent, with the *British Journal of Surgery* being a journal that is very important in a few of the sub-specialties, including general surgery, but not at all important in other sub-specialties.

As with psychiatry, paediatrics (Table 4) is dominated by one specialty journal — *The Archives of Disease in Childhood*. There are two general medical journals listed in the main body of the table, the *BMJ* and *The Lancet*, both are read widely, particularly by academics, and the *BMJ* is considered more important than *The Lancet* almost across the whole table. The *BMJ* is considered second in importance in all listed categories whereas *The Lancet* is considered third in importance by more paediatricians.

The role of general medical journals in providing the best evidence in paediatrics

Table 4 also contains two additional journals, added to the bottom of the table, that were the two out of seven journals identified by Birken and Parkin as providing the best evidence in paediatrics⁸ but not considered important by 20% or more of any of the listed categories of respondents in our survey. The journal impact factors of the journals listed in Table 4 also show that although *The Archives of Diseases in Childhood* is the most widely read and the most widely regarded as being important to inform clinical practice, it has the lowest impact factor of all the journals included and therefore the lowest JIF of all seven of the journals identified by Birken and Parkin.

Discussion and conclusions

The response rates of the three surveys (psychiatrists; 47%, surgeons; 38%, paediatricians; 43%) are comparable to similar surveys and the opinions of the non-respondents may differ from those of the respondents, however a study of surveys of paediatricians by Cull et al found that response rates were declining with time and for the levels of response rates studied there was no evidence of a significant effect on bias¹⁷. Whilst the authors consider that caution should still be exerted in the interpretation of the findings, a number of important points stand out in relation to the role of national general medical journals.

In terms of readership the role of one general medical journal, the *BMJ*, is striking in that not only is it widely read across all three UK specialties under study, but in each case it is one of a very small number of journals that are widely read across the sub-specialties. Whilst it is read slightly more by psychiatrists than surgeons or paediatricians, it is noticeable that the readership of the *BMJ* is consistently high across disciplines and between academics and non-academics. The *BMJ* is, of course, a UK-based journal, albeit aiming at an international audience, and Schein et al found a similar nationality bias by American surgeons in favour of USA-based general medical journals³. It is also a membership journal for most UK clinicians and until recently all contents were available freely online.

In terms of importance for informing clinical practice *BMJ* is not considered to be the most important journal overall within each specialty but rather to come second or third either to a major specialty journal or to dominant sub-specialty journals. Nevertheless, this important role is again reflected in all three specialties studied.

The Lancet is read by more paediatricians than surgeons or psychiatrists and more widely by academics than non-academics across all three specialties but the only groups amongst whom its readership is more than 50% of the figure achieved by the *BMJ* are academic paediatricians and academic surgeons. In the tables for being important for informing clinical practice it featured in the paediatrics table, as the fifth most consulted journal overall (and fourth in terms of readership for non-academics). Clearly *The Lancet* plays an important role, but it did not feature in either the surgery or the psychiatry tables. Whilst it is a UK-based journal it is not a membership journal. Its greater importance to academics than non-academics probably reflects both the nature of its role in describing major advances in medical fields and its greater availability to academics, in universities, than non-academics.

The *Journal of the Royal Society of Medicine* is again a UK journal and is a membership journal. It is not regarded as being as important as the other two general journals and its readership amongst non-academics is on average about half that of *The Lancet*, but distributed differently because it is read by twice as many surgeons as paediatricians.

Amongst UK paediatricians, the readership figures for the *NEJM* are similar to those for *The Lancet* in that they are much higher for academics than for non-academics.

Table 4 dramatically shows that if the aim of publishing medical research is to inform clinicians about important findings in the hope of alerting them to key advances in their field, then articles in some journals with comparatively low impact factors, such as *Archives of Diseases in Childhood*, should perhaps be regarded as being at least as important as those in the journals with the highest impact factors. This mismatch between impact factor and importance in the eye of the UK clinician is also borne out with the four general medical journals where the two with the highest impact factors, *NEJM* and *JAMA*, are considered important by fewer paediatricians than the two UK general medical journals, *BMJ* and *The Lancet*. These findings could have important implications for the way in which research evaluation develops.

It would seem, then, that general medical journals are not just read by clinicians for their broad interest but also because they contain information that is important to clinical practice. However, they are not considered to be as important as the most prominent specialty or sometimes sub-specialty journals. Further study of the reasons for their importance, perhaps of the role performed by the sections of the journals and the article types perceived as most important would add more information to the discussion.

It would be very interesting for similar studies to be conducted in other countries and for cross-country comparisons to be made.

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Declaration of conflicts of interests

The authors confirm that they have no conflict of interests.

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Appendix VI – Paper P5

Tracing the wider impacts of biomedical research: a literature search to develop a novel citation categorisation technique

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Abstract There is an increasing need both to understand the translation of biomedical research into improved healthcare and to assess the range of wider impacts from health research such as improved health policies, health practices and healthcare. Conducting such assessments is complex and new methods are being sought. Our new approach involves several steps. First, we developed a qualitative citation analysis technique to apply to biomedical research in order to assess the contribution that individual papers made to further research. Second, using this method, we then proposed to trace the citations to the original research through a series of generations of citing papers. Third, we aimed eventually to assess the wider impacts of the various generations. This article describes our comprehensive literature search to inform the new technique. We searched various databases, specific bibliometrics journals and the bibliographies of key papers. After excluding irrelevant papers we reviewed those remaining for either general or specific details that could inform development of our new technique. Various characteristics of citations were identified that had been found to predict their importance to the citing paper including the citation's location; number of citation occasions and whether the author(s) of the cited paper were named within the citing paper. We combined these objective characteristics with subjective approaches also identified from the literature search to develop a citation categorisation technique that would allow us to achieve the first of the steps above, i.e., being able routinely to assess the contribution that individual papers make to further research.

Keywords Research assessment · Citation categorisation · Methodology · Wider impacts of research · Citation generations

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Introduction

Funders of health research increasingly recognise the need both to understand the translation of biomedical research into improved healthcare and to assess the extent to which these wider impacts or benefits to society are achieved (Buxton and Hanney 1996; Cooksey 2006). In the UK, the Medical Research Council, Wellcome Trust and Academy of Medical Sciences together created the UK Evaluation Forum who, in 2006, described the evaluation of medical research benefits as crucial to research stakeholders (UK Evaluation Forum 2006). Various research funders have already commissioned studies to show the wider impact that is made by the research that they have funded. These include, in the UK, public sector bodies such as the National Health Service (NHS) R&D Programme (Buxton and Hanney 1996) and medical research charities such as the Arthritis Research Campaign (arc) (Wooding et al. 2005). In terms of the techniques adopted, considerable progress has been made using case studies to assess the wider impact of biomedical research (Hanney et al. 2007; Wooding et al. 2005). These can use a variety of techniques, including bibliometric analysis, but a major element involves qualitative interviewing and, therefore, such studies are resource intensive. Furthermore, the UK Evaluation Forum recommended that further work be undertaken to develop methods to assess the benefits or payback from health research (UK Evaluation Forum 2006).

There are still debates about the best approach to use to assess the academic quality of research. There is increasing discussion about how far citation analysis can be used but traditionally, most citation analysis that is used in research evaluation relies on simple quantitative techniques which can be more mechanised and are not resource-intensive. How far such simple citation counts provide adequate measures of research quality has long been debated (Cave et al. 1988; Moed 2005; Research Evaluation and Policy Project (REPP) 2005). It is widely agreed, however, that such counts do not provide adequate assessments of wider benefits from health research (Allen et al. 2009; Jones et al. 2004). As Lewison (2004) observes, ‘both paper and patent citation counts may be inappropriate as measures of the practical effects of biomedical research.’

Some progress has, however, been made in assessing wider impacts by using novel citation approaches. Some studies start with specific documents and work back by analysing the papers cited on them. These documents have tended to be clinical guidelines (Grant et al. 2000) but such analysis could be extended to other policy documents or text books that could be part of a wider impact achieved by the health research (Lewison 2004). Nevertheless, there are limitations on how starting with specific documents and working back could, on its own, provide a way of assessing the wider impact of specific bodies of research.

Going the other way, working forwards from specific research and attempting to identify policy documents on which it is cited, can have a role in case studies (Buxton and Hanney 1996; Wooding et al. 2005) but on its own again it would be limited because it would not allow tracing of the impact made by one study on subsequent studies and through that route on to eventual wider impacts. Kostoff commented that ‘one largely unutilized role of citations is to serve as a “radioactive tracer” of research impacts...this is a very fruitful area for future citation research and analysis’ (Kostoff 1998). Also, Hu et al. (2011) claimed that ‘when studying a publication’s contribution to the evolution of its field or to science in general, taking only direct citations into account, tells only part of the story’.

Hanney et al. (2006) used a variety of both qualitative and quantitative techniques to identify a wide range of impacts from a body of health research. Their comparison of

findings from the different methods used illustrated the inadequacies of using purely quantitative citation analysis for the task of identifying the wider impacts from research: some of the papers viewed by interviewees as having had an important impact on clinical practice did not receive many citations. In an attempt to move beyond purely quantitative citation analysis, one of the techniques developed in this study involved categorising citations received by a paper, to identify those where the cited paper was considered important (Hanney et al. 2005). In this approach Hanney et al. recorded details relating to each citation such as its location within the citing paper and the number of citing occasions, and also made an assessment of the reasons behind each citation occasion and the level of importance of the cited paper to the citing paper. This analysis suggested that just 9% of the citations received by a body of papers were considered to be of high importance to the papers citing them, and only 1% essential. Hanney et al. (2005) suggested that further work was needed.

In our current study we seek to build on the previous work and to develop a robust novel citation categorisation method and apply it to biomedical research in order to assess the contribution that individual papers make to further research by identifying those citing papers where the cited paper is of importance. Using this method we then propose to trace the important citations to the original research through a series of generations. Then we shall also attempt to identify the wider impacts made in any of the generations as a result of the papers being cited in clinical guidelines etc. This article describes the first part of the process, i.e., the steps taken to build on the previous study and develop our citation categorisation method. It describes our search of the bibliometrics' literature and the way in which the search findings informed our subsequent development of a template that could be used to categorise citations.

Method

For the development of our citation categorisation technique, we were particularly looking for ideas that would allow us quickly to examine all the citations given to a paper and identify those examples (probably few in number) where inclusion of the cited paper was of some importance to the citing paper. We also wanted to consider how we should manage self-citations. Furthermore, as we were not expecting to ask for authors' opinions about why they cited particular papers as the basis of our method, it was particularly important to look for information that would help us to develop a method that could be applied not only quickly but also consistently by diverse assessors. We searched the literature for relevant information including empirical and other data to aid in the design of a novel approach to categorise citations based on their importance to the citing paper.

Literature survey coverage

We conducted a comprehensive literature search both of citation databases and subject-specific databases for relevant articles (Tang and Safer, 2008). We included all years that the relevant databases were available up to October 2009, and all types of articles published in English (see Table 1). As we considered that the subject of our search was difficult to define precisely we attempted to increase the sensitivity of our survey by additionally conducting manual searches of four prominent journals (see Table 2) and by exploring the reference lists from eight key papers: two described above (Hanney et al. 2005; Kostoff 1998); a further five key papers describing both the positive and the negative motives behind citations (Case and Higgins 2000; Gilbert 1977; McCain and Turner 1989;

Table 1 Databases searched listed in the order of searching, details of the searches conducted and the dates covered by each search

Databases searched	Dates covered	Type of search	Extent of search	New papers identified after exact duplicates removed
WOS including SCI-expanded, SSCI, A&HCI, CPCI-S	1970–2009	Advanced	Title, abstract, author keywords, keywords plus	1,372
Scopus	1823–2009	Advanced	Title, abstract, keywords	640
Library, information science & technology abstracts (LISTA)	1965–2010	Boolean/ phrase	Title, abstract, keywords	230
SpringerLink	All	Basic	Summary	710
Sigle	1980–2005	Search	Title, author, subject abstract, series, sponsor, identifier	31
Medline	1950–2009	Advanced	Title, abstract, subject heading	662
InfoSci journals	All	Basic	Abstract	13
Information science reference	All	Basic	Abstract	19

Moravcsik and Murugesan [1975](#); Shadish et al. [1995](#)) and Bornmann and Daniel ([2008](#)) who had more recently completed a major review of the reasons behind citations.

Search strategy

We sought to find publications that would provide potentially relevant information on the assessment or classification of the use of citations within a citing paper. The key terms used to develop an appropriate search strategy for each database were: analysis of citations; categorisation or assessment of the importance of citations; reasons for citing. Identified articles were transferred to an EndNote database in the order of searching with duplicates electronically removed on transfer. The number of new articles found in each database after the removal of duplicates was noted. In addition we collected all of the papers included in the journals in [Table 2](#) and published between the dates listed and added them to the same EndNote database. Again duplicates were electronically removed on transfer.

Table 2 Journals hand-searched and the dates covered in the search

Journals searched	Dates covered	Number of papers identified
Journal of documentation	1961–2009	679
Scientometrics	1978–2009	2,450
Journal of the American society of information science & technology	1972–2009	2,501
Social studies of science	1975–2009	519

Review strategy

We chose to exclude papers that clearly were not relevant to our search by systematically reviewing each paper using the descriptions as listed in Table 3. Titles and abstracts were studied first and, where there was insufficient detail to make a decision, the full papers were obtained and the review process repeated to reach conclusions on relevance for each paper. Full papers for all those considered potentially useful were obtained and classified according to an iterative list of characteristics that was continuously developed throughout the review as informed by the research papers.

Findings

Details of the findings of our search strategy can be found in Tables 1 and 2. We identified 9,050 records after the automatic deletion of duplicates, 3,677 from the database searches, an additional 5,348 from journal hand-searches and a further 25 from the bibliography searches.

Findings from the first stage of the review procedure carried out on these 9,050 records are included in Table 3.

Through the survey we identified many research articles that were potentially of use to the development of our method although, apart from Hanney et al. (2005), no other research was identified that had attempted to explore Kostoff's original suggestion (1998) of using citations to trace impacts across generations of citing papers.

Meaning or use of citations

The considerable research that has previously been conducted on the use or meaning of citations within a citing paper covers various issues. For example, Gilbert (1977) discussed how citations could be considered as a method of persuasion for authors and Small (1978) regarded them as concept symbols. Numerous authors, e.g. (Case and Higgins 2000; Harwood 2009; Kostoff 1998; Oppenheim and Renn 1978; Peritz 1983; Shadish et al. 1995) have devised classification schemes for the use or meaning of citations. Moravcsik

Table 3 Findings from our initial review of the papers identified in the searches described and reasons for exclusion from further study

Excluded papers: Total	8,765
Not a study of citations.	5,307
Only a quantitative assessment, e.g., a count of citations, mathematical manipulations such as Lotka's law, Bradford, Hirsch; an assessment of a specific body of literature, e.g., as found in a journal, library, institution, geographical area; considering collaboration.	2,895
Only an assessment of the distribution of citations, e.g., co-citation, mapping, diffusion, data envelopment analysis, reference analysis.	496
Specifically describing: Ortega hypothesis; patents; comparisons of quantitative bibliometric techniques and peer-review; or paper not in English.	67
Papers for further study: Total	285
General background: theoretical papers concerning the meaning of citations without any relevant methodological detail but potentially interesting for our study.	179
Methodological: specific to the development of our method either in a general way or because they discuss particular issues such as self-citation or location of a citation.	106

and Murugesan (1975) proposed a series of dichotomous questions for the classification procedure rather than an unrelated list of possible answers or an open question inviting authors to list their own reasons. The use or meaning of self-citations has also been widely discussed, e.g. (Garfield 1996; Snyder and Bonzi 1989; Tang and Safer 2008). In 2008, Bornmann and Daniel reviewed citation behaviour of scientists over a period of 15 years and concluded that whereas findings from the included studies varied widely in their design and that their results were 'scarcely reliable', there was some basis for the use of citations (Bornmann and Daniel 2008).

The importance of citations

The importance of a citation to the citing paper has also been discussed, e.g. Safer and Tang (2009) used a scale of 1–7 for authors to indicate importance and found that only 9% of references contained a quote or discussed at least one point thoroughly. They also found that a further 11% mentioned the cited work in the text but in a limited way. Prabha (1983) also found the majority of citations to be of little importance as he identified that less than a third of cited papers were considered to be essential raw material to the citing papers. Researchers have widely investigated possible ways of characterising citations to indicate their influence, e.g. the location of a citation within a paper (Cano 1989; McCain and Turner 1989; Paul 2000; Peritz 1983; Safer and Tang 2009; Sombatsompop et al. 2006; Tang and Safer 2008) naming the first author (Paul 2000), the length of a citation (Tang and Safer 2008) or the number of occasions when a citation may be included in a citing paper (McCain and Turner 1989; Peritz 1983; Safer and Tang 2009; Sombatsompop et al. 2006; Tang and Safer 2008). Sombatsompop et al. (2006) combined the location of a citation within the paper with its significance on a four level scale within that section of the paper. Their findings indicated that citations in the Results and Discussion sections were comparatively more important than those in other sections. In some cases researchers asked authors to attach a level of significance to any reason that an author may have for including a citation (Case and Higgins 2000; Safer and Tang 2009; Shadish et al. 1995; Tang and Safer 2008).

The citation assessment process

We identified research that had considered the practicalities involved in the assessment procedure, for example Peritz considered whether the use of the text surrounding the citation was adequate for assessment (Peritz 1983). The type of assessors carrying out the analysis of the citations has also been considered by many. Some literature considered the author's views of why a citation has been included (Cano 1989; Harwood 2009; Prabha 1983; Tang and Safer 2008; White and Wang 1997). Hanney et al. (2005) had employed a number of assessors who were not the authors of the citing article, and the researchers examined the level of agreement between the assessors. In a slightly different but related context Moriarty et al. who were examining the sources of citations in cancer news articles, had considered the benefits of training assessors in preparation for a citation categorisation procedure (Moriarty et al. 2009).

Discussion

Our literature search identified much discussion around the meaning and use of citations and also different considerations and methods for evaluating the importance within a citing

paper of a particular citation. The literature search, therefore, could help us address a number of questions that we were facing in developing a citation analysis technique to apply to biomedical research in order to assess the contribution that individual papers made to further research. The issues we addressed included: how to filter out the large number of citations which are not really important to the cited paper; how to treat self citations; how to develop a template that could be applied quickly and consistently; how far objective characteristics of citations could be used to identify the citations that were important to the citing paper; how far we can identify appropriate subjective elements on which a qualitative assessment of importance will have to be made?

As we are proposing to trace the citations through up to six generations, there are potentially major questions about the feasibility of the overall project because the increase in the number of papers in the second and subsequent generations could be enormous and finding a way of managing it effectively could be a complex step in the assessment procedure. However, both our previous study and work identified in the literature search found that the numbers of citing papers for which the cited paper was highly important was only a small proportion of the total number of citations (Hanney et al. 2005; Prabha 1983). This is significant for our overall study but does mean that the identification of the citing papers for which the cited paper was highly important is a crucial practical step and, further, that this could require a multi-step assessment process.

We also examined discussions in the literature concerning the reasons behind self-citations, e.g. (Safer and Tang 2009; Snyder and Bonzi 1989; Tang and Safer 2008) and whether they should or should not be included in a citation assessment and, if included, whether they should be handled differently to non-self-citations (Safer and Tang 2009; Tang and Safer 2008). For quantitative citation analysis there is much concern about the potential for distortion of the outcome of the analysis should self-citations be considered in the same way as non-self-citations. However, some studies have concluded that when considering the wider impacts of research, authors often consider self-citations to be more important and informative to the research than non-self-citations, e.g. (Safer and Tang 2009; Snyder and Bonzi 1989; Tang and Safer 2008). Therefore, we concluded that at this stage self-citations should not be excluded from our study but data should be collected so that we could then more fully examine their role in tracing the wider impacts.

Concerns about the time required to conduct qualitative assessments, and the need for consistency were addressed in several of the identified papers. Peritz (1983) devised a categorisation method for the use of citations in empirical papers in the social sciences, specifically excluding historical studies, and considered that as little subjective judgement as possible should be included in the assessment process. In 2004, White considered that no citation classification scheme would be widely accepted unless its operation could be automated (White 2004). Therefore, we considered that objective data contained within a citing paper (e.g., location of citation, number of citation occasions) requires little evaluative judgement and so could be relatively simple and quick to collect accurately and also opened up the opportunity for possible future part-automation of the assessment process.

We identified various papers that analysed how far objective aspects of a research paper have been shown to relate to expert or author opinion of importance. Characteristics repeatedly found to be associated with expert or author opinion of the level of importance of a citation to the cited paper include the location of a citation and its frequency within the citing paper (Cano 1989; Peritz 1983; Safer and Tang 2009; Sombatsompop et al. 2006; Tang and Safer 2008). Characteristics that have been found to have some level of prediction of importance include naming of the first author (Paul 2000) and length of the

citation (Tang and Safer 2008). However, these characteristics were found not to have the same predictive level of importance for self-citations (Safer and Tang 2009; Tang and Safer 2008). Of these characteristics, we considered that data on the location and frequency of citation as well as whether the author(s) were named could be straightforward to collect and therefore should allow good inter-rater reliability as well as speedy completion. The length of citation could have a subjective element involved but it also could potentially be incorporated. We chose to collect data relating to these characteristics to inform the design of a trial template and subsequently to evaluate their usefulness as part of our subsequent assessment procedure.

In considering the qualitative aspect of the assessment procedure we intended to use the method devised by Hanney et al. (2005) as the starting point. This approach had used a range of five possible reasons for the use of a citation and a 4-point scale of importance. Findings from the use of this method could be combined with studies identified in the literature, for example, the works of Case and Higgins' (2000) and Shadish et al. (1995), to modify the characterisation scheme so as to allow the assessors to identify more easily the citing papers where the cited paper was of some importance rather than provide a full characterisation of the citation. We were not considering asking for authors' opinions of the citations that they had used and the evidence provided by Haslam et al. (2008) who had employed graduate and post-graduate students to carry out some of the data collection on article organisation and had achieved good inter-rater reliability and Peritz's (1983) conclusions that no more than a general acquaintance with the subject of the paper should be required from the assessors, we considered employing a group of post-graduates who were appropriately skilled. In light of Moriarty et al.'s findings (2009) we would provide familiarisation sessions and training for the post-graduates before the assessment procedure began. Inter-rater reliability would be measured using the Kappa coefficient and comparison of the assessors' views via the assessment procedure would be compared with expert opinion and also with other methods available, generally of a more quantitative and/or automated nature.

Overall, therefore, the literature review helped us identify the objective and subjective elements to include in our categorisation of citations.

Conclusions

Hanney et al. (2005) started developing an approach to put into practice an idea from Kostoff (1998) about using citations to trace the impacts of research. The literature reported here found no other attempts to apply a citation categorisation method to biomedical (or other) research in order to assess the wider impacts of research across many generations of citations. The survey, however, has revealed both objective and subjective techniques that could assist the development of a simple and informative assessment method to categorise citations.

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Appendix VII– Paper P6

Tracing the indirect societal impacts of biomedical research: development and piloting of a technique based on citations

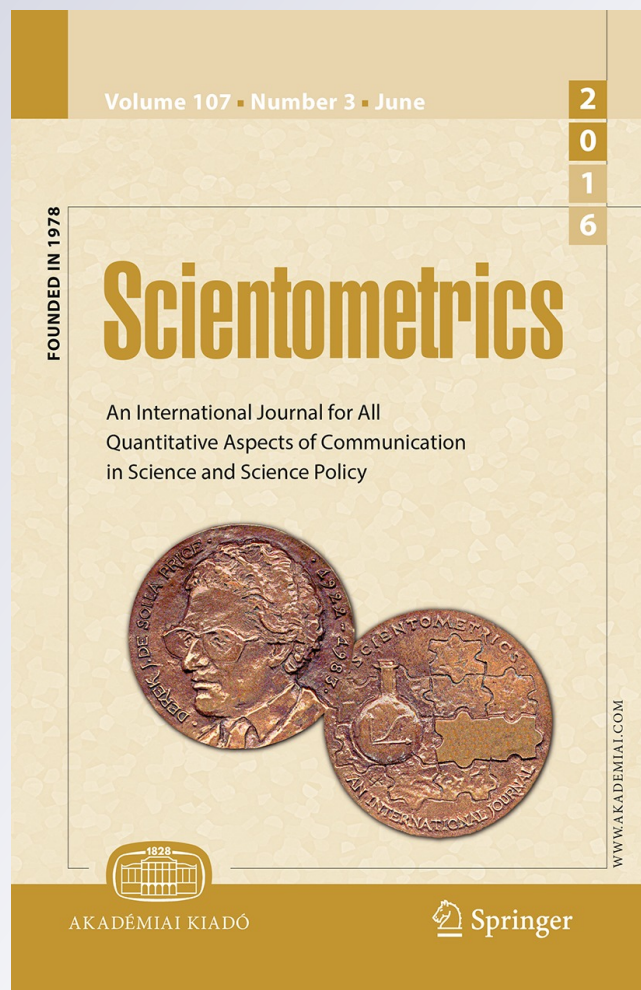
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Tracing the indirect societal impacts of biomedical research: development and piloting of a technique based on citations

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Abstract There is growing interest in assessing the societal impacts of research such as informing health policies and clinical practice, and contributing to improved health. Bibliometric approaches have long been used to assess knowledge outputs, but can they also help evaluate societal impacts? We aimed to see how far the societal impacts could be traced by identifying key research articles in the psychiatry/neuroscience area and exploring their societal impact through analysing several generations of citing papers. Informed by a literature review of citation categorisation, we developed a prototype template to qualitatively assess a reference's importance to the citing paper and tested it on 96 papers. We refined the template for a pilot study to assess the importance of citations, including self-cites, to four key research articles. We then similarly assessed citations to those citing papers for which the key article was Central i.e. it was very important to the message of the citing article. We applied a filter of three or more citation occasions in order to focus on the citing articles where the reference was most likely to be Central. We found the reference was Central for 4.4 % of citing research articles overall and ten times more frequently if the article contained three or more citation occasions. We created a citation stream of influence for each key paper across up to five generations of citations. We searched the Web of Science for citations to all Central papers and identified societal impacts, including international clinical guidelines citing papers across the generations.

Keywords Citation categorisation · Societal impacts of research · Qualitative analysis · Citation generations · Research assessment

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Introduction

The importance of assessing the impact and translation of biomedical research is increasingly being recognised by research funding bodies, partly as a way of demonstrating accountability for their spending to taxpayers and charitable donors. Recent reviews in the health field have identified the growing interest in expanding the scope of research evaluation so that in addition to assessing knowledge production it also covers economic/societal (or wider, or non-academic) impact of research in terms of informing health policies and clinical practice, and generating health and economic gains (Banzi et al. 2011; Bornmann 2013; Milat et al. 2015). Such reviews often also found the Payback Framework (Buxton and Hanney 1996; Donovan and Hanney 2011) to be the most frequently used approach to assess health research impact. One of the prominent features of the Payback Framework is its multi-dimensional categorisation of benefits. This includes the full range of impacts starting with knowledge production which can be assessed by traditional bibliometrics and, for example, was done so extensively in a study of the impacts of the National Breast Cancer Foundation (NBCF) in Australia (Donovan et al. 2014).

There are many well-established ways of conducting bibliometric analysis, and new approaches are frequently proposed (Wu 2015), but it is widely recognised that it is more difficult to assess outcomes, such as impacts on health, than outputs such as publications (Weiss 2007). Methods to assess outcomes are much less well developed. Nevertheless, there has been considerable recent progress reported in applications of the Payback Framework, and other studies reported in the reviews described above (Banzi et al. 2011; Milat et al. 2015). Furthermore, in the UK the Research Excellence Framework (REF) 2014 was successfully applied to assess the quality and impact of research from all UK Higher Education Institutions (Higher Education Funding Council 2015).

In this article we shall focus specifically on societal impacts, which the UK Medical Research Council (MRC) define as: 'Increasing the effectiveness of public services and policy. Enhancing quality of life, health and creative output.' (MRC 2015). There has been some interest in exploring how far approaches such as citation analysis that are used for assessing outputs can be extended and also be used to assess societal impacts. Some early studies started by looking at the role of citations in clinical guidelines (Grant et al. 2000) or in items that could be part of the societal impact achieved by health research such as other policy documents or text books (Lewison 2004). These early explorations are now being supplemented by further attempts to establish the scope of such approaches and consider how far they can demonstrate the societal impact from the research of particular funders or research centres (Kryl et al. 2012; Sullivan et al. 2011). The grey literature is also an increasingly important source for searches of citations on health policy documents (Sibbald et al. 2015). Furthermore, in some payback studies attempts have been made not just to identify the clinical guidelines on which research papers from a particular funder might be cited, but also to go further in detailed case studies and consider the importance of papers from a funder, such as Asthma UK, in terms of the specific contribution the paper might make to a particular guideline. This can be undertaken by considering factors such as: the importance of the point being made in the guideline that the citation is being used to support; how far that reference is the major source of evidence supporting the point in the guideline; and whether or not a paper is cited more than once on a particular guideline (Hanney et al. 2013).

So, new forms of citation analysis definitely have a role to play in assessing the societal impacts from research. There are, however, important limitations, including that such analysis of citations usually only focuses on the direct influence from the paper cited, and it

is argued that impacts usually arise from one or more streams of research or from a variety of papers.

Some researchers have already advocated that standard bibliometric analysis should consider more than one generation of citations by examining the inclusion of indirect as well as direct citations (Dervos and Kalkanis 2005; Fragkiadaki and Evangelidis 2014; Hu et al. 2011; Rousseau 1987). In 1987 Rousseau proposed the Gozinto theorem to determine the cited references that had the greatest influence on the paper under scrutiny. As part of his mathematical calculation of the total influence of the referenced paper, Rousseau added weights to the direct and the indirect references. He considered his method could equally be used looking forward to study the chosen paper's direct and indirect citations or backward to study direct and indirect references. Hu et al. (2011) similarly considered that direct citations to a publication only told part of the story of the contribution made by a paper to the evolution of its field of research and to science in general. They concluded that by taking more than one generation of citations into account the structure of the network underlying the progress in science could better be revealed. Dervos and Kalkanis (2005) included more than one citing generation in their framework for calculating the bibliometric impact of a research paper as they considered it provided a fairer quantitative method of assessment because it also took into consideration the research activity that had been triggered by the original publication. Fragkiadaki and Evangelidis (2014) reviewed citations across more than one generation (direct and indirect citations) and provided an overview of the concepts of multiple generations of citations and the indirect impact.

Kostoff (1998) commented that 'one largely unutilised role of citations is to serve as a "radioactive tracer" of research impacts...this is a very fruitful area for future citation research and analysis'. So, would it be feasible to indeed use citation analysis through a series of generations of papers in order to contribute to an analysis of the societal impacts from health research by examining whether later generations of citing papers were cited on documents such as clinical guidelines? In the account described here we adopt the term 'generations of citing papers' to mean moving from a source paper to the citing papers, and then to the papers that cite the citing papers and so on.

To be able to conduct such analysis we believe we would have to address a range of overlapping issues each of which have sometimes been explored, but which we do not believe have previously been brought together to address the concept of using citation analysis to trace the indirect societal impact of health research over a longer perspective. There are questions of the legitimacy and practicality of organising citation analysis through several generations, and taking account of not just direct citations but also of what some authors have described as 'indirect citations'. As Rousseau (1987) noted, the numbers of papers involved could rapidly become very large. But many citations are known just to be perfunctory (Kacmar and Whitfield 2000; Prabha 1983; Safer and Tang 2009), therefore any such exercise would soon risk considering large numbers of perfunctory citations of papers that themselves have perfunctorily cited the source paper, and so on. There could be large numbers of papers with a minimal connection to the original source paper. So, the questions of legitimacy and practicality overlap. Almost 30 years ago, Rousseau (1987) developed a formula that would take into account the fact that not all citations are of equal importance. But given the scale of the analysis envisaged it was suggested that this should be addressed in a formulaic way by, for example, giving citations different weights according to their location in the citing paper. This approach may be appropriate at the level of broad generalisations, but when the question being addressed is whether it is possible to identify the main references in order to selectively follow through

from generation to generation then the ability explicitly to identify the most influential individual references becomes very important.

In 2000, Kacmar and Whitfield (2000) assessed the influence of a body of papers from two journals (*Academy of Management Review* and *Academy of Management Journal*) on the papers citing them. They studied each citing paper to determine whether the reference was a major basis for the paper. They found that the papers from the *Academy of Management Review* were important for only 9 % of citing papers and papers from the *Academy of Management Journal* were important for only 6 % of citing papers. In 2005, Hanney et al. developed a method to identify a wide range of impacts from a body of research by using a variety of both qualitative and quantitative techniques. One such technique involved categorising citations received by a paper to identify those where the reference was considered important (Hanney et al. 2005). The analysis looked at a second generation consisting of all the papers citing 29 first generation papers. They concluded that the number of citing papers for which the reference was at least of considerable importance was only 9 % of the total number of citations, with just 1 % being essential (Hanney et al. 2005). This means that in any major analysis through generations of citing papers the identification of the citing papers for which the reference was highly important is a crucial practical step and, further, that this could require a multi-step assessment process.

We aimed to build on previous work on qualitative citation analysis in order to explore the development of biomedical research over numerous generations of citations, and eventually to identify indirect societal impacts. We had previously examined the literature in order to help us develop a robust citation categorisation method for application to biomedical research in order to help explore the societal impacts from that research (Jones et al. 2012). We had searched the literature extensively including by: automated searches of citation databases and subject specific databases; manual searches of four prominent journals: and by using ‘snowballing’ techniques on eight key papers. We identified and systematically reviewed 9050 potentially relevant papers and examined 285 in detail including many examples of studies discussing the meaning or use of citations and also papers discussing the importance within a paper of different citations. In the literature survey we identified both objective and subjective elements (i.e. independent and dependent on the assessors’ judgement) that could potentially help us to identify the citations for which the reference was very important.

In our continued monitoring of the literature we have identified further developments since our review published in 2012. In a recent review, Ding et al. (2014) gave an overview of content-based citation analysis which they considered to be the next generation of citation analysis, concluding that the development of a way to give weight to important citations within a citing paper was one of the tasks still unanswered (Ding et al. 2014). Zhu et al. (2015) built on previous work and claimed that the number of times a reference is mentioned in the body of a citing paper was one of the best ways of measuring academic influence.

In this article we describe the development and refinement of a qualitative citation assessment procedure that incorporated both objective and subjective elements identified in our literature survey (Jones et al. 2012). We developed a prototype template for the categorisation of citations, and tested it on a small number of papers. We then reflected on the results, revised the template and piloted it. We also applied an initial filter that reduced the number of papers we had to consider. In this pilot we aimed to trace the citation streams of some chosen health research articles across up to six generations of citations in order to understand more fully the progress and development of the research, and to explore the

potential for using the method as a contribution to the identification of the societal impacts of the original health research. Considerable progress was made in the pilot and in the “[Discussion](#)” section we consider how far this new approach could contribute to the increasing focus on assessing the societal impacts of research.

Method

We developed a prototype template, tested it on a group of 96 papers and modified the template based on our findings for use in the pilot. The modified template was applied to the papers that cited a small group of chosen key research articles. We used the papers for which the key research article was important and examined the citations to those papers through several generations to identify the indirect societal impacts of the research. Below we set out the full sequence of activities we undertook first in the testing of the prototype and then in the pilot and the search for societal impacts.

Description and testing of the prototype template developed as a result of the literature search

Following our literature search on qualitative citation analysis (Jones et al. 2012) we used the gathered evidence to inform the development of an assessment procedure for the qualitative citation analysis of biomedical research papers. We constructed a prototype assessment template that consisted of three sections: the first section collected some preparatory details; the second section related to characteristics of citations within a paper for each and every occasion where the reference was cited; and the third section considered the relationship between the reference and the citing paper as a whole including the way in which the reference was used within the citing paper and its importance to the citing paper. A space for comments and an instruction sheet for further guidance were also provided (Online resource 1).

To test the prototype template we applied it to a body of mental health research covering basic neuroscience as well as community psychiatry and clinical psychology as two ends of a spectrum of neurological/mental disorders. The mental health field was chosen for this study as interesting comparisons could potentially be made with findings from other studies on the impact of such research especially the Mental Health Retrosight project (Wooding et al. 2014a, b).

We identified research articles authored by two prominent researchers, Professor Tim Bliss researching an area of neuroscience and Professor Paul Salkovskis researching an area of clinical psychology. A selection of 96 research articles and reviews referencing articles authored by either Bliss or Salkovskis were chosen for study. Previous research had found that references cited on more than one occasion within a paper indicated greater influence of the reference to the citing paper (McCain and Turner 1989; Peritz 1983; Safer and Tang 2009; Sombatsompop et al. 2006; Tang and Safer 2008), therefore we preferentially selected papers with more than one citation occasion to increase the chances of including more papers where the reference was of high importance. Our selection of papers included 19 % of citing research articles with three or more citation occasions and 52 % of citing reviews with two or more citation occasions. Otherwise the selection was random from those papers identified on Web of Science (WOS) and listed in date order and available in full via Brunel University library.

A number of experts (Online resource 2) were invited to participate in the research project to provide guidance throughout. This group consisted of experts in social psychiatry, community psychiatry, neuropsychiatry, health and research policy and research impact.

We advertised for post-graduate students to carry out the assessment of the citations specifying our requirements for: a high level of ability in written and spoken English; a good understanding and preferably a working knowledge of the structure of scientific published papers; at least a graduate level of education; and availability for the whole time-frame of the assessment process. Previous knowledge of the area of research being studied in the project was not looked for in the selection of reviewers. Introductory sessions were held for the successful applicants together with group training sessions and practice papers. Group discussion sessions were also held to deal with differences in understanding of the evaluation procedure that was to be used and additional contact was provided when it was considered beneficial to the reviewers' understanding of the evaluation process and to consistency in its application.

In preparation for the assessment process, the full papers (preferably in pdf form) were obtained either electronically or as paper copies from Brunel University library. Adobe Acrobat 9.0 was used to find and highlight the reference in the bibliographies of the pdf copies as well as the locations of the citation occasions to that reference. Bibliographic details of the cited and citing papers as well as details for each citation occasion were pre-entered on the assessment template before its distribution together with a highlighted copy of the paper for assessment. In total there were 15 assessors (4 subject experts and 11 reviewers including 8 post graduates, 2 researchers i.e. TJ and SH, and a bibliometrics expert who became a research team member i.e. CD). They each assessed all papers. Completed assessment sheets were returned to the researchers for analysis using Microsoft Excel.

The discussion in the literature (Jones et al. 2012) about the pros and cons of inclusion of self-citations in citation analysis was inconclusive for our purposes. Therefore, we took the decision to include self-citations and collect data on them in the same way as for other citations. We would then be in a more informed position to examine the findings and make comparisons.

The nature of citations in reviews was also considered potentially to be different to citations in research articles and therefore a slightly different template was created for application to reviews.

Refinement of the prototype template for application in the pilot

The data collected in the testing of the prototype template (Online resource 2) were presented and discussed at a meeting with the panel of experts. We found that the opinions of the assessors on the use of the references by the citing authors were too varied for use as a categorisation procedure that might inform tracing the influence of a research article across several citation generations. Following much discussion, the meeting concluded that what was ultimately required from this assessment procedure was identification of the citing papers where the reference played a very important role rather than the identification of the type of role played. Therefore the most helpful part of the prototype template was a single question regarding the importance of the cited article to the citing article. For our purposes this was considered to be the principal question.

The meeting considered further that our principal question and accompanying guidance notes required re-wording to increase clarity on the decision that was to be made. We

restructured the principal question and guidance notes with input from all experts and researchers and agreed upon the question:

“Is the cited article **CENTRAL** to the message of this paper?” This had the following supporting guidance: Tick yes if the **KEY CONCLUSIONS** of this paper as a whole could not have been reached without one or more of the following:

- By applying a novel theory, method, scale or technology, etc. set out in the cited article.
- By supporting or developing, either by modification or different application, a concept or method set out in the cited article.
- By refuting a concept or method from the cited article.

The assessors were asked to adopt a default position of ‘NO’ when answering the question. [We also concluded that establishing a middle category was desirable. If the answer to the first question was NO then the assessors were asked to also consider a second question that would provide a middle category (Online resource 1)].

In our literature review (Jones et al. 2012) we had found that the citing papers where the reference was very important was likely to be a small percentage of all citing papers and so it would be beneficial to include an instrument in the assessment procedure that would help to focus the assessment on those papers where it was more likely that the reference would be viewed as Central, if such an instrument was available. The majority of the objective data that we collected in the prototype phase were insufficiently definitive for this purpose but we had found that within all research articles where the reference was considered to be important by at least one expert, the reference had been cited on three or more occasions. We therefore decided to introduce an initial filter of at least three citation occasions within a citing research article into the pilot, and, as a check on this filter, we decided to also assess 20 % of the excluded papers.

We also concluded that the role of references in reviews remained uncertain in the context of this assessment process and different from that of research articles, and that this role was important for the transfer of knowledge forwards towards clinical practice. Therefore the assessment procedure for reviews should be considered separately, and in light of the very limited results found in the testing of the prototype template should perhaps be more inclusive and with a different procedure employed. Therefore, due to this uncertainty, and as there were likely to be fewer reviews for assessment, the meeting decided to include all reviews with two or more citation occasions. This initial filter would be followed by just one question to determine a level of importance that required inclusion in the next round of citation analysis. The question was:

“Is the cited article **IMPORTANT** to a key message from this review/discussion paper?” with a default position of NO. We again provided additional guidance: “Tick yes if the cited article is used to help reach or sustain a **KEY TAKE-HOME MESSAGE** or **CONCLUSION** of this review/discussion paper i.e. there is one or more citation occasion which describes the cited paper in some detail (likely to be at least one full sentence) **AND** that or another citation occasion occurs at a point in the text where a key conclusion or take-home message from the review is being developed or discussed)”.

As a check, again we decided to assess 20 % of excluded reviews. The final templates used in the pilot, named the **HERG Assessment of Citations Template (HACT)** can be found in Online resource 1.

A further point that needed consideration was the role of self-citations in comparison to non-self-citations when the assessment was qualitative. Relevant papers had been identified in our literature search (Jones et al. 2012) and we found that the inclusion of self-citations in assessments has been a much discussed issue by researchers (Hartley 2012;

Harzing 2010; Kacmar and Whitfield 2000; Prabha 1983; Safer and Tang 2009; Snyder and Bonzi 1989; Tang and Safer 2008). As we had insufficient evidence to exclude self-citations we took the opportunity to examine this issue in the context of our evaluation procedure. There are many definitions of ‘self-citation’ and as WoS was being used to detect citing papers then we used the definition provided by and used by WoS. (“Self-citations refer to cited references that contain an author name that matches the name of the author of a citing article i.e. an author cites an earlier published paper that he or she authored”. http://images.webofknowledge.com/WOK45/help/WOS/h_citationrpt.html).

Selection of the bodies of mental health research to be studied

We were looking for work published about 10–15 years previously (approximately 1995–2000) as a result of research funded as part of a specific funding initiative or programme in the area of Mental Health. A short-list of five bodies of work was put to the meeting and prioritised. We chose five articles from these areas, selecting by using methods such as citation counts and publication in journals that were highly respected by clinicians (Jones et al. 2004) in order to maximise our chances of studying work that had led to societal impacts. Inclusion of our initial filters that focused assessment on selected citations meant that the numbers of key articles that we could process, while still uncertain at the start of the pilot, was more than it would have been. So, we prioritised five such articles rather than just considering two articles as had been our original intention.

The chosen bodies of research, in priority order were:

1. NHS R&D Programme: Mental Health and Learning Disability
 - (a) Kuipers, E., Garety, P., Fowler, D., Dunn, G., Bebbington, P., Freeman, D., et al. (1997). London-East Anglia randomised controlled trial of cognitive-behavioural therapy for psychosis. I: effects of the treatment phase. *The British Journal of Psychiatry*, 171(4), 319–327.
 - (b) Burns, T., Creed, F., Fahy, T., Thompson, S., Tyrer, P., & White, I. (1999). Intensive versus standard case management for severe psychotic illness: a randomised trial. *The Lancet*, 353(9171), 2185–2189.
2. Vesa, J., Hellsten, E., Verkruyse, L., Camp, L., Rapola, J., Santavuori, P., et al. (1995). Mutations in the palmitoyl protein thioesterase gene causing infantile neuronal ceroid lipofuscinosis. *Nature*, 376(6541), 584.
3. Clark, D. M., Salkovskis, P. M., Hackmann, A., Middleton, H., Anastasiades, P., & Gelder, M. (1994). A comparison of cognitive therapy, applied relaxation and imipramine in the treatment of panic disorder. *The British Journal of Psychiatry*, 164(6), 759–769.
4. Richardson, W. D., Pringle, N., Mosley, M. J., Westermarck, B., & Dubois-Dalcq, M. (1988). A role for platelet-derived growth factor in normal gliogenesis in the central nervous system. *Cell*, 53(2), 309–319.

Preparation of the citing papers

The preparation of the citing papers before assessment was carried out by TJ and EN as had been previously carried out in the testing of the prototype template. Reviews were automatically identified and prepared separately from research articles. For research articles, if

three or more citation occasions were identified then processing of the paper was continued. For reviews, processing was continued when two or more citation occasions were identified. In addition, for both research articles and reviews, every fifth and nearest to fifth available paper in time order, from those remaining, was processed. This provided the 20 % sample of those excluded by the filter. Where there were fewer than ten remaining citing papers then two such citing papers were processed. These measures of inclusion resulted in a larger than 20 % sample of articles with fewer than three citation occasions and reviews with fewer than two citation occasions being analysed.

The processed documents were carefully labelled to ensure identification with the correct citing generation as well as with the correct reference.

The assessment procedure

A secure online application was constructed specifically for this assessment process. This allowed: the central up-loading of previously prepared batches of papers; secure access to the papers and assessment template by the assessors for assessment; electronic recording of the assessment results by the assessors; and batch collection of results to be carried out centrally. New batches of processed papers were uploaded regularly and the assessors were asked to complete their assessment within a fixed time scale. Once the assessment of a paper had been completed and submitted by an assessor then that assessment form was no longer available to that assessor.

Eight assessors who had joined us for the testing of the prototype template were introduced to the refinements that had been made and given some practice papers to help them prepare for the pilot. A discussion session was held to help address any uncertainties.

Part of the way through the assessment process, two of the assessors were unable to continue and had to leave the project thus reducing our numbers to six assessors. We adjusted our assessment procedure to accommodate this change by asking one of the researchers (TJ) to carry out the extra assessments required. This allowed us to maintain the same number of assessments per paper.

The assessment of the citing paper either as Central for research articles or Important for reviews proceeded as follows:

1. Where three or four assessors out of four considered the reference to be Central/Important then the citing paper was taken through to the next citation generation.
2. Where two assessors out of four considered the reference to be Central/Important then the citing paper was additionally assessed by two researchers and if either considered it Central/Important then it continued through to the next citation generation.
3. Where just one or no assessors considered it to be Central/Important then the paper was not studied further.

Analysis of the results and applying the template to further generations of papers

The centrally collected results were regularly downloaded to an Excel spreadsheet for analysis and to inform the preparation of the next generation of citing papers. We called the key articles generation 1, generation 2 consisted of all the papers citing the four key articles. All of these citing articles where the key article was assessed as Central, and reviews where the key article was assessed as Important, we called generation 2 (Central). Generation 3 consisted of all citing papers to generation 2 (Central). We prepared and

assessed them in the same way as described above to create generation 3 (Central). Therefore, generation 3 (Central) consisted of all of the citing articles where a generation 2 (Central) paper was assessed as Central and all reviews where a generation 2 (Central) paper was assessed as Important. We continued to study additional generations of citing papers in the same way to create generation 4 (Central), generation 5 (Central) etc. until either there were no more citing papers to be considered, we reached generation 6 (Central) for that key article or we ran out of time.

In order to manage the uncertain numbers of papers that would require assessment, and expecting the numbers of citing papers to increase as we worked through at least the first two or three generations, we started with our first key article (Kuipers et al. 1997) and worked through at least two generations of citing papers to Kuipers et al. (1997) before starting our study of the next key article (Burns et al. 1999) and so on. The result of this process was likely to be that we would not start or make as much progress with our fourth and fifth key articles (Clark et al. 1994; Richardson et al. 1988) as we did with the other three key articles. Final analysis was carried out in Microsoft Excel.

Experts' views on a sample of assessed papers

As a form of quality control, a small number of citing papers from across the citing generations to all key articles were selected and distributed to the experts for their assessment. The papers selected included samples of: Central articles with less than three citation occasions; Central articles with three or more citation occasions; non-Central papers; papers that reviewers' had had particular difficulty assessing; and where there was an issue that was considered important for discussion for example citations included in letters and book reviews. Findings from these assessments were discussed at a meeting of all experts and researchers.

Identification of societal impacts

We considered the societal impacts of the key research articles that could be explored using citations, and that therefore we might identify using this method, to be any evidence of their use in clinical guidelines or case reports. Case reports are sections in some medical journals where clinicians describe the treatments given in particular, anonymous, cases and where references might be given to show the evidence supporting the particular treatment. We explored the societal impacts of the original research by examining all citing papers to the key research articles and all citing papers to those articles/reviews where the reference was assessed as Central/Important across all citation generations studied. The direct and indirect societal impacts were measured as follows:

- (a) We went back to the WoS but used a different process to that used for preparing the citing papers. Using all key research articles, and the Central/Important papers in all generations of citations that we had examined in our assessment process to each key article, we identified all citing papers from the Web of Science. We collected just the abstracts and transferred them to EndNote. These abstracts were then automatically searched for the terms 'guideline' or 'case' located anywhere using EndNote's search facility. The abstracts of the identified papers were studied and when necessary whole papers obtained so that any evidence of use in clinical guidelines and case reports could be found.

- (b) A web-search using Google was carried out on the key articles in order to identify any guidelines or case reports that had directly cited these articles, but resources restricted the extent to which this could be completed.

Comparison of the finding

We used other methods to compare with our findings. These included requesting authors' views on the societal impacts of the research described in the key article via a structured questionnaire and the views of experts in the field via a similar structured questionnaire. Details of the findings from these will be reported more fully elsewhere.

Results

The results of our pilot including the application of the HACT template are included here for four of the key articles (Burns et al. 1999; Clark et al. 1994; Kuipers et al. 1997; Vesa et al. 1995) considered as one body. Time did not allow us to complete the assessment of all papers citing the fifth key article (Richardson et al. 1988) and therefore they have been omitted. The results for the identification of the societal impacts are also discussed.

Number of assessments

Assessments took place over a 9 month period ending in September 2011. A small number of papers were not available to us over this period for various reasons. However we had included steps in the method to ensure the correct proportions of papers from each category were included. The numbers included and assessed can be found in Table 1.

Table 1a shows the distribution of all papers examined across the citing generations of the four key articles. Assessment of generations 2 and 3 were completed for all four key articles, assessment of generation 4 was completed for the streams from three key articles (Kuipers et al. 1997; Burns et al. 1999; Vesa et al. 1995) and generation 5 assessment was completed for the streams from two key articles (Kuipers et al. 1997; Burns et al. 1999). In Table 1a the papers assessed as Central/Important (column 4) in each generation were carried through to the following generation where they became the cited papers. These numbers of cited papers were lower than the numbers of Central/Important papers from the previous generation for generations 4 and 5 due to the assessments for Clark et al. (1994) concluding at generation 3 (Central) and Vesa et al. (1995) at generation 4 (Central).

We examined 3464 citing research articles and 1051 citing reviews. Of these, our groups of assessors assessed 1242 articles and 554 reviews (Table 1b). Therefore 2222 articles and 497 reviews were eliminated from further analysis by the use of our filter mechanism. The groups of assessors found, overall, that the reference was Central for 9 % of assessed citing research articles and Important for 10 % of assessed citing reviews. Thirteen percent (448) of the citing research articles examined had 3 or more citation occasions, all of these were assessed and for 89 (20 %) the reference was considered Central. This compared to the remaining 3016 (87 %) of research articles with less than 3 citation occasions where 794 (26 % of the remainder) were assessed and for 17 (2 % of those assessed) the reference was considered Central. We describe later how we extrapolated from these figures to produce an overall figure for the percentage of citing research articles for which the reference was Central.

Table 1 Numbers of papers (research articles and reviews) included in the citing streams of all four key articles (generation 1): the numbers assessed and the numbers of those assessed that were considered Central/Important

Number of papers included in study	Total citing	Number assessed	Number Central/Important
(a) The numbers of papers in each generation of citations to all four key articles			
Generation 2 (papers citing the four key articles)	1082	382	77
Generation 3 (papers citing 77 Central/Important papers from generation 2)	2722	1122	57
Generation 4 (papers citing 46 of the 57 Central/Important papers from generation 3)	541	226	25
Generation 5 (papers citing 18 of the 25 Central/Important papers from generation 4)	170	66	1
Total papers	4515	1796	160
Number of papers included in study	Total citing (%)	Number assessed	Number Central/Important (% of assessed)
(b) The numbers of research articles and reviews across all citing generations of all four key articles passing through the initial filter process based on the number of citation occasions			
Total papers	4515	1796	160 (9)
Research articles	3464	1242	106 (9)
With 3 or more citation occasions	448 (13)	448	89 (20)
With <3 citation occasions	3016 (87)	794	17 (2)
Reviews	1051	554	54 (10)
With 2 or more citation occasions	321 (31)	321	49 (15)
With 1 citation occasion	730 (69)	233	5 (2)

For citing reviews, 321 (31 %) had 2 or more citation occasions, all of these were assessed and for 49 (15 %) the reference was considered Important. This compared to the remaining 730 (69 %) reviews which had less than 2 citation occasion, 233 (32 %) of these were assessed and for 5 (2 % of those assessed) the reference was considered Important.

Variations by key article

Table 2 contains a breakdown of the figures included in Table 1 by key article. Some variation was found across the four key articles. The number of citing research articles throughout the Burns et al. (1999) stream (291) was significantly lower than for the other three key research articles (Kuipers et al. 1997, 975; Vesa et al. 1995, 1192 Clark et al. 1994, 1006). However, across all four key articles the percentage of citing articles (and reviews) found with 3 or more (for reviews 2 or more) citation occasions was reasonably consistent with a mean of 13 % of all citing articles (range 11–15 %) and 31 % of all citing reviews (ranging from 26 to 34 %).

The findings for the Burns et al. (1999) citation stream also showed a significant difference to the other three citation streams in the percentage of assessed research articles that were Central. This applied whether or not the citing article had three or more citation occasions: 49 % of research articles with three or more citation occasions (compared to an average of 17 % for the other three key articles) and 10.5 % of research articles with less

Table 2 Numbers of citing papers (research articles and reviews) to all papers in the citation streams that were examined for each of the four key articles

Citing articles	Number citing research articles (% of all)			Number assessed (% of all assessed)			Number (%) classified as Central		
	Less than 3	3 or more	3 or more	Less than 3	3 or more	3 or more	Less than 3	3 or more	3 or more
(a) All citing research articles; assessed articles; articles where the reference is considered Central with less than three citation occasions and with three or more citation occasions									
Kuipers et al. (1997)	850	125 (13)	226	125 (36)	1 (0.4)	18 (14)			
Burns et al. (1999)	250	41 (14)	124	41 (25)	13 (10.5)	20 (49)			
Vesa et al. (1995)	1056	136 (11)	247	136 (36)	3 (1.2)	28 (21)			
Clark et al. (1994)	860	146 (15)	197	146 (43)	0 (0)	23 (16)			
Total	3016	448 (13)	794	448 (36)	17 (2.1)	89 (20)			
(b) All citing reviews; assessed reviews; reviews where the reference is considered Important with less than two citation occasions and with two or more citation occasions									
Citing reviews									
	Number citing reviews (% of all)			Number assessed (% of all assessed)			Number (%) classified as Important		
	Less than 2	2 or more	2 or more	Less than 2	2 or more	2 or more	Less than 2	2 or more	2 or more
Citation occasions per citing review									
Kuipers et al. (1997)	223	115 (34)	69	115 (63)	3 (4)	22 (19)			
Burns et al. (1999)	47	16 (26)	26	16 (38)	1 (4)	2 (13)			
Vesa et al. (1995)	250	97 (28)	82	97 (54)	1 (1)	16 (16)			
Clark et al. (1994)	210	93 (31)	56	93 (62)	0 (0)	9 (10)			
Total	730	321 (31)	233	321 (58)	5 (2)	49 (15)			

than three citation occasions (compared to an average of 0.6 % for the other three key articles) were assessed as Central. Possible reasons for this variation, which was not apparent for citing reviews, are examined later.

As an additional check on the filter, a complete set of citing papers in one generation of one stream of papers was assessed. We analysed all citing papers in the third generation of the Burns et al. (1999) stream and found very similar results for the percentage of articles with less than 3 citation occasions that were Central as we found for the sample of such papers assessed in the other generations of the Burns stream. Therefore we included the whole of the third generation of citations to Burns et al. (1999) in the continuing analysis.

Using our methodology (i.e. assessing all articles with three or more citing occasions and a sample of those with fewer than three) an average of 36 % of assessed articles (58 % for assessed reviews) had 3 or more (2 or more) citation occasions. The percentages for the Burns et al. (1999) article are lower: 25 % of assessed articles with 3 or more citation occasions and 38 % of assessed reviews with 2 or more citation occasions. This is at least in part because of the inclusion of the whole of the third generation of citing papers.

Finally, we built on finding that the assessment of all the papers in the third generation of Burns et al. (1999) was similar to that for all Burns et al. (1999) generations. This reinforced the view that our assessment of 20 % of the articles with fewer than three citation occasions provided a reasonable reflection of all the articles in a generation with less than three citation occasions. Therefore we extrapolated from the 20 % figure to calculate the total percentage of articles that were Central in the whole citing streams of the four key articles. When calculated as a percentage of the whole body of citing articles examined, adjusting for the percentage of those excluded by our filter, we found 4.4 % of citing articles to be Central. In reviews, we found that the reference was Important for 6.1 % of all those examined.

Number of citation occasions

An illustration of the number of citation occasions found within the citing articles and reviews and the percentage where the reference was considered to be Central or Important is shown in Fig. 1.

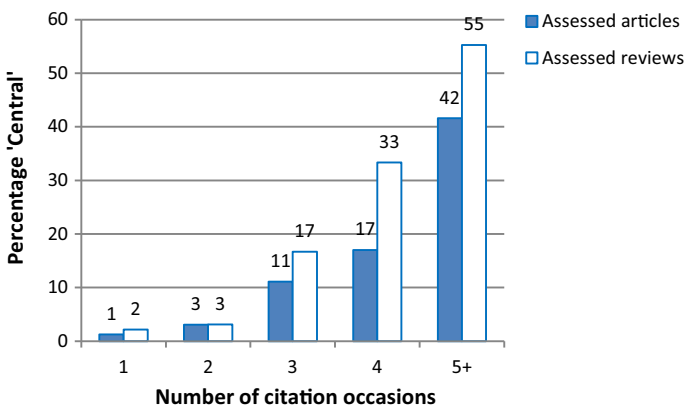


Fig. 1 Numbers of citation occasions in assessed papers (research articles and reviews) across all citing generations

Table 3 The level of agreement found between assessors when assessing all research articles and reviews included in the citation classification procedure

Number of assessors assessing Central/Important	Number of research articles	Percentage of total research articles	Number of reviews	Percentage of total reviews
0	918	74	307	55
1	200	16	161	29
2–	20	2	29	5
2+	52	4	30	5
3	37	3	23	4
4	14	1	5	1

2–, Cases where two assessors considered the reference Central/Important to the citing article/review and neither of the two researchers considered it Central/Important. These papers were not carried through to the next citation generation

2+, Cases where two assessors considered the reference Central/Important to the citing article/review and at least one of the two researchers considered it Central/Important. These papers were carried through to the next citation generation

A strong positive correlation was found for both citing articles ($r = 0.976$) and citing reviews ($r = 0.947$). This correlation was more erratic above five citation occasions probably due, at least in part, to the small number of citing articles (113 in total) and reviews (38 in total) that fell into these categories and which we have combined in Fig. 1. There was a noticeable increase in the percentage of articles and reviews where the reference was Central or Important when the number of citation occasions increased from 2 to 3. This reflects the findings from the testing of the prototype (see “Method” section) and is more prominent for reviews than for research articles.

Agreement between assessors

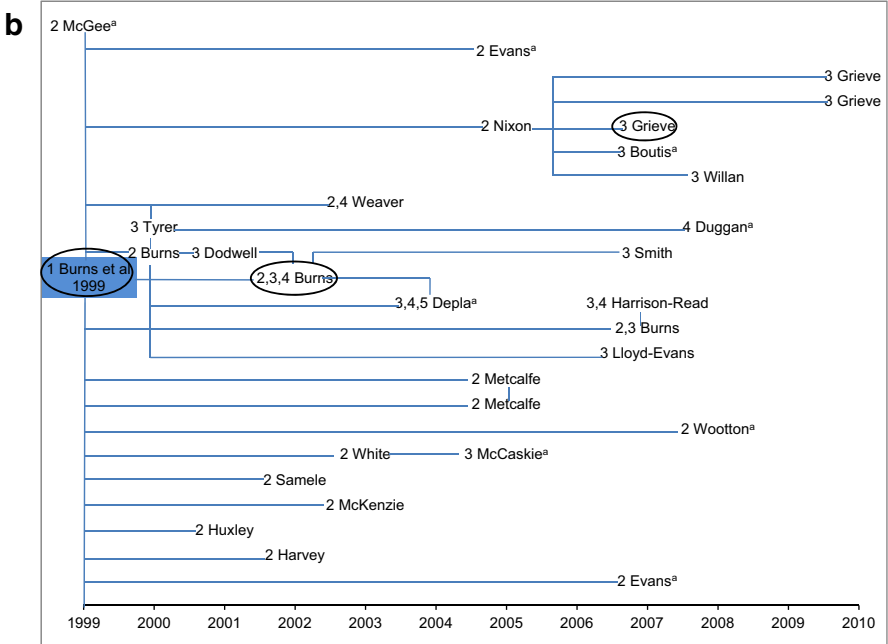
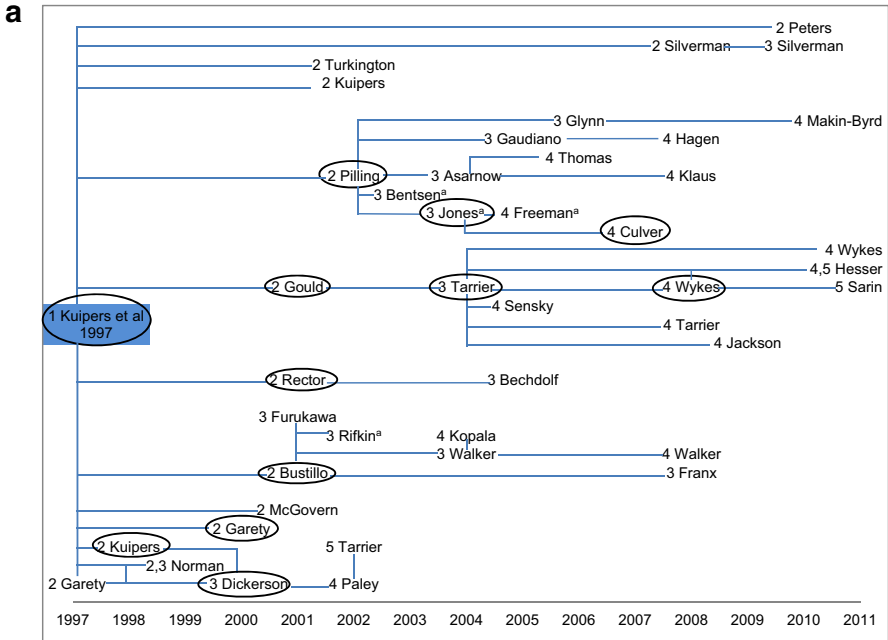
The level of agreement that was found between assessors for the assessment of research articles and reviews is shown in Table 3.

Using our method of assessment our assessors were in total agreement that the cited paper was not Central for 74 % of citing research articles and not Important for 55 % of citing reviews. There was also total agreement amongst the assessors that the cited paper

Table 4 Numbers of research articles citing each key article and the percentages that were self-citations: all citing articles; assessed articles; articles considered Central

Number of citing articles	All citing articles		Number assessed		Number Central	
	<i>n</i>	Self-cites (%)	<i>n</i>	Self-cites (%)	<i>n</i>	Self-cites (%)
Kuipers et al. (1997)	135	20 (15)	43	9 (21)	7	5 (71)
Burns et al. (1999)	146	74 (51)	51	27 (53)	16	11 (69)
Vesa et al. (1995)	338	74 (22)	97	32 (33)	18	10 (56)
Clark et al. (1994)	234	21 (9)	79	10 (13)	16	4 (25)
Total	853	189 (22)	270	78 (29)	57	30 (53)

For each key article there is a progressive increase in the percentage of citing articles that were self-cites as we move from all citing articles, through articles assessed and on to articles considered Central



◀ **Fig. 2** Key articles chosen for study and the citation streams produced using our technique. *Superscript letter a* Papers that would not have been identified using the initial filter based on number of citation occasions. *Oval symbol* Papers cited in societal impacts. *1, 2, 3, 4, 5* Generations of citing papers for which the cited paper in the previous generation was ‘Central/Important’. **a** Kuipers et al. (1997) and the citing papers in subsequent generations 2–5 for which the reference in the previous generation was Central/Important. **b** Burns et al. (1999) and the citing papers in subsequent generations 2–5 for which the reference in the previous generation was Central/Important. **c** Vesa et al. (1995) and the citing papers in subsequent generations 2–4 for which the reference in the previous generation was Central/Important. **d** Clark et al. (1994) and the citing papers in subsequent generations 2, 3 for which the reference in the previous generation was Central/Important

was Central for 1 % of assessed citing articles and Important for 1 % of assessed citing reviews.

For comparison, a small number of papers were assessed by the experts as part of the pilot study. Out of 44 articles and reviews assessed by both assessors and experts, there was agreement on 26. For the 18 citing papers where assessors and experts did not agree, 16 were considered Central by assessors but not by experts and 2 were considered Central by experts but not by assessors. The general pattern, therefore, reflected the prototype phase where the experts were less likely than the assessors to view a reference as being of importance to the citing paper but there were exceptions.

The importance of self-citations

A further aspect that we wanted to explore was the numbers of self-citations to the key articles in comparison to non-self-citations and particularly the percentages of self-citations where the reference was considered to be Central and those that led to societal impacts. The findings, included in Table 4, refer to generation 2 for the four key articles, i.e. the citations directly to the four key articles and not to subsequent citing generations.

There was considerable variation in the percentages of citing articles that were found to be self-citations for each of the four key articles [9 % for Clark et al. (1994) up to 51 % for Burns et al. (1999)], and this was found to be similarly varied for the percentages assessed [Clark et al. (1994) 13 % and Burns et al. (1999) 53 %] and the percentages considered to be Central. The Burns et al. (1999) and Kuipers et al. (1997) key articles had the highest percentage of Central articles that were self-cites at 69 and 71 % respectively and Clark et al. (1994) had the lowest percentage at 25 %.

Streams of Central/Important papers

The citation streams produced from our technique using HACT are illustrated in Fig. 2a–d. The figures illustrate both the time span and the influence of the four key articles found within our study though this influence has quite possibly spread further since. The citing generation where each of the Central articles and Important reviews was identified is included in the figures, pre-fixing the first author’s name (e.g. 2 Gould). Central/Important papers were traced and examined to create up to generation 5 (Central) of the Kuipers et al. (1997) and Burns et al. (1999) streams, generation 4 (Central) for the Vesa et al. (1995) stream and generation 3 (Central) for Clark et al. (1994). The Burns et al. (1999) citation stream as it existed at that time was exhausted within the time frame of our study. We followed up all of the published citations that we were able to access at that time. However more papers citing any of the Central/Important papers in the Burns et al. (1999) stream

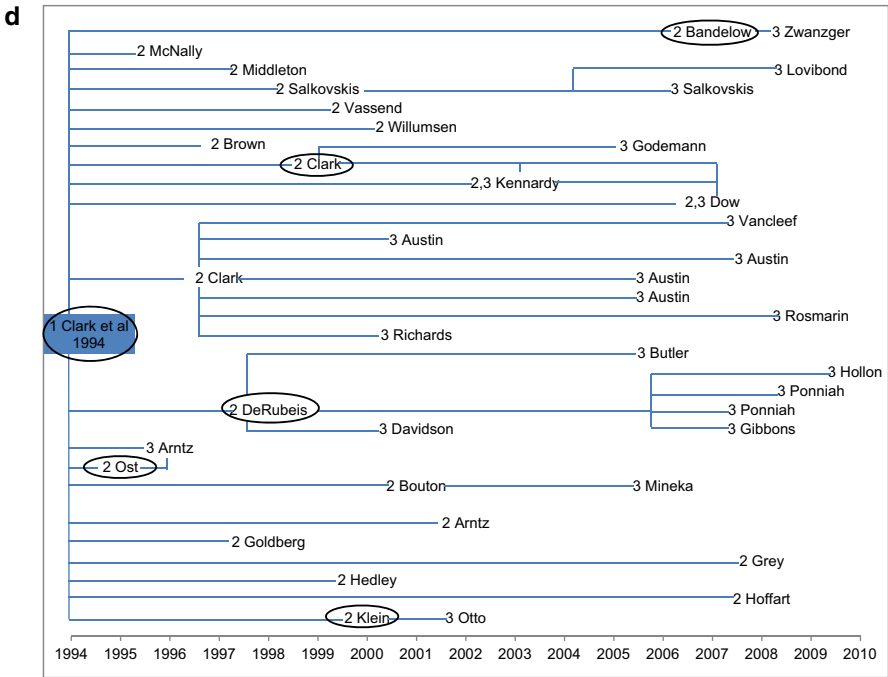
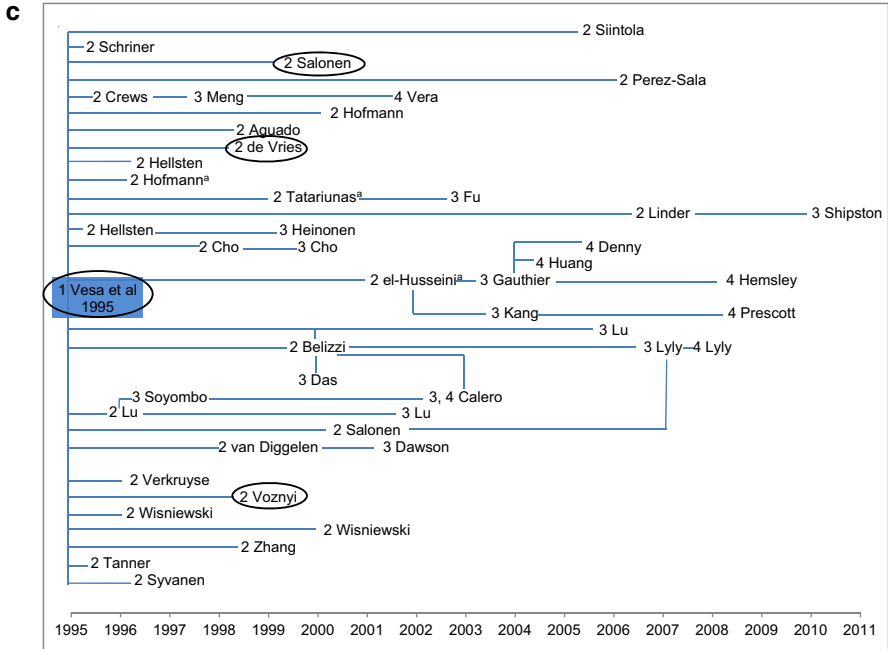


Fig. 2 continued

Table 5 Kuipers et al. (1997) citations in societal impacts

<p>Directly citing generation 1 [key article i.e. Kuipers et al. (1997)]: Scottish Intercollegiate Guidelines Network (SIGN) Guideline 30: Psychosocial Interventions in the Management of Schizophrenia (1998)</p> <p>British Columbia Ministry of Health Best Practice document: Core Information Document on Cognitive-Behavioural Therapy (2007)</p> <p>Citing generation 2 (Central) papers: Two generation 2 (Central) papers were cited in the Royal Australian and NZ College of Psychiatrists clinical practice guidelines for the treatment of schizophrenia and related disorders (2005)</p> <p>American Psychiatric Association (APA) practice guideline for the treatment of patients with schizophrenia (2009)</p> <p>Two generation 2 (Central) papers were cited in a paper providing an overview and describing the scientific base for APA's 2001 guideline and the relevance for behaviour therapy</p> <p>Italian Guidelines for early intervention in schizophrenia: development and conclusions (2008)</p> <p>Best Practices document from Nebraska Department of Health and Human Services (2005). Influence on training citation demonstrating the evidence-base behind the training requirements in psychotherapy in Canada (2010)</p> <p>Citing generation 3 (Central) papers: World Federation of Societies of Biological Psychiatry (WFSBP) Guidelines for the Biological Treatment of Bipolar Disorders: Update 2010 on the treatment of acute bipolar depression (2010)</p> <p>Canadian Network for Mood and Anxiety Treatments (CANMAT) guidelines for the management of patients with bipolar disorder: consensus and controversies (2005)</p> <p>Citing generation 4 (Central) papers numerous generation 4 (Central) papers were cited in Diagnostic guidelines for bipolar disorder: a summary of the International Society for Bipolar Disorders Diagnostic Guidelines workforce (2008)</p> <p>A citation analysing attitudes towards and implementation of NICE guidelines for schizophrenia (2011) uses the generation 4 (Central) paper as essential evidence</p> <p>Numerous papers in generation 2–4 (Central), were cited in documents providing evidence of impact on practice including papers analysing attitudes towards and implementation of NICE guidelines for schizophrenia and papers illustrating strength of evidence supporting CBT for schizophrenia and showing the levels of use of CBT (2006)</p>	<p>Scottish Intercollegiate Guidelines Network (SIGN) Guideline 30: Psychosocial Interventions in the Management of Schizophrenia (1998)</p> <p>British Columbia Ministry of Health Best Practice document: Core Information Document on Cognitive-Behavioural Therapy (2007)</p> <p>Royal Australian and NZ College of Psychiatrists clinical practice guidelines for the treatment of schizophrenia and related disorders (2005)</p> <p>American Psychiatric Association (APA) practice guideline for the treatment of patients with schizophrenia (2009)</p> <p>Paper providing an overview and describing the scientific base for APA's 2001 guideline and the relevance for behaviour therapy</p> <p>Italian Guidelines for early intervention in schizophrenia: development and conclusions (2008)</p> <p>Best Practices document from Nebraska Department of Health and Human Services (2005). Influence on training citation demonstrating the evidence-base behind the training requirements in psychotherapy in Canada (2010)</p> <p>World Federation of Societies of Biological Psychiatry (WFSBP) Guidelines for the Biological Treatment of Bipolar Disorders: Update 2010 on the treatment of acute bipolar depression (2010)</p> <p>Canadian Network for Mood and Anxiety Treatments (CANMAT) guidelines for the management of patients with bipolar disorder: consensus and controversies (2005)</p> <p>Diagnostic guidelines for bipolar disorder: a summary of the International Society for Bipolar Disorders Diagnostic Guidelines workforce (2008)</p> <p>Citation analysing attitudes towards and implementation of NICE guidelines for schizophrenia (2011) uses the generation 4 (Central) paper as essential evidence</p> <p>Documents providing evidence of impact on practice including papers analysing attitudes towards and implementation of NICE guidelines for schizophrenia and papers illustrating strength of evidence supporting CBT for schizophrenia and showing the levels of use of CBT (2006)</p>
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could have been published or made available later which may have continued the citation stream. For the other three key articles, with more time we would have been able to continue studying more citations and further generations of citations.

Societal impacts

We explored the societal impacts, for example influence on clinical guidelines or on clinical behaviour as described in case reports, by searching on Web of Science (WoS) for citations initially to the key articles and then to any of the Central/Important papers in the citation streams to the four key articles. In addition we searched on Google for societal impacts to the key articles. The papers that are circled in Fig. 2a–d are those that we identified, within the resources we had available, as the earliest in the citation stream to be included in a societal impact such as a clinical guideline or case report.

For the Kuipers et al. (1997) citation stream, citations in direct and indirect societal impacts were numerous and found to the key article as well as to papers in generations 2–4 (Central). They are described in Table 5.

The Burns et al. (1999) key article was directly cited in the Royal Australian and NZ College of Psychiatrists clinical practice guidelines for the treatment of schizophrenia and related disorders (2005), a best practices document from Nebraska Department of Health

and Human Services (2005), Assertive Outreach from The Sainsbury Centre for Mental health (2001), a paper linking the World Health Organisation Europe Mental Health Declaration to the evidence supporting it and a paper describing service developments in early intervention in psychosis (2009). A generation 2 (Central) paper was cited in the Evidence-based Guidelines for Treating Bipolar Disorder: Recommendations from the British Association of Psychopharmacology (2003 and 2009 editions). A generation 3 (Central) paper was cited in the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) Good Practices for Quality Improvement of Cost-effectiveness Research Task Force.

The Vesa et al. (1995) key article was cited directly in the European Federation of Neurological Societies (EFNS) task force on molecular diagnosis of neurologic disorders guidelines from the molecular diagnosis of inherited neurologic diseases (2001). Impact on practice was found in numerous case reports citing the key article and some generation 2 (Central) papers in which a breakthrough by Vesa et al. (1995) seemed to contribute to the diagnosis of infantile neuronal ceroid lipofuscinoses (INCL).

Clark et al. (1994) was directly cited, and generation 2 (Central) papers were also cited, in the Royal Australian and NZ College of Psychiatrists Clinical Practice Guidelines for the treatment of panic disorder and agoraphobia (2003) and in the World Federation of Societies of Biological Psychiatry (WFSBP) Guidelines for the Pharmacological Treatment of Anxiety, Obsessive–Compulsive and Post-Traumatic Stress Disorders—first revision (2008). The key article is also cited in a case report in which the use of CBT, supported by Clark et al. (1994), is applied using videoconferencing to a rural area of South Australia (2000). Generation 2 (Central) papers were cited in Canadian Practice Guidelines—Management of Anxiety Disorders (2006) and the Clinical Guidelines for the Treatment of Depressive Disorders. III Psychotherapy from the Canadian Psychiatric Association and Canadian Network for Mood and Anxiety Treatments (CANMAT 2001). Overviews and comments on the empirical base for the American Psychiatric Association Practice Guidelines for Schizophrenia: Scientific Base and relevance for behaviour Therapy (2001) and the American Psychiatric Association practice guidelines for major Depressive Disorder (2001) also included citations to generation 2 (Central) papers.

Having demonstrated the societal impacts that were identified we move on in the Discussion to show how such analysis could be used in impact assessment and be the focus for further developments enabling the approach to be used more widely.

Discussion

We aimed to explore how far it was legitimate and feasible to assess the impact of health research by using bibliometric methods through a series of generations of citing papers. In order to do this we needed to find a way to identify the citing papers for which the reference was of high importance, then use those papers as the source for the next generation of citing papers, and so on, and finally identify the impact from all the citing generations of papers. We piloted a new approach to classifying citations, designed specifically to facilitate citation analysis across generations of citing papers. Our method included the use of an initial filter based on the number of citation occasions within a citing paper followed by the application of a citation classification template called the HERG Assessment of Citations Template (HACT) based on the importance of a reference to the citing paper. A similar method (Kacmar and Whitfield 2000) involved determination of the

influence of a reference to all of its citing papers across one generation of citations. In our pilot study we applied HACT to four chosen key articles across up to five generations of citations, involving a total of 4515 papers, and identified the impacts from all citations to the papers in each generation for which the reference in the previous generation had been of central importance.

In going through a series of generations of citing papers the whole exercise would have rapidly become impractical if all the papers citing the original key articles were then used as the basis for the next generation of citing papers. So, in each generation of papers we identified and focused on what previous research (Kacmar and Whitfield 2000; Prabha 1983; Safer and Tang 2009) suggested would be the very small proportion of citing papers for which the reference was very important. We realised that doing this would be necessary to increase the legitimacy of tracing impact through several generations of citations, but, in practice, it would also enhance the feasibility of the exercise because in each generation the focus on important papers would reduce the number of papers whose citations would form the next generation of citing papers.

The feasibility issues were more acute because the articles that we had chosen to be the key first generation articles for the pilot study (Burns et al. 1999; Clark et al. 1994; Kuipers et al. 1997; Richardson et al. 1988; Vesa et al. 1995) were generally specifically chosen as highly cited articles from streams of work thought likely to show societal impacts. It was possible, therefore, that the subsequent generations of citing papers might also include many citations.

In developing a template for classifying citations we chose to revise the approach originally developed for the prototype template that had been informed by our literature survey (Jones et al. 2012). We found that identifying the number of citation occasions had been the most useful step in comparison to other aspects of the original template. We found that the opinions of the assessors on the use of a reference within the citing paper were too varied, and that in order to trace through to indirect societal impacts we needed to classify the citing papers based on the importance of the reference within the citing paper rather than to categorise the actual role the reference played. This led us to developing and applying HACT, which has similarities to Kacmar and Whitfield's (2000) assessment of the influence of a reference to the citing paper, though in a different context. The methodology we finally adopted for the pilot, therefore contained two stages, the initial filter based on numbers of citation occasions which would provide us with fast and reproducible verdicts (as suggested by the work of Peritz 1983 and White 2004) on which papers to take through to the second stage which was assessment by applying the HACT. (We had included an additional question in the HACT that provided us with a third middle category of importance of the reference to the citing article. Analysis of this data has not been included here but such an analysis may further inform the qualitative assessment).

We explored how far the application of our method might produce results that were comparable with previous studies based on categorisations of citations. We had found, by extrapolation to account for papers excluded by our initial filter, that the reference was Central to 4.4 % of articles and Important to 6.1 % of reviews in the whole body of citing papers examined. These figures fall somewhere between Hanney et al.'s (2005) findings from categorisation of one generation of citations that for 8 % of cases the reference was of considerable importance to the citing paper and for 1 % it was essential. It is also in agreement with other findings that the reference was highly important for only a small proportion of citations (Prabha 1983; Safer and Tang 2009). Kacmar and Whitfield's (2000) findings, using different criteria, reported that 9 % of *Academy of Management Review* papers and 6 % of *Academy of Management Journal* papers were important.

In the pilot study we found that the reference was Central to the citing article 10 times more frequently if it was cited on three or more occasions compared to those articles containing less than three citation occasions (Table 1). For references in reviews, the difference was only slightly lower with 7.5 times the proportion considered Important if there were two or more citation occasions. This finding supports our use of the initial filter as a first step in our assessment method for both research articles and reviews. These findings are also in agreement with previous research findings (McCain and Turner 1989; Peritz 1983; Safer and Tang 2009; Tang and Safer 2008). The correlation between the number of citation occasions and the degree of connection between the cited and citing papers has been discussed for many years. Voos and Dagaev discussed it in 1976 (Voos and Dagaev 1976) and more recently Zhu et al. (2015) found that the number of times a reference was mentioned in the body of the paper was the best of those features examined at predicting those references identified by the author as most important to their paper. Similarly Hou et al. (2011) had considered counting citations in texts to be a more accurate means of assessing the scientific contribution of such references than counting citations in the reference list.

Nevertheless, our findings also showed that a very small proportion of citing articles with fewer than three citing occasions were also classified as ones for which the reference was Central. Furthermore, because there were very many more citing articles with fewer than three citation occasions to a reference than ones with three or more citation occasions it was clear that the number of Central articles that would be missed by the application of the filter would not be negligible. We should, however, note the differences found across the citation streams of the four key articles. The citation stream for Burns et al. (1999) contains 13 out of the total of 17 articles with less than three citation occasions where the reference was Central. A potential reason for this is discussed later but here we consider all four citation streams together. With a potentially significant number of Central articles being missed, the usefulness of the filter would clearly depend on the purposes for which HACT was being applied. In particular, if it was to provide possible additional ways to identify the societal impacts from research, which was the starting point for our project, then the use of the filter could make an important contribution to the feasibility of doing so by focusing attention on the articles that are ten times more likely to be viewed as Central. And this part of the process could also be speeded up through automation, a step considered to be very beneficial by White (2004). If the intention of using HACT was to provide a fully comprehensive analysis then the use of the filter would become more problematic and further investigation about how to deal with the Central articles that would be missed out would clearly be of benefit.

One aspect of qualitative citation assessment that has been much debated and that we chose to address was the question of self-cites; should they be included or not? When a quantitative citation assessment is conducted it is generally considered prudent to omit all self-cites as they can lead to distortion of the value of the assessment (Harzing 2010). However the value of a self-cite could be argued to potentially be of greater importance to the development of a research theme than a non-self-cite (Prabha 1983; Safer and Tang 2009; Snyder and Bonzi 1989; Tang and Safer 2008). According to Hartley (2012) the reasons for self-cites were varied and therefore he argued that it was not correct to consider them all as purely self-enhancing. Although Hartley was discussing self-cites in relation to journal impact factor his thoughts relate to the use of self-cites by an author and how these can vary within a paper and therefore are also informative in this context. He argued that it is the role of the self-citation within the paper that is important in assessing the contribution made by the reference. Kacmar and Whitfield (2000) also examined self-cites and

found considerable variation in percentage from one paper to another and that most of those with the larger numbers of self-cites also had greater than average levels of citing papers where the reference was important. They discussed that some researchers appeared to be focusing their research in one particular area which resulted in a greater number of self-cites in their publications. We examined the self-citations in generation 2, i.e. in citations to just the key articles, due to the difficulties with the definition of a self-cite in subsequent citation generations. We found some variation in the percentage of citations to the key articles that were self-cites but we found that for all four of the key articles, a greater proportion of self-citing articles were Central than non-self-cites, though the numbers were quite small. Additionally, for three of the four key articles the majority of Central articles were self-cites. These findings agree with those of Tang and Safer (2008) and lead to the suggestion that self-cites may have a greater level of importance than non-self-cites when tracing the influence of research and therefore supports their inclusion in a qualitative evaluation.

When considering our findings for the citation streams of the four key articles, we found many similarities including the percentage of citing articles with three or more citation occasions, the percentage of reviews with two or more citation occasions and the percentages of reviews where the cited paper was considered Important whether it was cited more than twice or not. We also found some differences and this was particularly noticeable for the Burns et al. (1999) stream in comparison to the citation streams for the other three key articles. The cited paper was Central for a much higher percentage of the citing articles in the Burns et al. (1999) stream and citations to the Burns et al. (1999) key article included a much higher percentage of self-cites than the other three articles. Both of these findings applied whether or not the cited paper was cited on three or more citation occasions. Nevertheless, the percentage of Central articles that were self-cites was as high for the Kuipers et al. (1997) key article as for Burns et al. (1999) (Table 4). Previous work (Hanney et al. 2005) has shown that the authors of the self-citing articles would often write in an authoritative way about how they were building on their own previous work, even if they did not find it necessary to cite it on three or more occasions. This is also supported by Safer and Tang's findings (2009) that not only were self-citations more important than non-self-cites and that this was independent of the number of citation occasions within the text but also that authors judged their prior research as very important for their research article even if it was cited just once in the introduction. This issue, together with our findings, may indeed lead to a need for self-cites to be considered separately to non-self-cites.

The citation streams created by use of our selective qualitative citation analysis method illustrate the influence of the key articles across subsequent citing papers. The selective nature of our method could be likened to Kostoff's 'radioactive tracer' (1998) allowing us to trace influence across up to five citing generations and on to the indirect societal impacts of health research. Figure 2a–d show the citing papers where the reference was considered Central/Important from the key article across up to five citing generations. These citation streams illustrate the sometimes linear pathway of citation generations and also more complex interactions with many papers being included in more than one citing generation. The length of time passed between cited and Central/Important citing paper varies widely. Some generation 2 (Central) papers were published in the same year as the key article, maybe indicating that those papers were based on the same data source as the key article, and others were published some 13 years later for Kuipers et al. (1997) and 14 years later for Clark et al. (1994). The Vesa et al. (1995) citation stream contained more Central/Important citations within the first 3 years after publication of the key article in comparison to the other three key articles. This may reflect differences in research areas as Vesa et al.'s

(1995) work is closer to basic neuroscience whilst the other three key articles are closer to the social psychiatry end of the mental health research spectrum.

Over the time that the research project was conducted, we assessed citations across up to five generations for the Kuipers et al. (1997) and Burns et al. (1999) key articles, and as far as four generations for the Vesa et al. (1995) key article and three generations for Clark et al. (1994). We then used all of the Central/Important papers in all generations of citations to each key article to try to identify the direct and indirect societal impacts. This entailed us going further than in previous studies, including those using the Payback framework (Hanney et al. 2013), where one generation of citing papers was examined to see how far it included items such as clinical guidelines that could be counted as societal impacts from the research. In our current analysis we identified numerous examples of societal impacts by searching Web of Science for citations to any Central/Important paper and additionally by searching Google for citations to the key articles. A major strength of the citation analysis was in the number of clinical guideline documents that we identified in these citation searches. These citations, that sometimes occurred generations later, illustrated the international importance of the work described in the key articles, in conjunction with other published research. On the databases accessed it was striking how much of the impact was first associated with later generations of papers in the citation streams, impact that is usually not easily identified and may be not known to the original authors. Sometimes more than one of the papers included in the citation streams was cited in a document identified as a societal impact therefore in Fig. 2a–d we have marked just the earliest Central/Important paper that was cited. Sibbald et al. (2015) described the importance of including grey literature in a study of research impact. As the transition from research to clinical impact is complex perhaps the range of information sources used to identify the societal impacts add to our understanding of the complexity involved, especially in the way in which we have presented it in our series of figures that highlight the timelines over which the impacts arose.

Drawing all this together we believe the approach we have developed could add further dimensions to the growing range of approaches that exist to demonstrate the societal impacts from research (Banzi et al. 2011; Bornmann 2013; Buxton and Hanney 1996; Guthrie et al. 2013; HEFCE 2015; Milat et al. 2015). The existing approaches vary in nature and scope, and have been developed to meet the increasing demand on researchers and research funders to demonstrate the societal impacts of the research they fund. There is increasing interest in collecting data on the impact made by health research on clinical guidelines (Turner et al. 2015). Furthermore, an impact on guidelines was reported to be one of the most frequently claimed impacts in the case studies produced in the recent REF2014 by health and life science research departments in UK universities to demonstrate how they had benefitted wider society (HEFCE 2015).

Case studies conducted to identify the impact of specific pieces or streams from research can draw on a range of data sources (Hanney et al. 2013). Because our approach works through a series of generations the approach might illustrate the level of influence that the bodies of work have had in a range of ways that other impact assessment approaches might be less able to identify. For example, our method could provide an additional tool for assessing the impact of knowledge production on other policy-relevant research and on clinical policies such as in clinical guidelines. And at the international level our approach would possibly take things further than impact assessment analyses that rely on the knowledge of the researchers and/or their local peers. The potential relevance of our approach was illustrated in the recent REF2014 exercise in the UK. The Kuipers et al. (1997) key article formed an important part of an impact case study conducted as part of

submission from King's College London (Higher Education Funding Council 2015). The type of analysis facilitated by our approach could potentially have contributed further data for the analysis.

Furthermore, assessments of research impact can also be conducted in order to understand more about the processes through which the societal impacts arise (Wooding et al. 2014a, b). It is widely recognised that pathways to impact might be long, and many streams of work can make a contribution to the societal impacts that arise. Here, too, conducting case studies informed by our approach would feed into discussions about the pathways through which impacts can be achieved. Applying our approach opens up a new way of analysing impact through a series of generations of papers which might help shed light on processes that had previously been assumed to be happening but which had not been properly mapped. This complements other recent work that provides greater understanding of how to analyse the elapsed time (more commonly called time lags) between early research and its eventual impact on health policies and practice (Hanney et al. 2015).

Limitations and next steps

The approach developed here is very resource intensive as is traditional peer review. We realised it would be impossible to make extensive use of experts on such a large-scale enterprise. We therefore relied considerably on non-experts, mostly post-graduate students in other fields, to assess the importance of citations. We compared the majority verdict of our group of non-expert assessors with the findings of the experts who we did involve in the project in a highly selective way. This revealed that the post-graduate assessors tended to be less discriminating and had a lower threshold at which they consider a reference to be important when compared to expert judgement. This has potentially resulted in an over-estimation of the numbers of Central/Important papers using our method relative to expert view. It is, however, extremely unlikely that even a group of experts would completely agree that a paper was Central/Important. We found in the pilot, as we had previously in our test of the prototype template, that perfect agreement by all experts on the 'Centrality/Importance' of a reference was not achieved. Hanney et al. (2005) had also found that complete agreement between assessors was rare. Therefore, employing a majority verdict approach by groups of four postgraduate assessors might have provided a reasonable compromise between use of resources and 'accuracy' of the findings and we found agreement between at least three out of four assessors for 90 % of citing articles and for 84 % of citing reviews.

While tracing the influence of key research articles over many generations of citations by selectively identifying those citations where the reference is Central/Important is an interesting exploration of the progress from research to societal impacts, the level of influence that the key article may have had on the indirect societal impact is speculative unless examined and assessed carefully. Further studies using HACT, probably supplemented by the use of the filter, could contribute further understanding of the influence of a citation across many subsequent citation generations, which has been an issue of interest at least since Rousseau's pioneering 1987 article (1987) although that considered academic impact as opposed to societal impact. An examination of more key articles by this method would expand our understanding of the variations in influential citation streams for different key articles and the spread of influence of key pieces of health research on the societal impacts. Furthermore, despite the progress in tracing societal impacts, and the ability to conduct web-based searches, access to the grey literature is often challenging and time consuming as Sibbald et al. (2015) note.

A range of questions arose about what would be the most appropriate starting point for the analysis. Further work on identifying which paper should be selected as the appropriate starting point and whether a body of work should be used rather than a single key article would help to present a more accurate picture of the development of the societal impacts of health research.

Further research that could help refine the assessment procedure described here could include an investigation of automated procedures that could usefully be applied at some steps of the procedure to increase the efficiency of the process. Zhu et al. (2015) suggested that the counting of citation occasions would be one of the easiest additional aspects of citation analysis to automate and Teufel et al. (2006) have previously developed an automated procedure that can identify citation occasions within a paper. More analysis of the role or importance of self-citations relative to non-self-citations could further inform the use of objective measures in a qualitative citation analysis. Tang and Safer (2008) had found that the relationship between objective measures such as citation occasions and the importance of a reference were weaker for self-citations.

We have shown that we can use our new approach to contribute towards assessing the societal impacts of research, and help understand the processes involved in achieving research impact. However, on a case by case basis, it might be worth considering when this new approach contributes sufficient additional data to that provided from other sources, to justify the resources that would be used in conducting the analysis. We could possibly further inform this by a fuller analysis of both data already gathered from authors and experts in the course of our project, and new data emerging for the REF2014 exercise in the UK (Higher Education Funding Council 2015) which included assessment of the societal impacts of research, for example the case study involving Kuipers et al. (1997). Despite the extensive nature of our analysis we are aware there were further steps we could have taken had resources allowed, including exploring the impacts of any previous generation of (cited) clinical guidelines and case reports on the next generation of (citing) clinical guidelines and case reports and exploring the importance of a citation within a clinical guideline or case study. The new method described here should perhaps not be viewed as a comprehensive method of identifying the societal impacts of a body of research. It has, however, identified a number of important impacts and pathways to impact on clinical practice and policy made by some of the chosen key articles.

Conclusions

Following a systematic review of the literature on the meaning and use of citations (Jones et al. 2012), we developed a simple template to qualitatively assess a reference's importance to the citing paper in which it appears. We applied the template, called the HACT, in a pilot study to qualitatively assess the citations to four chosen key research articles from the area of psychiatry/neuroscience and then to similarly assess citations to those papers for which the key article was Central/Important. To increase the legitimacy of the study we applied an initial filter based on the number of citation occasions so that we did not classify all the citing papers. We identified a suitable cut-off point of three or more citation occasions.

We have found that the reference was Central for 4.4 % of citing articles overall and it was Central ten times more frequently for those articles containing three or more citation occasions. We found more self-cites to be Central than non-self-cites. We traced through

up to five generations of citations in order to create a citation stream of influence for each of the key articles. We then conducted a citation search on the Web of Science of all the papers in each generation, as well as a citation search of the key articles on Google, in order to identify the direct and indirect societal impacts such as a citation on a clinical guideline. We identified societal impacts in the citation streams including citations in international clinical guidelines. We believe that we have shown that this is an approach that should be further explored given the increasing interest in identifying the societal impacts of research as it potentially provides an additional qualitative method of exploring the influence that a piece of biomedical research has had and in illuminating the processes involved in the translation of the research findings and the eventual impact on clinical practice.

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Tracing the indirect societal impacts of biomedical research: development and piloting of a technique based on citations

Scientometrics

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Online resource 1: Templates

Prototype template for published original research articles

Prototype template for reviews and discussion articles

HERG Assessment of Citations Template (HACT)

- Pilot template for original research articles
- Pilot template for reviews and discussion articles

Published original research articles. Datasheet: Categorising citations

Please complete your initials and the date before starting the assessment. You will be answering questions about the citing article.

Cited article ID: A

Citing article ID: B

Authors:

Authors:

Title:

Title:

Journal:

Journal:

Vol: Pages: Year:

Vol: Pages: Year:

Initials of reviewer.....

What style is the bibliography?

Date of assessment.....

Harvard (Author names)....

Pdf/paper/other electronic (Please circle)

Vancouver (Numbers).....Number.....

1. Individual citation occasion details

Please consider each citation occasion separately. Locate each highlighted citation occasion in the copy of the citing article and make an assessment using the guidance provided in the instruction sheet. **Note/Review only** is the *default* position and should be ticked unless there is explicit evidence of greater involvement of the citation occasion.

Citation occasion	Page number	Location				First author named in text	Note/Review only	Fuller use
		Intro/	Method/	Results/	Discuss			
1 st		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2 nd		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3 rd		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4 th		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

If either of the following conditions apply then please proceed on to Question 2 below:

- **there are three or more citation occasions marked 'Note/Review only'**
- **any of the citation occasions is marked 'Fuller use'.**

2. Whole article details

Please consider the citing article as a whole. Read around the citation occasions as much as is considered necessary, first at sentence level, progressing to whole paragraph level and so on until an assessment can be made.

A. Please tick the boxes, *if appropriate*, according to the definitions and examples provided in the instruction sheet and your own judgement. **You may tick more than one box.**

Apply: The citing article applies or replicates methods, technologies, theories, scales etc found in the cited article in a similar way as described in the cited article.	<input type="checkbox"/>
Develop: The citing article is further developing (partially or totally) a concept or method previously described in the cited article either by modification or different application.	<input type="checkbox"/>
Refute: The citing article <i>either</i> claims that the cited article is incorrect <i>or</i> disputes (partially or totally) the cited article but is unable to come to a firm conclusion.	<input type="checkbox"/>

B. Please tick whichever box is most applicable according to the definitions provided and your own judgement BUT the *default* position is to tick '**Not highly important**'.

Highly important: The cited paper is considered to be necessary for the research described in the citing paper to have taken place i.e. BUT FOR the cited paper the citing paper could not have been written. The key conclusions significantly depend on applying, replicating, developing or refuting the cited article.	<input type="checkbox"/>
Not highly important: (Default) The cited paper is NOT considered to be necessary for the research described in the citing paper to have taken place.	<input type="checkbox"/>

Notes: *Please add any comments that you wish to record here.*

Published original research articles. Instruction Sheet: Categorising citations

We are tracing the impact of biomedical research as part of an MRC-funded project and are collecting information on the relationships between cited and citing articles. You have been provided with one datasheet per citing article and a copy of the citing article. The following notes are provided for your guidance but if you need further clarification on completing this datasheet please contact Teri Jones on 01895 265492 or e-mail Teresa.Jones@brunel.ac.uk

Use this datasheet to assess citations within published articles or notes describing original biomedical research. Each citation occasion of the cited article has been highlighted in the copy of the paper provided and some details relating to each citation occasion have been completed in the table.

1. Individual citation occasion details

Please consider each citation occasion separately. Locate each highlighted citation occasion in the copy of the citing article and make an assessment using this guidance.

Note/Review only: This category is the *default* position and should be ticked unless there is explicit evidence of greater involvement of this citation occasion. This category covers the citing article referring to the cited article as part of the relevant literature but either serving no explicit role in the discussion or analysis (note) or being compared to other relevant literature (review). This judgement could include: just a reference number in the Vancouver referencing style e.g. [34] or [32-36] or the name of the paper for the Harvard style e.g. [Smith et al. 2004] or [Smith et al, 2004, Brown et al, 2003 and Morgan et al, 2005].

Fuller use: Any explicit evidence of greater involvement of the citation at this citation occasion over and above Note/Review only e.g. explicit evidence in a single sentence of a greater level of involvement or importance; extended discussion across more than one sentence; inclusion of a quotation from the cited paper.

2. Whole article details

Please consider the citing article as a whole. Read around the citation occasions as much as is considered necessary, first at sentence level, progressing to whole paragraph level and so on until an assessment can be made.

A. Please tick the boxes, *if appropriate*, according to these definitions and examples and your own judgement. **You may tick more than one box.**

Apply: The citing article applies or replicates methods, technologies, theories, scales etc found in the cited article in a similar way as described in the cited article.

Develop: The citing article is further developing (partially or totally) a concept or method previously described in the cited article either by modification or different application.

Example. A concept or method in the cited paper is described in the Introduction/Method AND reference is made in the Discussion/Conclusion to how this concept or method has worked or can be compared.

Refute: The citing article *either* claims that the cited article is incorrect *or* disputes (partially or totally) the cited article but is unable to come to a firm conclusion.

B. Please tick whichever box is most applicable according to the definitions provided and your own judgement BUT the *default* position is to tick the '**Not highly important**' box.

Highly important: The cited paper is considered to be necessary for the research described in the citing paper to have taken place i.e. BUT FOR the cited paper the citing paper could not have been written. The key conclusions significantly depend on applying, replicating, developing or refuting the cited article.

Not highly important: (*Default*) The cited paper is NOT considered to be necessary for the research described in the citing paper to have taken place.

Prototype template for reviews and discussion articles

Reviews and discussion articles. Datasheet: Categorising citations.

Please complete your initials and the date before starting the assessment. You will be answering questions about the citing article.

Cited article ID: A

Citing article ID: B

Authors:

Authors:

Title:

Title:

Journal:

Journal:

Vol: Pages: Year:

Vol: Pages: Year:

Initials of reviewer.....

What style is the bibliography?

Date of assessment.....

Harvard (Author names)....

Pdf/paper/other electronic (Please circle)

Vancouver (Numbers)..... Number.....

Systematic Review (Please circle).....Yes/No

1. Individual citation occasion details

Please consider each citation occasion separately. Locate each highlighted citation occasion in the copy of the citing article and make an assessment using the guidance provided in the instruction sheet. **Note/Review only** is the *default* position and should be ticked unless there is explicit evidence of greater involvement of the citation occasion.

Citation occasion	Page number	Location			First author named in text	Note/Review only	Fuller use
		Intro	Body of article	Discuss			
1 st		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2 nd		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3 rd		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4 th		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

If either of the following conditions apply then please proceed on to Question 2 below

- **there are three or more citation occasions marked 'Note/Review only'**
- **any of the citation occasions is marked 'Fuller use'.**

2. Whole article details

Please consider the citing article as a whole. Read around the citation occasions as much as is considered necessary, first at sentence level, progressing to whole paragraph level and so on until an assessment can be made.

C. Please tick the boxes, *if appropriate*, according to the definitions provided and your own judgement.

You may tick more than one box.

Support: The citing article is supporting (partially or totally) a concept or method or results described in the cited article.	<input type="checkbox"/>
Refute: The citing article either claims that the cited article is incorrect or disputes (partially or totally) the cited article but is unable to come to a firm conclusion.	<input type="checkbox"/>

D. Please tick whichever box is most applicable according to the definitions provided and your own judgement BUT the *default* position is to tick '**Not highly important**'.

Highly important: The cited paper is considered to form a necessary part of the discussion/conclusions reached for the topic under discussion/review.	<input type="checkbox"/>
Not highly important: (<i>Default</i>) The cited paper is NOT considered to form a necessary part of the discussion/conclusions reached for the topic under discussion/review.	<input type="checkbox"/>

Notes: *Please add any comments that you wish to record here.*

Reviews and discussion articles. Instruction Sheet: Categorising citations.

We are tracing the impact of biomedical research as part of an MRC-funded project and are collecting information on the relationships between cited and citing articles. You have been provided with one datasheet per citing article and a copy of the citing article. The following notes are provided for your guidance but if you need further clarification on completing this datasheet please contact Teri Jones on 01895 265492 or e-mail Teresa.Jones@brunel.ac.uk

Use this datasheet to assess citations within published reviews or discussion papers.

Reviews. If you consider the citing article that you are studying to be a review only, then please complete this datasheet, marking whether or not it is a systematic review. If, however, the article contains a literature review as part of a larger piece of work that is not a review then it should be assessed using the alternative form '*Published original research articles. Datasheet: Categorising citations*'.

Discussion papers. This type of paper may not follow the usual structure of a scientific paper (Intro/Method/Results/Discuss). It should be assessed using this datasheet.

Please complete your initials and date before starting the assessment. You will be answering questions about the citing article.

1. Individual citation occasion details

Please consider each citation occasion separately. Locate each highlighted citation occasion in the copy of the citing article and make an assessment using this guidance.

Note/Review only: This category is the *default* position and should be ticked unless there is explicit evidence of greater involvement of this citation occasion. This category covers the citing article referring to the cited article as part of the relevant literature but either serving no explicit role in the discussion or analysis (note) or being compared to other relevant literature (review). This judgement could include: just a reference number in the Vancouver referencing style e.g. [34] or [32-36] or the name of the paper for the Harvard style e.g. [Smith et al. 2004] or [Smith et al, 2004, Brown et al, 2003 and Morgan et al, 2005].

Fuller use: Any explicit evidence of greater involvement of the citation at this citation occasion over and above Note/Review only e.g. explicit evidence in a single sentence of a greater level of involvement or importance; extended discussion across more than one sentence; inclusion of a quotation from the cited paper.

2. Whole article details

Please consider the citing article as a whole. Read around the citation occasions as much as is considered necessary, first at sentence level, progressing to whole paragraph level and so on until an assessment can be made.

A. Please tick the boxes, *if appropriate*, according to these definitions and your own judgement.

You may tick more than one box.

Support: The *citing* article is supporting (partially or totally) a concept or method or results described in the cited article.

Refute: The *citing* article either claims that the cited article is incorrect or disputes (partially or totally) the cited article but is unable to come to a firm conclusion

B. Please tick whichever box is most applicable according to the definitions provided and your own judgement BUT the *default* position is to tick the '**Not highly important**' box.

Highly important: The cited paper is considered to form a necessary part of the discussion/conclusions reached for the topic under discussion/review

Not highly important: (*Default*) The cited paper is NOT considered to form a necessary part of the discussion/conclusions reached for the topic under discussion/review

ORIGINAL RESEARCH ARTICLE

Question 1: Is the cited article CENTRAL to the message of this paper? The DEFAULT position is NO.

Guidance for Q1:

Tick yes if the KEY CONCLUSIONS of this paper as a whole, could not have been reached without one or more of the following?

- By applying a novel theory, method, scale or technology, etc set out in the cited article.
- By supporting or developing, either by modification or different application, a concept or method set out in the cited article.
- By refuting a concept or method from the cited article

Yes – end of assessment of this paper

No – please continue onto Question 2

If your answer to Question 1 was NO then please answer Q2.

Question 2: Is the cited article used to make a SIGNIFICANT CONTRIBUTION to the argument in at least one part of this paper? The DEFAULT position is NO.

Guidance for Q2:

Tick yes if this paper:

- Describes some aspect of the method, findings or conclusions of the cited article in detail in at least one full sentence and not simply “as Smith has shown” OR “see Smith, 2008”.
Example 1. “The current finding is also in line with the cognitive behavioural model of OCD which proposes that negative appraisals lead OCD patients to require unusually stringent criteria for deciding that an action has been appropriately completed (Salkovskis, 1999).”
Example 2. “The findings of Wroe and Salkovskis (2000) suggest that, in such situations, the decision not to act to prevent possible harm is viewed by individuals with OCD as being equivalent to causing the harm in the first place.”
- Includes a quotation from the cited article

Yes

No

END OF ASSESSMENT

REVIEW OR DISCUSSION ARTICLE

Question 1: Is the cited article **IMPORTANT** to a key message from this review/discussion paper? Please consider this paper as a whole and that the **DEFAULT** position is **NO**.

Guidance for Q1:

Tick yes if the cited article is used to help reach or sustain a **KEY TAKE-HOME MESSAGE** or **CONCLUSION** of this review/discussion paper.

i.e. There is one or more citation occasion which describes the cited paper in some detail (likely to be at least one full sentence)

AND that or another citation occasion occurs at a point in the text where a key conclusion or take-home message from the review is being developed or discussed.

Yes

No

END OF ASSESSMENT

Tracing the indirect societal impacts of biomedical research: development and piloting of a technique based on citations

Scientometrics

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Online resource 2:

Panel of experts providing guidance throughout the project

Analysis of the application of the prototype templates

Panel of experts providing guidance throughout the project

- Professor Tom Burns, Chair of Social Psychiatry, University of Oxford
- Dr Jon Cooper, (now Professor of) Experimental Neuropathology, Institute of Psychiatry, King’s College London
- Dr Claire Donovan, Reader in Assessing Research Impact, Brunel University London
- Dr Chris Henshall: Honorary Professor, Brunel University London; Health, Research & Innovation Policy Consultant.
- Professor Peter Jones, Head of Community Psychiatry, University of Cambridge.
- Dr Amy Pooler, Post-doctoral Research Fellow specialising in research into Alzheimer’s Disease, Institute of Psychiatry, King’s College London

Analysis of the application of the prototype template.

Of the 96 papers included in the assessment process 75 were research articles and 21 were reviews/discussion papers. The chief criterion of the analysis was considered to be an assessment of the reference as highly important or not highly important to the citing paper.

Table 1 contains details of the analysis of the findings for assessed research articles. For 70 of the 75 assessed articles all experts and a majority of reviewers agreed that the cited article was not highly important to the citing article. For the five assessed articles where at least one expert considered the reference to be highly important, there were no occasions where all four experts agreed. Out of the 11 reviewers, between two and eight thought that the reference was highly important to these five citing articles. An examination of the characteristics of these assessed papers showed a correlation between numbers of citation occasions and high importance of the reference. All five citing articles where at least one expert thought that the reference was highly important cited the reference on at least three occasions. In addition there were nine citing papers with three or more citation occasions where no experts but at least two reviewers considered the cited reference to be highly important.

Table 1. Results from the assessment of 75 research articles

<i>Combinations of number of assessors classifying the reference as being highly important to the citing paper</i>		<i>Number of examples of each combination of assessment by subject experts and reviewers</i>	
<i>Subject experts n=4</i>	<i>Reviewers n=11</i>	<i>Total number of each combination</i>	<i>Examples with ≥ 3 citation occasions in the citing paper</i>
3	8	1	1
3	6	1	1
2	5	1	1
2	2	1	1
1	8	1	1
0	5	1	1
0	4	4	3
0	3	4	2
0	2	9	3
0	1	19	0
0	0	33	0
-	-	Total = 75	Total = 14

The findings from the assessment of reviews can be found in Table 2. For one citing review out of the 21 assessed, the reference was considered highly important by an expert, and that was by just one of the four experts. The paper cited in this review was also considered highly important to the review by the majority, six out of eleven, of reviewers. This review contained three or more citation occasions. There were 12 other reviews, four with three or more citation occasions, where a minority of the reviewers (ranging from one to four), thought that the reference was highly important to the review.

Table 2. Results from the assessment of 21 review articles

<i>Combinations of number of assessors classifying the reference as being highly important to the citing paper</i>		<i>Number of examples of each combination of assessment by experts and reviewers</i>		
<i>Subject experts, n=4</i>	<i>Reviewers, n=11</i>	<i>Assessed n=21</i>	<i>"=\geq2 citation occasions"</i>	<i>"=\geq3 citation occasions"</i>
1	6	1	1	1
0	4	1	1	1
0	3	1	1	1
0	2	4	3	2
0	1	6	2	0
0	0	8	0	0
-	-	Total = 21	Total = 8	Total = 5

Our overall findings from this testing of the prototype phase were that:

- For 66 out of 96 citing papers the reference was considered to be highly important by either no assessors or just one and this one assessor was not an expert on any occasion.
- No reference was considered to be highly important to the citing paper by all experts or all reviewers.
- All citing papers where the reference was considered highly important by at least one expert contained three or more citation occasions. See Tables 1&2
- The experts were considerably more conservative than the reviewers in their opinions of the high importance of a reference (mean of papers ticked by experts 6%, mean of papers ticked by reviewers 21%).
- There was substantial variation in the opinions of the assessors for some other parameters, i.e. those included in Section 2 of the Test template. This rendered the collection of these data as unhelpful for our purposes. These categories included whether the citation was noted or reviewed only or included in the text more fully.

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