

Title: Limited engagement with transparent and open science standards in the policies of pain journals: a cross-sectional evaluation

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ABSTRACT

Scientific progress requires transparency and openness. The ability to critique, replicate and implement scientific findings depends on the transparency of the study design and methods, and the open availability of study materials, data and code. Journals are key stakeholders in supporting transparency and openness. This study aimed to evaluate 10 highest ranked pain journals' authorship policies with respect to their support for transparent and open research practices. Two independent authors evaluated the journal policies (as at 27th May 2019) using three tools: the self-developed Transparency and Openness Evaluation Tool, the Centre for Open Science Transparency Factor and the ICMJE requirements for disclosure of conflicts of interest. We found that the journal policies had an overall low level of engagement with research transparency and openness standards. The median COS Transparency Factor score was 3.5 (IQR 2.8) of 29 possible points, and only 7 of 10 journals' stated requirements for disclosure of conflicts of interest aligned fully with the ICMJE recommendations. Improved transparency and openness of pain research has the potential to benefit all that are involved in generating and using research findings. Journal policies that endorse and facilitate transparent and open research practices will ultimately improve the evidence base that informs the care provided for people with pain.

Key words

Transparency, Openness, Journalology, Pain Research, Reproducibility, Replicability

INTRODUCTION

Scientific progress is facilitated by research that is conducted and reported transparently and openly.[1,2] Research that is conducted and reported transparently and openly can be adequately appraised and replicated.[3,4] Scientific journals, a key stakeholder in scientific reporting,[4–6] can help achieve research transparency and openness by implementing practices such as requiring preregistration of studies,[7] the use of reporting guidelines[8] and the sharing of data and code,[9,10] or by adopting publishing models such as registered reports.[11,12] Implementing these practices within journal policy has been shown to improve the quality and reproduction or replication of scientific findings.[4,9,13–18]

Pain is a major clinical, social and economic problem affecting approximately one in three people worldwide.[19,20] In 2010, pain accounted for approximately \$635 billion USD per annum, greater than the costs of heart disease (\$309 billion), cancer (\$243 billion), and diabetes (\$188 billion).[21] There is intense research activity aimed at improving the management of pain conditions. In 2018, approximately 15,500 articles were indexed under the ‘pain’ medical subject heading (MeSH) on PubMed [MEDLINE]. Until recently, the extent of pain journals’ support for transparent and open research practices was unknown. An ad-hoc evaluation of the 10 highest impact-factor pain journals in February 2018 found that the level of engagement with standards for transparency and openness was low.[22] Easily implementable initiatives such as providing a data-sharing statement or the adoption of reporting guidelines for non-randomised controlled studies were not widely supported.

Since 2018, efforts to promote research transparency and openness have intensified.[17] For example, the European Commission has released the Open Science Policy Platform Recommendations (OSPP-REC)[23] and The International Committee of Medical Journal Editors (ICMJE)[24] has updated recommendations for mandatory data sharing statements in manuscripts of clinical trials. Greater use of established initiatives such as preregistration of systematic review protocols [25] and depositing of research manuscripts to pre-print archives[26] highlights researcher’s increased adoption and demand for transparency and openness.

Changes to journal editorial policies have been intended to increase the transparency of published research. For example, *Psychological Science*[27] have introduced so-called “open science badges” to incentivise transparent practice and the *Nature* life-science journals[16]

have introduced a reporting checklist.[28] Currently 5056 journals have indicated their commitment to improving transparency of published research by signing the Transparent and Open Promotion (TOP) Guidelines (<https://cos.io/top/>).

Given these recent developments in scientific publishing, the introduction of new initiatives to facilitate open research practices, and notable intentions to change pain journal policies,[29] this study aimed to evaluate the extent to which the 10 leading pain journals' editorial policies reflect open science standards. A secondary aim was to assess editorial requirements for disclosing conflicts of interest.

METHODS

We pre-registered the protocol for this study on May 26, 2019 on the *Open Science Framework* [<https://osf.io/krntg>].[30]

Sampling Procedure

We selected the 10 highest ranked pain journals according to impact-factor from the Web of Science 2018 Journal Citation Reports.[31] These were *PAIN*, *Journal of Pain*, *Journal of Headache and Pain*, *Molecular Pain*, *Regional Anaesthesia and Pain Medicine*, *Clinical Journal of Pain*, *European Journal of Pain*, *Journal of Pain and Symptom Management*, *Pain Physician*, and *Pain Medicine*. These 10 journals published 2051 research papers in 2018. We considered the journals' policies regarding transparent and open scientific practice and their requirements for disclosing conflicts of interest to be reflected in the "guidance" or "instructions to authors", and the broader policies of the journal's publishing house if a reference and link was provided (e.g. Nature Journals or BioMed Central). We sourced the on-line journal "guidance/instructions to authors" or the equivalent section of the respective journal websites on May 27, 2019. We saved the relevant web-page(s) in HTML format and used Adobe Acrobat Pro DC[32] to create time-stamped, PDF files. These files are publicly available at [<https://osf.io/e4rkf/>].

Measurement Tools

We used three measurement tools. Two tools, based on the TOP Guidelines[33] (<https://cos.io/our-services/top-guidelines/>), were used to evaluate the support for transparency and openness in journal policies. A single tool, based on The International Committee of Medical Journal Editors (ICMJE) standards for disclosing actual or potential

conflicts of interest,[34] was used to evaluate journal requirements for disclosing conflicts of interest.

Transparency and Openness Evaluation Tool

The Transparency and Openness Evaluation Tool has 7 items; preregistration, registered reports, data sharing, data-sharing statement, code sharing, reporting guidelines and TOP signatory status. These 7 items reflect several standards for transparency and openness espoused in the TOP Guidelines.[33] The tool evaluates the extent to which journal policies reflect support for each item. Support is coded using 4 descriptors: i) a yes/no response measure; ii) a verbatim description of the policy, as relevant; iii) a verbatim measure of policy stringency, where reported; iv) the study type to which the policy applies, where reported. This tool was developed *ad hoc* in 2018 with guidance from the TOP guidelines.

COS Transparency Factor

The COS Transparency Factor was developed by the Centre for Open Science to provide a quantitative measure of the support for transparency and openness in journal policies.[35] The COS Transparency Factor includes the 8 standards in the TOP Guidelines as well as three additional items (TOP signatory status, Registered Reports, open science badges). There are two sub-scales, with separate scores that sum to a total possible score of 29. The first sub-scale (0 to 24) scores the level of journal policy support for each of the 8 transparency standards from 0 to 3 (Supplementary table 1). The second sub-scale scores the three additional three items; i) TOP signatory status (0 = no, 1 = yes), ii) Registered Reports (0 = no, 2 = yes) and iii) open science badges (0 = no, 2 = yes). Note, 'yes' to items ii and iii are worth 2 points in the scoring system.

Requirements for disclosure of conflicts of interest

We appraised the requirements for the disclosure of conflicts of interest by evaluating whether the journal policies stated the four standards stated in the ICMJE disclosure form: a) recipient of payment or services from a third party (government, commercial, private foundation, etc.) for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.); b) any financial relationships (regardless of amount of compensation) with entities in the biomedical arena that could be perceived to influence, or that give the appearance of influencing, the submitted work; c) any patents, whether planned, pending or issued, broadly relevant to

the submitted work; and d) any other relationships or activities that readers could perceive to have influenced, or that give the appearance of potentially influencing, the submitted work. We coded each journal's requirements on a 0 to 4 scale (with 0 being no statement of any of the standards, and 4 being statement of all standards or provision of the full ICMJE disclosure form).[34]

Measurement Procedure

Two independent authors (AGC, MKB, GCR, HL) evaluated each journal by using a pre-specified customised spreadsheet containing the three measurement tools. Conflicts were resolved by discussion between two independent authors (AGC and MKB).

Data Analysis

We tabulated the raw measurements from each tool. We used R (Version 3.4.0)[36] to summarise categorical data with frequencies and percentages, and continuous data with the mean and standard deviation.

Protocol Deviations

We had pre-specified that the primary aim was to “evaluate the current adherence to minimum transparency research standards in the top 10 pain journals (as rated by impact factor) using the *Transparency and Openness Evaluation Tool*” and that a secondary aim was to “assess journal policies using the Transparency Factor”, with the corresponding specification of primary and secondary outcomes.[30] We determined during the study that there were no grounds to separate the utility of either tool for evaluating journal policies as neither tool has established reliability or validity. Accordingly, we do not distinguish between either tool as primary or secondary in this report. Future research should assess the inter-rater reliability, internal consistency and standard error of measurement (SEM) to ensure each tool exhibits sufficient agreement between raters and between the equivalent constructs measured.

We pre-specified a secondary aim “to qualitatively describe changes in journal policy between audit-1 and 2”. Specifically, this meant comparing measurements using the *Transparency and Openness Evaluation Tool* taken in February 2018,[22] with those taken in May 2019 (this study). We determined during this study that as the *Transparency and Openness Evaluation Tool* has no established reliability (particularly known SEM), it would

be inappropriate to use it to evaluate change across time. Accordingly, we abandoned this aim.

RESULTS

Transparency and Openness Evaluation Tool

Table 1 displays the level of support for transparency and openness in journal policies as at May 27, 2019, measured using the *Transparency and Openness Evaluation Tool*. Most journals required pre-registration of clinical trials (8/10) and encouraged the use of reporting guidelines (7/10). One journal (*Journal of Headache and Pain*) encouraged pre-registration of other study types. Three journals were signatories of the TOP Guidelines (*Journal of Pain*, *Molecular Pain* and *Journal of Pain and Symptom Management*) however none of the journals utilized the Registered Reports format. Data and code sharing were the least supported item, encouraged in only 5/10 and 4/10 journals respectively.

Journal	Pre-registration	Registered reports	Data sharing	Data sharing statement	Code sharing	Reporting guidelines	TOP signatory
Journal of Pain	Required for all clinical trials	Not mentioned	Encouraged [#]	Encouraged	Encouraged	Requires*: ARRIVE, CONSORT, PRISMA, STARD, STROBE checklist	Yes
Journal of Headache and Pain	Required for all clinical trials, Encouraged for systematic reviews	Not mentioned	Encouraged [#]	Required	Encouraged	Encourages: CONSORT, SPIRIT, PRISMA, PRISMA-P, STROBE, CARE, COREQ, STARD, TRIPOD, CHEERS, ARRIVE, SAMPL and other relevant guidelines from the EQUATOR Network and FAIRsharing.org	No
European Journal of Pain	Required for all clinical trials	Not mentioned	Encouraged	Encouraged	Not mentioned	Requires*: CONSORT and PRISMA Encourages: outcome measures described following the IMMPACT recommendations	No
Journal of Pain and Symptom Management	Required for all clinical trials	Not mentioned	Encouraged [#]	Encouraged	Encouraged	Not mentioned	Yes
PAIN	Required for all clinical trials	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Requires: CONSORT and PRISMA. Encourages: TIDieR, SPIRIT or another relevant guideline from www.equator-network.org	No
Molecular Pain	Required for all clinical trials	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Encourages: the relevant EQUATOR Network reporting guidelines depending on the type of study	Yes
Pain Physician	Required for all clinical trials, observational studies that are experimental or performed under research criteria, and diagnostic studies that meet the criteria of a clinical trial	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Requires: CONSORT Encourages: PRISMA, MOOSE, STROBE, TREND, STARD	No
Regional Anaesthesia and Pain Medicine	Required for all clinical trials	Not mentioned	Encouraged [#]	Encouraged	Encouraged	Encourages: authors use reporting guidelines	No
Pain Medicine	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Not mentioned	No
Clinical Journal of Pain	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Not mentioned	No

Table 1. Results from the Transparency and Openness Evaluation Tool. Snapshot of the author guidelines and journal policies were taken on 27 May 2019.

* Submitted papers will be returned or not considered if authors are not compliant.

[#] Enables data to be interlinked with the published article.

COS Transparency Factor

Table 2 displays the COS Transparency Factor measurements and score for each journal. The median COS Transparency Factor score was 3.5 (IQR 2.8) out of 29 points. *Journal of Pain* (7 out of 29) and *Journal of Headache and Pain* (7 out of 29) had the highest score. The *Clinical Journal of Pain* had the lowest score (0 out of 29), satisfying none of the COS Transparency Factor items.

Journal	Citation standards	Data transparency	Analytic methods transparency	Research materials transparency	Design and analysis transparency	Preregistration of studies	Preregistration of analysis plans	Replication	TOPG Sub-total (/24)	TOP Signatory	Registered Reports	Open Science Badges	TOTAL (/29)
Journal of Pain	1	1	0	0	3	1	0	0	6	Yes	No	No	7
Journal of Headache and Pain	1	1	2	1	1	1	0	0	7	No	No	No	7
European Journal of Pain	1	0	0	0	3	1	0	0	5	No	No	No	5
Journal of Pain and Symptom Management	1	1	0	1	0	1	0	0	4	Yes	No	No	5
PAIN	0	0	0	0	2	2	0	0	4	No	No	No	4
Molecular Pain	0	0	0	0	1	1	0	0	2	Yes	No	No	3
Pain Physician	0	0	0	0	2	1	0	0	3	No	No	No	3
Regional Anaesthesia and Pain Medicine	0	0	0	0	1	1	0	0	2	No	No	No	2
Pain Medicine	0	0	0	1	0	0	0	0	1	No	No	No	1
Clinical Journal of Pain	0	0	0	0	0	0	0	0	0	No	No	No	0

Table 2. Results from the COS Transparency Factor. Snapshot of the author guidelines and journal policies were taken on 27 May 2019. Each of the 8 standards (citation, data, analytic methods, materials, design and analysis, preregistration, analysis plan preregistration and replication) are scored across four levels (0-3), with each increase in level reflecting greater support. The Total is calculated by adding the TOPG sub-total (0-24) with the scores for the additional three items, TOP signatory status (0 = no, 1 = yes), Registered Reports (0 = no, 2 = yes) and open science badges (0 = no, 2 = yes).

Conflicts of Interest

Table 3 presents the journals' requirements for disclosure of conflicts of interest. Most journals (7/10) stated all four ICMJE requirements for disclosure of conflicts of interest. The median score was 4 (IQR 0.7) out of 4. The *Clinical Journal of Pain* (3 out of 4), *European Journal of Pain* (3 out of 4) and *Pain Physician* (2 out of 4) did not satisfy all four ICMJE requirements.

Journal	Conflicts of interest statements requested (/4)
Journal of Pain	4
Journal of Headache and Pain	4
Regional Anaesthesia and Pain Medicine	4
Journal of Pain and Symptom Management	4
Molecular Pain	4
PAIN	4
Pain Medicine	4
Clinical Journal of Pain	3
European Journal of Pain	3
Pain Physician	2

Table 3. Results of appraisal of requirements for disclosure of conflicts of interest.

Snapshot of the author guidelines and journal policies were taken on 27 May 2019.

DISCUSSION

Summary of findings

Our evaluation of pain journals' engagement with transparency and openness standards as indicated in their editorial policies in 2019 indicates there is substantial room for improvement. The *Journal of Pain* and *Journal of Headache and Pain* had the greatest level of engagement with standards for transparency and openness, although still considered relatively low (7/29). We are aware of several on-going evaluations in other fields; however, these are not published. Accordingly, we are unable to compare our results to other fields. The findings from this study will serve as a reference point for future comparisons. The ability to critique, replicate and implement scientific findings depends on the transparency of study design and method, and the open availability of study materials, data and code.[3,4,37–39] Our findings show that open and transparent research practices are not required for publication in the highest ranked pain journals, and are not actively encouraged (Table 1 and 2). Further, none of the highest ranked pain journals engaged with new approaches to improve transparency and openness,[12,27] such as Registered Reports (<https://cos.io/rr/>).

We encourage editors of pain journals to consider such models, as their implementation may assist journals to improve the transparency and openness of the research they publish.

In some contexts, conflicts of interests can unintentionally influence the manner in which research is designed, conducted, and reported. The distortion of this process can introduce bias and influence the degree to which the public place confidence in scientific findings.[40] To minimise the influence of conflicts of interests, ICMJE recommends complete disclosure of actual or potential conflicts of interest to facilitate assessment during peer-review and publication.[41] Although full disclosure does not eliminate conflicts, such transparency in reporting serves to highlight the potential for bias.[42] It is encouraging to see that the majority of pain journals satisfied all four requirements for the ICMJE disclosure of conflicts of interest. This finding is consistent with Dal-Ré et al (2019)[43] that showed 99% of 130 highest ranked medical speciality journals require authors to disclose conflicts of interest. However, author adherence to reporting conflict of interests, reliability of the self-reporting and what conflicts should be disclosed remains an unresolved and significant problem in medical research.[44] A recent cross-sectional study of published articles in biomedicine found that 13.6% of 1002 articles were missing a conflict of interest statement.[45] In light of the global awareness of conflicts associated with the opioid crisis, it seems important for pain journals to fully adhere to ICMJE recommendations for declaring conflicts of interests.

Limitations

Our study had some limitations. We selected 10 pain journals based on their impact-factor rating from the Web of Science 2018 Journal Citation Reports.[31] The utility of the impact factor to reflect the quality of scientific journals and publications has been questioned.[46,47] As such, future research should expand our current evaluation to include a broader sample of pain journals. Secondly, we focused on the indicators of transparency and openness that were proposed in the TOP Guidelines.[33] The TOP Guidelines may not capture all potential areas or initiatives that are available to promote transparent and open research. Thirdly, we made the assumption that the information provided on each journal's website would reflect the journal's policies. We captured multiple layers of the website to ensure all available information was examined and we included policies set by the publisher. However, it is possible that the information provided on the journal's website is not an accurate or complete reflection of current journal policy. For example, we are aware of an editorial in *PAIN* in March 2019 describing forthcoming policy updates to encourage transparency and openness;

however, these policies were not reflected in the author guidelines as of May 2019.[29] Finally, the measurement properties of the three tools used in this study are unknown.

Future research

Future research should evaluate the measurement properties of the three tools used in this study to enable comparative evaluations of journal policies across fields and over time. Because changing journal policies will not necessarily cause authors to adhere to open science principles, future work should evaluate individual published papers to understand the effects of changing journal policies. Finally, future research should consider optimal interventions to change journal transparency and openness policies. Consideration of behaviour change theories[48] and established intervention mechanisms[49] may improve efficiency of the intervention design and implementation.

CONCLUSION

Our evaluation of 10 highest ranked pain journals demonstrates limited support for transparent and open research practices in journal policies. It appears that researchers are not required or actively encouraged to transparently report study methods and findings or share data and materials. This is a problem for pain science because transparent and open conduct and reporting of pain research is required to appropriately appraise and use pain research findings. There are multiple ways pain journals can improve transparency and open scientific practices. We expect that improved transparency and openness will improve the conduct and translation of pain research to ultimately benefit people living with pain.

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Conflicts of interest

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REFERENCES

- 1 Anderson MS, Martinson BC, De Vries R. Normative Dissonance in Science: Results from a National Survey of U.S. Scientists. *J Empir Res Hum Res Ethics* 2007;**2**:3–14. doi:10.1525/jer.2007.2.4.3
- 2 Institute of Medicine. *Sharing Clinical Trial Data: Maximizing Benefits, Minimizing Risk*. Washington, D.C.: : The National Academies Press 2015. doi:10.17226/18998
- 3 Ioannidis JPA, Greenland S, Hlatky MA, *et al*. Increasing value and reducing waste in research design, conduct, and analysis. *Lancet* 2014;**383**:166–75. doi:10.1016/S0140-6736(13)62227-8
- 4 Munafò MR, Nosek BA, Bishop DVM, *et al*. A manifesto for reproducible science. *Nat Hum Behav* 2017;**1**:0021. doi:10.1038/s41562-016-0021
- 5 Wallach JD, Gonsalves GS, Ross JS. Research, regulatory, and clinical decision-

- making: the importance of scientific integrity. *J Clin Epidemiol* 2018;**93**:88–93. doi:10.1016/j.jclinepi.2017.08.021
- 6 Ioannidis JPA, Forstman B, Boutron I, *et al.* How to Make More Published Research True. *PLoS Med* 2014;**11**:e1001747. doi:10.1371/journal.pmed.1001747
 - 7 Nosek BA, Ebersole CR, DeHaven AC, *et al.* The preregistration revolution. *Proc Natl Acad Sci* 2018;**115**:2600–6. doi:10.1073/pnas.1708274114
 - 8 Simera I, Moher D, Hirst A, *et al.* Transparent and accurate reporting increases reliability, utility, and impact of your research: reporting guidelines and the EQUATOR Network. *BMC Med* 2010;**8**:24. doi:10.1186/1741-7015-8-24
 - 9 Naudet F, Sakarovitch C, Janiaud P, *et al.* Data sharing and reanalysis of randomized controlled trials in leading biomedical journals with a full data sharing policy: Survey of studies published in the BMJ and PLOS Medicine. *BMJ* 2018;**360**:k400. doi:10.1136/bmj.k400
 - 10 Herbert R, Elkins M. Publishing code: an initiative to enhance transparency of data analyses reported in Journal of Physiotherapy. *J Physiother* 2017;**63**:129–30. doi:10.1016/j.jphys.2017.05.011
 - 11 Chambers CD, Dienes Z, McIntosh RD, *et al.* Registered Reports: Realigning incentives in scientific publishing. *Cortex* 2015;**66**:1–2. doi:10.1016/j.cortex.2015.03.022
 - 12 Nosek BA, Lakens D. Registered reports: A method to increase the credibility of published results. *Soc Psychol (Gott)* 2014;**45**:137–41. doi:10.1027/1864-9335/a000192
 - 13 Moher D, Glasziou P, Chalmers I, *et al.* Increasing value and reducing waste in biomedical research: who’s listening? *Lancet* 2016;**387**:1573–86. doi:10.1016/S0140-6736(15)00307-4
 - 14 Ge L, Tian J hui, Li Y nan, *et al.* Association between prospective registration and overall reporting and methodological quality of systematic reviews: a meta-epidemiological study. *J Clin Epidemiol* 2018;**93**:45–55. doi:10.1016/j.jclinepi.2017.10.012
 - 15 Hopewell S, Ravaud P, Baron G, *et al.* Effect of editors’ implementation of CONSORT guidelines on the reporting of abstracts in high impact medical journals: interrupted time series analysis. *BMJ* 2012;**344**. doi:10.1136/bmj.e4178
 - 16 The NPQIP Collaborative group. Did a change in Nature journals’ editorial policy for life sciences research improve reporting? *BMJ Open Sci* 2019;**3**:e000035.

- doi:10.1136/bmj-2017-000035
- 17 Wallach JD, Boyack KW, Ioannidis JPA. Reproducible research practices, transparency, and open access data in the biomedical literature, 2015–2017. *PLoS Biol* 2018;**16**:2015–7. doi:10.1371/journal.pbio.2006930
 - 18 Stodden V, Seiler J, Ma Z. An empirical analysis of journal policy effectiveness for computational reproducibility. *Proc Natl Acad Sci* 2018;**115**:2584–9. doi:10.1073/pnas.1708290115
 - 19 Henschke N, Kamper SJ, Maher CG. The epidemiology and economic consequences of pain. *Mayo Clinic Proceedings* 2015. 139–47. doi:10.1016/j.mayocp.2014.09.010
 - 20 Briggs AM, Woolf AD, Dreinhöfer K, *et al.* Reducing the global burden of musculoskeletal conditions. *Bull World Health Organ* 2018;**96**:366–8. doi:10.2471/BLT.17.204891
 - 21 Gaskin DJ, Richard P. The economic costs of pain in the United States. *J Pain* 2012;**13**:715–24. doi:10.1016/j.jpain.2012.03.009
 - 22 Lee H, Lamb SE, Bagg MK, *et al.* Reproducible and replicable pain research: a critical review. *Pain* 2018;**159**:1683–9. doi:10.1097/j.pain.0000000000001254
 - 23 OSPP-REC Open Science Policy Platform Recommendations. doi:10.2777/958647
 - 24 Taichman DB, Sahni P, Pinborg A, *et al.* Data sharing statements for clinical trials: A requirement of the international committee of medical journal editors. *Ann Intern Med* 2017;**167**:63–5. doi:10.7326/M17-1028
 - 25 Rombey T, Doni K, Hoffmann F, *et al.* More systematic reviews were registered in PROSPERO each year, but few records’ status was up-to-date. *J Clin Epidemiol* 2020;**117**:60–7. doi:10.1016/j.jclinepi.2019.09.026
 - 26 Learn JR. What bioRxiv’s first 30,000 preprints reveal about biologists. *Nature* Published Online First: 22 January 2019. doi:10.1038/d41586-019-00199-6
 - 27 Kidwell MC, Lazarević LB, Baranski E, *et al.* Badges to Acknowledge Open Practices: A Simple, Low-Cost, Effective Method for Increasing Transparency. *PLoS Biol* 2016;**14**:e1002456. doi:10.1371/journal.pbio.1002456
 - 28 Anon. Announcement: Reducing our irreproducibility. *Nature* 2013;**496**:398–398. doi:10.1038/496398a
 - 29 Keefe FJ, Ballantyne J, Blyth F, *et al.* Publishing the best basic and applied pain science: open science and PAIN. *Pain* 2018;**159**:405–6. doi:10.1097/j.pain.0000000000001166
 - 30 Cashin A, Bagg MK, Lee H, *et al.* 2019 Evaluation of Leading Pain Journal Policies

- (protocol). Published Online First: 26 May 2019.<https://osf.io/krntg> (accessed 20 Sep 2019).
- 31 Journal Citation Reports - Clarivate. <https://clarivate.com/products/journal-citation-reports/> (accessed 19 Jun 2019).
 - 32 Adobe Cloud Creative. Adobe Acrobat PRO DC, 2019 release (continuous). 2019.<https://acrobat.adobe.com/au/en/acrobat.html>
 - 33 Nosek BA, Alter G, Banks GC, *et al.* Promoting an open research culture. *Science* 2015;**348**:1422–5. doi:10.1126/science.aab2374
 - 34 ICMJE | Conflicts of Interest. <http://www.icmje.org/conflicts-of-interest/> (accessed 13 Aug 2019).
 - 35 Mellor D, DeHaven A. Promoting Adoption of Open Science Policies at Journals. 2019. doi:none
 - 36 R Core Team. R: A language and environment for statistical computing. 2013.<http://www.r-project.org/>
 - 37 Heneghan C, Mahtani KR, Goldacre B, *et al.* Evidence based medicine manifesto for better healthcare. *Evid Based Med* 2017;**22**:120–2. doi:10.1136/ebmed-2017-j2973rep
 - 38 Moher D, Glasziou P, Chalmers I, *et al.* Increasing value and reducing waste in biomedical research: Who’s listening? *Lancet* 2016;**387**:1573–86. doi:10.1016/S0140-6736(15)00307-4
 - 39 Aalbersberg IJ, Appleyard T, Brookhart S, *et al.* Making Science Transparent By Default; Introducing the TOP Statement. *OSF Prepr* Published Online First: 2018. doi:10.31219/osf.io/sm78t
 - 40 Moynihan R, MacDonald H, Heneghan C, *et al.* Commercial interests, transparency, and independence: A call for submissions. *BMJ* 2019;**365**:11706. doi:10.1136/bmj.11706
 - 41 ICMJE | Recommendations | Author Responsibilities—Conflicts of Interest. <http://www.icmje.org/recommendations/browse/roles-and-responsibilities/author-responsibilities--conflicts-of-interest.html>
 - 42 Friedman PJ. The Troublesome Semantics of Conflict of Interest. *Ethics Behav* 1992;**2**:245–51. doi:10.1207/s15327019eb0204_2
 - 43 Dal-Ré R, Caplan AL, Marusic A. Editors’ and authors’ individual conflicts of interest disclosure and journal transparency. A cross-sectional study of high-impact medical specialty journals. *BMJ Open* 2019;**9**:e029796. doi:10.1136/bmjopen-2019-029796
 - 44 McCartney M, Heneghan C, Finnikin S. Health care: conflicted, confused, and in need

- of change. *Lancet* 2019;**393**:2281–3. doi:10.1016/S0140-6736(19)30844-X
- 45 Grundy Q, Dunn AG, Bourgeois FT, *et al.* Prevalence of Disclosed Conflicts of Interest in Biomedical Research and Associations With Journal Impact Factors and Altmetric Scores. *JAMA* 2018;**319**:408–9. doi:10.1001/jama.2017.20738
- 46 Smaldino PE, McElreath R. The natural selection of bad science. *R Soc Open Sci* 2016;**3**:160384. doi:10.1098/rsos.160384
- 47 Smaldino PE, Turner MA, Contreras Kallens PA. Open science and modified funding lotteries can impede the natural selection of bad science. *R Soc Open Sci* 2019;**6**:190194. doi:10.1098/rsos.190194
- 48 Norris E, O'Connor DB. Science as behaviour: Using a behaviour change approach to increase uptake of open science. *Psychol Heal* 2019;**34**:1397–406. doi:10.1080/08870446.2019.1679373
- 49 Blanco D, Altman D, Moher D, *et al.* Scoping review on interventions to improve adherence to reporting guidelines in health research. *BMJ Open* 2019;**9**. doi:10.1136/bmjopen-2018-026589