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Transitioning from a Conventional to a 'Mega' Journal: A Bibliometric Case Study of the Journal *Medicine*

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Abstract: Open-Access Mega-Journals (OAMJs) are a relatively new and increasingly important publishing phenomenon. The journal *Medicine* is in the unique position of having transitioned in 2014 from being a 'traditional' highly-selective journal to the OAMJ model. This study compares the bibliometric profile of the journal *Medicine* before and after its transition to the OAMJ model. Three standard modes of bibliometric analysis are employed, based on data from *Web of Science*: journal output volume, author characteristics, and citation analysis. The journal's article output is seen to have grown hugely since its conversion to an OAMJ, a rise driven in large part by authors from China. Articles published since 2015 have fewer citations, and are cited by lower impact journals than articles published before the OAMJ transition. The adoption of the OAMJ model has completely changed the bibliometric profile of the journal, raising questions about the impact of OAMJ peer-review practices. In many respects, the post-2014 version of *Medicine* is best viewed as a new journal rather than a continuation of the original title.

Keywords: mega-journal; open access; bibliometrics

1. Introduction

The journal *Medicine* is the only journal to date to have moved from being a conventional journal to being a so-called 'mega-journal'. Analysing the effects of this transition has the potential to cast light on the current scholarly communications market in general and on the 'mega-journals' phenomenon in particular. This paper provides a bibliometric study of the effects of the transition of *Medicine*.

Published by Wolters Kluwer, *Medicine* was launched in 1922 as a selective, subscription journal covering all areas of medicine. Since the 1960s, the journal has published between 30 and 50 articles per year across six issues. In 2012, however, the publisher announced that it would be converting the journal to the mega-journal model. Duncan MacRae, the journal's Senior Publisher, described the rationale behind the transition:

> "The journal did not have the support of a society, and that lack of a built-in base of authors and readers limited its ability to compete with other general medicine journals. At the same time, Wolters Kluwer was looking to produce a broad open access publication, and

converting an established title was considered a more attractive option than launching an entirely new title" [1].

The mega-journal iteration of *Medicine*, which began publishing mid-way through 2014, covers 45 distinct medical sub-disciplines, and lists 845 editorial board members. It operates a Gold Open Access (OA) publishing model in which authors are required to pay an Article Processing Charge (APC) of $1400, and journal content is then made freely available to any reader on publication. The journal now publishes a new issue each week, and employs a peer-review policy that focuses solely on an article's 'scientific soundness':

"The goal of *Medicine*'s review process is to establish an article's technical, scientific and ethical validity. Novelty and potential for impact are not to be considered when assessing a manuscript or providing an editorial recommendation" [2].

This was controversial, with some seeing it as signalling a decline in quality [3]. However, 'soundness-only' peer review is a key feature of open-access mega-journals (OAMJs) in general, which are a relatively recent feature in the scholarly communication landscape.

The term 'mega-journal' appears to have been coined to describe *PLOS ONE*, which launched in 2006 and has been followed, particularly since 2011, by a number of other '*PLOS ONE*-like' journals, including *Scientific Reports*, *PeerJ*, *BMJ Open* and *Royal Society Open Science* [4]. As with any emergent term, opinions vary as to the precise definition, but recent work suggests that mega-journals have four key characteristics: high publishing volume, a broad subject scope, a Gold OA business model, and a peer-review policy that seeks only to evaluate objectively the technical or scientific soundness of an article, rather than its potential significance or impact [5]. This last characteristic—'objective' peer review—undoubtedly represents the most disruptive innovation, since it challenges the long-established practice of journals selecting content based on perceived novelty or importance. Advocates and publishers of OAMJs argue that their approach essentially democratises knowledge by facilitating the publication of all scientifically-sound papers and allowing the academic community as a whole, rather than a small group of editors and reviewers, to determine which are most important or useful [6]. In contrast, critics of the model perceive OAMJs as low quality 'dumping grounds' for articles rejected from traditional journals, suggesting that the pre-publication filtering of content by editors and reviewers serves a vital purpose within scholarly discourse [7].

As the only journal to have transitioned from a selective to a mega-journal model, *Medicine* offers a unique opportunity to analyse the impact of the new model. A recent review of the literature relating to OAMJs has revealed that relatively few peer-reviewed articles have addressed the mega-journal phenomenon [4]. Of these, Björk provides an overview, including OAMJ publishing volume, subject scope, and peer review policies [5]. He also identifies a larger number of secondary OAMJ characteristics, including fast publication times, the incorporation of altmetrics in discovery platforms, moderate APCs, and the use of academic (rather than in-house) editors. Solomon surveyed authors published in four mega-journals (*BMJ Open*, *PeerJ*, *PLOS ONE* and *Sage Open*), finding that just over half of all papers (52%) had previously been submitted to other journals [8]. This is more than double the rate of 25% found by Calcagno et al. in their study of 923 biosciences journals [9]. Authors were found to view the quality of the journal and the speed of publication as the two most important factors influencing submission to a mega-journal, with the journal's impact factor also being a significant factor for *PLOS ONE* authors.

There are also a number of bibliometric studies focusing on OAMJs. Fein presents a study of *PLOS ONE* which analyses the volume and type of journal output, as well as citation rates [10]. Burns bases his analysis of *PeerJ* on a sample of 49 articles, investigating author demographics, usage data and citation rates [11]. Bjork and Catani investigate the effect of OAMJ peer review policies, comparing citation distributions of several OAMJs with more traditional selective journals [12]. They found little difference between the two groups. Finally a broad study by the authors of this paper presents bibliometric profiles for 11 mega-journals, with analyses focused on journal output, subject scope, author demographics and citation rates [13]. While this study includes some data relating to *Medicine*, the scope of the paper precludes any detailed analysis of the journal's transition to OAMJ status.

2. Methods

The aim of this study is to provide a comparative bibliometric analysis of *Medicine* before and after its transition from a traditional selective journal to an OAMJ, in order both to reveal potentially significant changes to the character of the journal, and potentially better understand the impact of the OAMJ model. Bibliometric studies of single journals are relatively common—reviews by Tiew [14] and by Anyi et al. [15] report around 200 such studies—and this paper utilises three frequently employed modes of analysis: journal output, author characteristics (particularly nationality and institutional affiliation), and citation analysis. All data were obtained using the *Web of Science* core collection database (*WoS*), which was found to have slightly greater coverage of *Medicine* than *Scopus* (both in terms of years and number of articles indexed). For all analyses presented below, 'Publication Name' searches were used to retrieve all items published in *Medicine* (and other journals where appropriate), and refinements by date used to limit results to relevant time periods. Only items classified by *WoS* as 'Articles' or 'Reviews' were considered, with both types of paper referred to as 'articles' in the remainder of this study. Where appropriate, analyses were also conducted on two additional journals in order to provide some context to the *Medicine* results: *BMJ Open*, the largest other mega-journal covering solely medicine; and *PLOS Medicine*, a selective OA journal.

3. Results

3.1. Journal Output

Table 1 shows the number of articles published in *Medicine* each year since 2004, along with the percentage increase or decrease in output from the previous year. In the eight years prior to the mega-journal transition (2006–2013) the journal published a total of 299 articles, an average of 37.4 per year, and indeed the journal had been publishing at this level since the 1960s. Although output fluctuated somewhat, there appears to be little evidence suggesting a deliberate attempt to grow the journal, since each year of growth is followed by a reduction in size the following year. In the first six months of 2014, a further 23 articles were published, at which point the journal began operating as a mega-journal. 292 articles were published in the remaining six months of the year, almost as many as in the previous eight years combined, while 2015 saw a further dramatic rise to almost 2000 articles. Although the rate of growth slowed somewhat in 2016, the journal still published no less than 3124 articles. It is helpful to provide some context for these figures: *Medicine's* output in 2016 makes it the 12th largest journal of the almost 12,000 indexed in *WoS*, and the 6th largest title covering medical disciplines.

Table 1. Annual output of *Medicine* since 2004, and % change from previous year.

Year	Output	% Change
2004	30	−25.0
2005	36	+20.0
2006	32	−11.1
2007	38	+18.8
2008	36	−5.3
2009	42	+16.7
2010	38	−9.5
2011	48	+26.3
2012	35	−27.1
2013	30	−14.3
2014	315	+950.0
2015	1989	+531.4
2016	3124	+57.1

It is also instructive to compare this output with that of other mega-journals. While *PLOS ONE* remained the largest journal in the world (2016 = 21,011 articles), *Medicine* is already larger than all but one other OAMJ—Nature's *Scientific Reports* (2016 = 19,999).

3.2. Author Characteristics

Analysis of author characteristics focuses on author nationalities and institutional affiliations. In both cases a comparison is made between the ten years prior to the mega-journal launch (2004–2013), and the two years after the transition (2015–2016). A ten year period was used to ensure sufficient articles were included in the analysis. 2014 was excluded from the analysis since the journal published articles evaluated under both traditional and OAMJ peer review policies for parts of this year; mega-journal articles were first published in July, but it was not clear when the final article reviewed under the traditional model was published.

Table 2 shows the ten most common author nationalities for the 365 articles published in *Medicine* between 2004 and 2013, along with the number and percentage of articles with at least one author from each country. Author nationalities are derived from the location of their affiliated institution. For papers with multiple authors, data relating to each author are included. The results show that during the earlier period the journal published articles predominantly from authors based in the USA, France and Spain. In total 278 of the 365 articles (76.2%) have an author from one of these three countries. This stands in stark contrast to the figures for 2015–2016. China emerges as the most prolific contributor, and 2633 of 3517 articles (74.9%) have at least one author from one of four Asian countries: China, Taiwan, South Korea and Japan. It should also be noted that while French, Spanish and American authors each provide proportionally fewer articles, their actual contribution has increased considerably. The USA, for example, provides an author for on average 13.1 articles per year between 2004 and 2013, a figure that rises to 213.3 for the post-mega-journal period.

Table 2. *Medicine* 2004–2013 and 2015–2016—Ten most common author nationalities and % of articles with at least one author from that country.

	***Medicine* 2004–2013 (365 Articles)**			***Medicine* 2015–2016 (5113 Articles)**		
	Country	**Articles**	**% of All Articles**	**Country**	**Articles**	**% of All Articles**
1	USA	131	35.9	China	2207	43.2
2	France	92	25.2	Taiwan	830	16.2
3	Spain	69	18.9	South Korea	616	12.1
4	Taiwan	15	4.1	USA	484	9.5
5	Israel	13	3.6	Japan	223	4.4
6	Japan	11	3.0	Italy	206	4.0
7	Canada	10	2.7	France	178	3.5
8	UK	10	2.7	Germany	111	2.2
9	Italy	10	2.7	Spain	108	2.1
10	China	10	2.7	UK	111	2.0

Table 3 presents the 10 most common author affiliations for articles published in the same two periods. Prior to the mega-journal transition the most prolific institutions were European (particularly French) or American, with the top five contributing institutions providing almost a third (32.9%) of all papers published by the journal. The most commonly found contributors to the mega-journal, in contrast, are all Asian institutions. The top five institutions are all Taiwanese, and four of the remaining five Chinese (the exception is Yonsei University, South Korea). These top contributors, while providing many more articles in total than the top-producing institutions pre-OAMJ, are responsible for a lower proportion of total journal output, the top five institutions contributing to 11.8% of all articles published in this period. Table 3 also shows the number of articles published by each institution in the other time period. Here we note that all of the most prolific contributors in the 2003–2014 period have also published papers in the mega-journal iteration of the journal. Indeed, given the much shorter lifespan of the mega-journal, these institutions have published proportionally more frequently in the mega-journal than they did in the decade prior to the transition. This contrasts strongly with the most common OAMJ contributing institutions, only half of whom had authored any articles at all in the 2004–2013 period.

Table 3. *Medicine* 2004–2013 and 2015–2016—Ten most common author institutional affiliations and % of articles with at least one author from that institution.

	***Medicine* 2004–2013 (365 Articles)**			
	Institution	**Articles**	**% of All Articles**	**2015–2016 Articles**
1	Assistance Publique Hôpitaux Paris (APHP)	68	18.6	96
2	University of Barcelona	33	9.0	30
3	Université Sorbonne Paris Cité (USPC)	30	8.2	52
4	Hôpital Universitaire Pitié Salpêtrière (APHP)	26	7.1	29
5	National Institutes of Health (NIH)	22	6.0	12
6	Hospital Clinic de Barcelona	21	5.8	15
7	INSERM	21	5.8	78
8	Johns Hopkins University	20	5.5	29
9	Pierre Marie Curie University Paris 6	18	4.9	32
10	Hôpital Universitaire Saint Louis (APHP)	17	4.7	15
	***Medicine* 2015–2016 (5113 Articles)**			
	Institution	**Articles**	**% of All Articles**	**2004–2013 Articles**
1	Chang Gung Memorial Hospital	230	4.5	0
2	China Medical University Taiwan	224	4.4	3
3	China Medical University Hospital Taiwan	224	4.4	3
4	Chang Gung University	205	4.0	0
5	National Yang Ming University	165	3.2	1
6	Sun Yat Sen University	156	3.1	1
7	Yonsei University	151	3.0	0
8	National Taiwan University	145	2.8	6
9	Sichuan University	135	2.6	0
10	Peking Union Medical College Hospital	129	2.5	0

3.3. Citation Analysis

Before presenting a more detailed analysis of citation distributions before and after *Medicine's* change to the mega-journal model, it is helpful to review the yearly Journal Impact Factors (JIFs) awarded to the journal. Table 4 shows these figures, along with the JIFs for *BMJ Open* and *PLOS Medicine*. It is notable that *Medicine's* JIF dropped substantially in 2015, the first year to include only articles published under the mega-journal peer-review policies. 2014 produced *Medicine's* highest JIF of the preceding decade, and ranked the journal 15th of all titles classified as '*Medicine*, General and Internal' in *WoS*. The 2015 figure places the journal 40th in the same list. *BMJ Open*, which operates an ostensibly similar peer-review policy, achieved a slightly higher JIF in 2015, and ranks 32nd.

Table 4. Journal Impact Factors for *Medicine*, *PLOS Medicine* and *BMJ Open*.

Year	***Medicine***	***PLOS Medicine***	***BMJ Open***
2004	3.7	n/a	n/a
2005	5.1	8.4	n/a
2006	5.2	13.8	n/a
2007	4.7	12.6	n/a
2008	4.3	12.2	n/a
2009	5.1	13.2	n/a
2010	4.3	15.6	n/a
2011	4.4	16.3	n/a
2012	4.2	15.3	1.6
2013	4.9	14.0	2.1
2014	5.7	14.4	2.3
2015	2.1	13.6	2.6

To compare citation rates and distributions, all articles published in *Medicine* in 2015 were identified, and the number of times these papers were cited in articles published before the end of 2016 was calculated. A similar approach was taken for *BMJ Open* and *PLOS Medicine*. Since the pre-2014 incarnation of *Medicine* published only ca. 35 articles per year, aggregated data for the three years prior to the mega-journal transition were used (2011–2013). Only citations made in articles published before the end of the next calendar year were considered, in order to match the period used for the other three journals. Table 5 shows the results of this analysis, with a focus on the number of infrequently cited articles. The pre-mega-journal version of *Medicine* is found to have a far smaller proportion of uncited articles, while 78.1% of articles published in 2015 have 2 or fewer citations. It is, however, notable that the mega-journal version of *Medicine* has a very similar citation distribution to that of *BMJ Open*.

Table 5. Citation data for *Medicine* (pre- and post-OAMJ transition), *BMJ Open* and *PLOS Medicine*.

					% of Articles with *n* Citations			
	Year	**Articles**	**Citations by End of Next Calendar Year**	**Citations per Article**	0	1	2	≤2
Medicine (Trad.)	2011–2013	113	623	5.5	11.5	14.2	15.0	40.7
Medicine (OAMJ)	2015	1989	3176	1.6	36.6	26.8	14.8	78.1
BMJ Open	2015	1427	2675	1.9	32.3	25.4	16.2	73.9
PLOS Medicine	2015	97	905	9.3	5.2	9.3	11.3	25.8

Following Björk and Catani [12], cumulative distribution function curves were also plotted for the four journals, as shown in Figure 1. Once again the citation distributions for the mega-journal iteration of *Medicine* and *BMJ Open* were found to be remarkably similar. The pre-2014 version of *Medicine* is shown to have published many more highly cited articles than the two OAMJs, but fewer than *PLOS Medicine*.

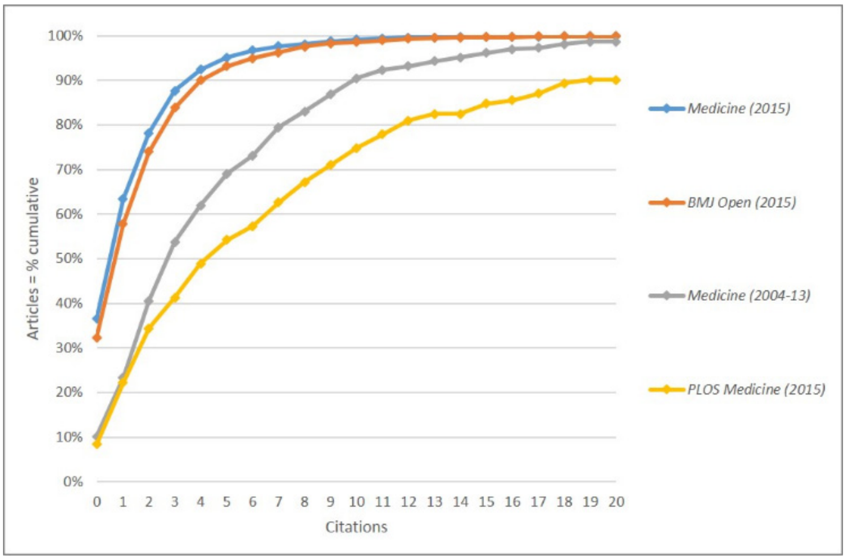

Figure 1. Cumulative citation frequency for *Medicine* (pre- and post-OAMJ transition), *BMJ Open* and *PLOS Medicine*.

Analysis was also carried out on citing journals. Table 6 shows the 20 most common citing journals for *Medicine* before and after its change to a mega-journal. Only two journals are common to both lists (*Medicine* itself, and *PLOS ONE)*. The proportion of citations to *Medicine* articles published in *Medicine* itself is substantially larger for the mega-journal iteration, accounting for almost a quarter (23.4%) of all citations. It is noticeable that a high proportion (45%) of the 2004–2013 list relate to rheumatology, suggesting that while ostensibly a general medicine title, it may have attracted a high number of submissions relating to that specialty. It is also interesting to note that the three most commonly found citing journals for the post-2015 iteration of *Medicine* are all themselves mega-journals; it is possible that this may be due to the faster publication speeds often offered by mega-journals.

Table 6. The 20 most common citing journals for *Medicine* (pre- and post-mega-journal transition). Titles in bold are common to both lists.

	***Medicine* 2004–2013 (13,107 Total Citations)**			***Medicine* 2015–2016 (3,406 Total Citations)**		
	Citing Journal	***n***	**%**	**Citing Journal**	***n***	**%**
1	*Medicine*	217	1.7	*Medicine*	579	17.0
2	*PLOS ONE*	180	1.4	*PLOS ONE*	133	3.9
3	*Clinical and Experimental Rheumatology*	176	1.3	*Scientific Reports*	105	3.1
4	*Journal of Rheumatology*	167	1.3	*Oncotarget*	103	3.0
5	*Revue de Medecine Interne*	158	1.2	*World Journal of Gastroenterology*	50	1.5
6	*Rheumatology*	144	1.1	*International Journal of Clinical and Experimental Pathology*	28	0.8
7	*Lupus*	132	1.0	*International Journal of Clinical and Experimental Medicine*	27	0.8
8	*Rheumatology International*	127	1.0	*Tumor Biology*	27	0.8
9	*Clinical Rheumatology*	124	0.9	*Oncotargets and Therapy*	26	0.8
10	*Autoimmunity Reviews*	117	0.9	*International Journal of Cardiology*	22	0.7
11	*Clinical Infectious Diseases*	117	0.9	*International Journal of Molecular Sciences*	21	0.6
12	*Annals of the Rheumatic Diseases*	105	0.8	*European Review for Medical and Pharmacological Sciences*	13	0.4
13	*Current Opinion in Rheumatology*	97	0.7	*Nutrients*	12	0.4
14	*Internal Medicine*	91	0.7	*American Journal of Emergency Medicine*	11	0.3
15	*Presse Medicale*	86	0.7	*Journal of Surgical Oncology*	11	0.3
16	*Seminars in Arthritis and Rheumatism*	75	0.6	*Journal of Thoracic Disease*	11	0.3
17	*New England Journal of Medicine*	73	0.6	*Medical Science Monitor*	11	0.3
18	*Blood*	71	0.5	*Alimentary Pharmacology Therapeutics*	10	0.3
19	*Journal of Infection*	66	0.5	*Biomed Research International*	10	0.3
20	*Arthritis Care Research*	64	0.5	*European Journal of Internal Medicine*	10	0.3

While the journal's declining impact factor, and the data presented in Table 5, suggest that recent *Medicine* articles are being cited less frequently, they do not indicate whether the characteristics of citing journals have changed. To explore this, the mean JIF was calculated for the citing journals for each time period, weighted by the number of citations made in each citing journal. The JIF awarded to the citing journal for the year of the citation was used, and the results are presented in Table 7. Significant differences between group means were confirmed by a one-way Welch Anova ($F(3,3394) = 83.3$, $p < 0.001$), with a post-hoc Games-Howell test revealing significant differences between each journal ($p < 0.001$). It is apparent that *PLOS Medicine's* citations generally come in journals with significantly higher JIFs than the other titles. While noting the crudity of JIF as a measure, it is interesting to observe that *BMJ Open*, while having a similar number of citations to the OAMJ iteration of *Medicine* (as shown in Table 5), is shown to publish articles that are cited in journals with higher JIFs than journals citing *Medicine* OAMJ articles.

Table 7. Weighted mean JIFs of citing journals.

Journal	Weighted Mean JIF	Standard Error of the Mean
Medicine (2004–2013)	3.8	0.05
Medicine (2015–2016)	3.3	0.06
BMJ Open (2015–2016)	4.8	0.13
PLOS Medicine (2015–2016)	7.4	0.32

One final analysis carried out related to articles published by authors affiliated with the most prolific institutions of the 2004–2013 period. As noted, authors affiliated with all but one of these institutions have continued to publish in *Medicine* after its change to an OAMJ, with much greater frequency. It was considered of interest to compare citation rates for articles by authors at these ten institutions (i.e., those listed in the top half of Table 3) before and after the OAMJ transition, using the method described above. The results presented in Table 8 suggest that while volume has increased, citations have decreased. Over two-thirds (68.2%) of mega-journal articles by these authors were not cited in the 12–18 months following publication, compared to just 12.5% prior to 2014. Between 2004 and 2013, 8 articles (5.7%) were cited at least 10 times within 18 months of publication, while for 2015–2016 no paper has been cited more than 10 times, and only one article has received more than 5 citations. The weighted mean JIF of the citing journals has also declined significantly (t (4913) = 1.28, $p = 0.007$).

Table 8. Citation rates and weighted mean JIFs of citing journals for *Medicine* articles by authors at the ten most common 2004–2013 institutions, pre- and post- mega-journal transition.

				% of Articles with *n* Citations			
	Articles	**Weighted Mean JIF of Citing Journals**	**SEM**	0	1	2	≤2
2004–2013	141	4.0	0.08	12.5	20.8	15.3	48.6
2015	138	3.1	0.30	68.2	20.2	6.2	94.6

4. Discussion

The results presented show clearly how the shift to a mega-journal model has changed the bibliometric profile of *Medicine*. Most striking is the large increase in output, with the journal now publishing over 3,000 articles per year—an eighty-fold increase on the mean annual output for the preceding 10 years. While 'big publishing volume' is considered a key characteristic of a mega-journal [5], there remains some disagreement as to what exactly constitutes 'big'. It is nonetheless hard to argue that a journal publishing on this scale, which would place it in the top 20 of all journals by output, and the third largest mega-journal, is not 'big'. It seems reasonable, therefore, to conclude that this aspect of the journal's transition to a mega-journal has been successfully achieved.

Analysis of author characteristics reveals one important factor in this transformation. The vast increase in publishing volume has clearly been fuelled in large part by an influx of submissions from Asian authors, particularly Chinese and Taiwanese academics; over half of all papers published have an author from one of these two countries. This rise in Chinese-authored papers to some extent matches the broader trend of increased research output from this country, although the extent of 2015 Chinese output in *Medicine* (42.7%) is much larger than both the equivalent figure across all journals in *WoS* (14.6%). It is higher too than the contribution of Chinese authors to *PLOS ONE*, which Yan and Rousseau calculate to be 19% [16], and the rate across all other mega-journals (23.1%) [13] . It must also be noted that analysis of the most common author affiliations reveals that the most prolific contributors from the pre-OAMJ version of *Medicine* are still publishing in the journal, in most cases at a much higher rate. Chinese output can, therefore, be said to be supplementing rather than replacing articles submitted by authors from European and US institutions.

This large rise in output can, of course, be partly explained by the change of peer-review policy; clearly a much higher number of papers are deemed to pass a test of 'scientific soundness' than would be viewed as significant enough to merit publication in the highly selective version of the journal. Yet this alone is not enough to explain *Medicine's* dramatic increase in size. Other OAMJs that cover medical disciplines, for example *PeerJ* and *BMJ Open*, operate almost identical editorial policies yet are smaller than *Medicine*. One further explanation lies in *Medicine's* impact factor. Until mid-2016, when the 2015 impact factor was published, the journal could boast a JIF of at least 4.200 for the previous five years. It seems likely that this legacy Impact Factor, combined with the shift in reviewing policy, provided a powerful incentive for authors to publish in the journal. Given the generally accepted view that Chinese authors are particularly sensitive to JIF in selecting journals for publishing their work [17] (in some cases with financial incentives offered to authors publishing in high Impact Factor titles), this also goes some way to explaining the demographic profile of the mega-journal.

The fall of *Medicine's* Impact Factor is, of course, a result in a decline in citation rates since the mega-journal transition. The citation analysis presented in this paper reflects this, with a much higher proportion of post-2015 articles being infrequently cited, or not cited at all within 18 months of publication. We also find that post-2015 *Medicine* articles are being cited in journals with a lower JIF than pre-2014 articles. While it is tempting to draw immediate conclusions about the quality of articles being published in the mega-journal, it should be noted that other factors may be relevant. It is possible, for example, that researchers have recognised the change in character of *Medicine*, and have as a consequence been less likely to cite articles published in the journal as a whole. More importantly, the mega-journal model is viewed by many as a mechanism for allowing the dissemination of research output that might otherwise not be published (commonly cited examples being negative results and replication studies) [4]. Many such articles are by their nature unlikely to accrue large numbers of citations, but are still seen by many to contribute to the scientific discourse. Questions of 'quality' therefore become more difficult to answer. Ultimately there is a crucial tension at the heart of the OAMJ approach; the model is by definition counterproductive to maintaining a high impact factor, yet the JIF remains a powerful factor in attracting high quality submissions. It remains to be seen whether *Medicine* is able to maintain its current high output given the much lower 2015 JIF, particularly in terms of submissions from Chinese authors. Wolters Kluwer must hope that the new OAMJ brand, and its ability to meet authors' needs in other ways (for example speed of publication), are robust enough to mitigate the much lower impact factor. Anecdotal evidence from discussions carried out as part of a broader mega-journal project suggests that other publishers who do not yet produce a mega-journal title have viewed the *Medicine* approach—converting an existing title to the mega-journal model—as an attractive way to launch an OAMJ. It will be interesting to note the extent to which *Medicine's* evolution serves to support or discourage that view.

The analysis presented in this paper has found the pre- and post-mega-journal iterations of *Medicine* to be different in numerous ways: the journal has a different peer-review policy and editorial board, is vastly different in scale, has different author demographics, and is publishing articles with different citation rates, which are cited in different journals. Aside from the title and ISSN, the journal since 2014 is unrecognisable from its previous form. It seems reasonable to conclude, therefore, that *Medicine* post-2014 is essentially a different journal. Some might view the rise in publishing output, combined with falling citation rates, as somehow indicative of a decline in quality or standards. However, to base such a perception of the journal on raw bibliometric data alone is to ignore the rationale and ethos behind the OAMJ model. In challenging traditional norms of scholarly communication mega-journals are attempting to offer a platform for sound research, without pre-judging the impact of that research. It is important that assessments of the journal are made in that changing context.

5. Conclusions

Medicine converted to the mega-journal model in 2014, and has subsequently seen a vast rise in output combined with a steep fall in citation rates and Impact Factor. The journal's increase in output has been driven in large part by Chinese authors, but it is notable that submissions from European and American authors have also increased. As output has increased, citation rates and, Impact Factor have declined, a decline that can largely be attributed to the rise in submission rates which has accompanied the adoption of a 'soundness-only' peer-review policy. Ultimately, the view taken on the value of journals operating such policies will inform any judgement on the role *Medicine* now plays in the dissemination of medical research. Mega-journals (of which *Medicine* is now a prominent example) are a controversial subject. For some, they represent a paradigm shift towards a more democratic form of scientific discourse; for others, they are little more than dumping grounds, cynical money-making operations for publishers willing to compromise editorial standards. Further research into the mega-journal phenomenon will serve to properly inform this debate. To what extent are 'soundness-only' peer review policies applied consistently within and across mega-journals? Do publishers view mega-journals primarily as revenue generators, or as instruments of change? How do authors view OAMJs, and are they influencing publication practices? Will other journals transition from a traditional to OAMJ model, and will the effects be similar to *Medicine*? Answering these questions will not only contextualise quantitative bibliometric studies of mega-journals, but allow all players to better understand how OAMJs might shape the scholarly communications system.

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