Clinical Biochemistry 73 (2019) 118–120

Contents lists available at ScienceDirect

Clinical Biochemistry

journal homepage: www.elsevier.com/locate/clinbiochem

Opinion Piece

Playing the game of scientific publishing

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Research papers are widely considered to be the premier currency of science. Consequently, from the beginning of graduate training, students are taught to publish or perish. Among other benefits, publishing papers can pave the way for grants, career advancement, patents and fame. However, the business of publishing can be intimidating and complicated, particularly for students and young investigators. Here, we have compiled some basic rules and strategies for playing the game of scientific publishing based on our extensive experience in the field, including many hundreds of published papers and mentorship of over 100 graduate students and post-doctoral fellows.

The following scenario plays out countless times in laboratories across the world: a research paper or review is complete, and it is ready for the final step on its preparation journey that spanned weeks, months or even years. Publication in a scientific journal is the standard way to disseminate new research and ideas, and competition to get into a prestigious journal can be fierce.

However, history shows that almost every written paper will eventually be published in some academic journal. We agree with Drummond Rennie, a former deputy editor of JAMA, that there is very little that will keep a scientific paper out of print [1,2].

> *"There seems to be no study too fragmented, no hypothesis too trivial, no literature citation too biased or too egotistical, no design too warped, no methodology too bungled, no presentation of results too inaccurate, too obscure, and too contradictory, no analysis too self-serving, no argument too circular, no conclusions too trifling or too unjustified, and no grammar and syntax too offensive for a paper to end up in print.*
> *-Drummond Rennie, JAMA (1986)*

We have all read papers that make us wonder how they passed editorial or peer review due to their trivial conclusions, questionable methodology, awful style and grammar or even blatant inaccuracies. Regardless, many other papers are carefully designed and elegantly written; understandably most investigators want the product of months or sometimes years of hard work to be published in a respectable, preferably high-impact journal.

Tens of thousands of new journals have been established since the first scientific journal, *Philosophical Transactions,* was published in 1665 [3]. However, prestigious journals like *Nature*, *Science* and *The New England Journal of Medicine* still receive far more manuscripts than they can review, let alone publish. Nevertheless, five publishers accounted for more than half the papers published in 2013 [4]. In 2018, the publishing giant Elsevier published more than 470,000 manuscripts in over 2500 journals [5].

All these papers are expensive to edit, format and disseminate – one study estimated that the average publishing cost of a scientific article is $3500–$4000 [6]. Traditionally, in the closed- access model, scientists submit papers for free and production costs are covered by publishers who then charge individuals and institutions large fees to access their work.

Open access is a novel publishing trend facilitated by the internet's elimination of printing costs. Currently, only 15% of papers are published open access though this percentage varies widely by country [7]. In this model, journal articles are freely available to everyone, but the production costs are covered by the authors, funders or institutions. Fees vary significantly from $1595 in *PLOS ONE* [8] to $5200 in *Cell Reports* [9], though many journals offer significant discounts to academics from low income countries. Many funders are leading the charge for universal open access; the Bill & Melinda Gates Foundation already requires all grant recipients to publish in open access journals [10] and the Wellcome Trust intends to adopt a similar policy by next year [11]. Eleven major European funders who spend $8.8 billion annually are banding together under Plan S to mandate universal open access for their funded research by 2020 [12]. Finally, the University of California terminated its' contract with Elsevier in March 2019 after the mega publisher refused to make all papers published by the institution freely available [13,14].

In the last few decades, innovative new online publishing practices have sprung up, capitalizing on the opportunities provided by open access and the internet. For example, some journals such as the *BMJ Open* now offer mandatory eponymous review where peer reviewers' names and affiliations are published alongside the final article [15]. The *Public Library of Science* (*PLoS*) family of journals operates on a review policy that evaluates for accuracy but not impact [8]. *F1000R* offers post publication review where papers are posted within days of

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https://doi.org/10.1016/j.clinbiochem.2019.07.016
Received 8 July 2019; Received in revised form 30 July 2019; Accepted 31 July 2019
Available online 01 August 2019

Table 1
Points to consider for playing and winning the game of scientific publishing.

Determine which publishing strategies may or may not be beneficial to you, the trainee, not your supervisor
Do not blame reviewers or editors for your rejections
Have a backup plan because it is very common that your manuscript will be rejected from your first-choice journal
Allow some time before responding to a rejection; immediate action is usually not the best approach
Do not let rejections hurt your self-esteem or confidence. Make them a learning experience
Identify and avoid predatory journals
Remember that long-term your paper will be recognized for its content and impact, not for its publication in a specific journal (you can win a Nobel Prize, even if your discovery is published in a low impact journal)
Publish preferentially in open access and PubMed-indexed journals
Know journal impact factor's limitations
Never fabricate or falsify your data
Take care of your papers until they are published; do not leave this to others.
Remember that a CV with some lower impact publications is better than an empty CV

submission to the journal website following a brief editorial check [16]. Peer reviewers are invited to assess the paper, and their eponymous comments are visible online and citable with the paper. After the paper gets two acceptances, it is indexed in PubMed.

Pre-print servers such as bioRxiv and arXiv allow researchers to post a manuscript without any review. Once limited to the physical sciences, these fora are gaining popularity among life scientists though some journals have restrictions on whether submissions can be previously posted in these fora. Finally, *Collabra* is one of the few journals that pays experts for peer review out of a $975 article processing charge [17].

Peer review is one of the most fundamental components of the scientific publishing process, yet it is almost exclusively performed for free. Expert feedback can improve a paper as well as provide a stamp of approval and credibility. However, peer review is certainly not infallible. For example, *Nature* withdrew 7 papers and *Science* withdrew 9 papers by the infamous nanotechnology scientist Jan Hendrick Schon after discovering fabricated results after the papers had been peer reviewed and published [18]. Critics also say peer review can be ineffective at catching flawed data and assessing reproducibility as well as at times, unfair and unhelpful [19]. It is also very time consuming and reviewers are often not even acknowledged so there is a significant lack of reviewers [20]. One of us has advocated elsewhere for paying reviewers to address these problems. Small payments such as $200 would incentivize early career researchers or retired academics to assess more papers and spend more time evaluating the manuscript and giving feedback, improving the peer review process [19,20]. Nonetheless, even though this proposal is controversial and there is vigorous debate surrounding the new methods of publishing and peer review, the following advice about playing the publishing game is widely relevant wherever a researcher decides to submit. It is summarized in Table 1.

First, it is important to determine which publishing strategies may or may not be beneficial to the trainee or supervisor. It is often in the supervisor's interest to publish in top journals, particularly if they are beginning their research career and need to secure continued funding. As a result, they will often instruct their trainees to perform vast numbers of experiments that take years to build a compelling story that will stand out from all the other submissions to high impact publications. We dubbed these individuals “selfish supervisors”. This approach can make it challenging for these students to graduate on time which can lead them to put off major life decisions and finding a job. This can be damaging to morale, cause significant stress, strain personal relationships and even lead to mental illness particularly if their resulting papers are ultimately rejected by these extremely selective journals.

Since rejection is so common, it is very important to have a backup plan if a paper is not accepted to a first-choice journal. Looking elsewhere ensures the hard work preparing the manuscript will not go to waste. When selecting an alternative publication, it is crucial to avoid predatory journals. These journals scam authors by charging often exorbitant open access and publication fees without proper review or editorial services [21]. Sometimes, once credible journals are acquired by unscrupulous companies, making a careful assessment of an unknown journal essential [22]. In the life sciences, preferred journals should be indexed in PubMed and journals should be affiliated with a credible, even if small, publisher or scientific organization.

We encourage our lab members to publish in open access journals because it means their work is easily accessible to everyone. It also reduces the pressure of journal impact factor (the number of citations received divided by the number of articles the journal publishes within a specified period) because a recent study shows that impact factor does not influence the citation rate in open access journals [23]. This is unlike closed access journals where citations and impact factor are directly proportional. Even though impact factor is widely used as a proxy metric to judge scientists' research, it does not actually say anything about the quality of a paper itself. We, as well as many others, have critiqued the impact factor elsewhere [24–28]. Altimetrics which quantify a scholar impact through the social media activity and online articles referencing their papers are growing in popularity [29].

Some investigators find it is tempting to falsify or tweak results, so they are more attractive for publication in a journal with a high impact factor [30,31]. However, this strategy always backfires eventually, and will have major ramifications for the perpetrator's career [32]. We always stress to our trainees that dishonesty in publishing should be avoided at all costs. Another common sense recommendation: it is important to keep track of all of your papers and submit revisions on time. When leaving a lab, we recommend finishing all manuscripts and projects if possible, to avoid losing them in the transition [33]. After so much effort, it would be unfortunate to let uncomplete papers languish on a hard drive.

Ultimately, we recommend that trainees submit papers to ‘prestigious’ journals if they wish, but be emotionally prepared for rejection, and have a well thought out back up plan. They should also keep in mind that a decent CV is better than an empty CV. We hope this advice will be useful for playing the game of scientific publishing and enable papers to find their place more smoothly.

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