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Open Access to scientific articles – a review of benefits and challenges

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Abstract

The Internet has fundamentally changed the publishing of scholarly peer reviewed journals and the way readers find and access articles. Digital access is nowadays the norm, in particular for researchers. The Internet has enabled a totally new business model, Open Access (OA), in which an article is openly available in full text for anyone with Internet access. This article reviews the different options to achieve this, whether by journals changing their revenue structures from subscription to publishing charges, or authors utilizing a number of options for posting OA versions of article manuscripts in repositories. It also discusses the regrettable emergence of “predatory” publishers, which spam academics and make money by promising them rapid publication with only the semblance of peer review.

The situation is further discussed from the viewpoints of different stakeholders, including academics as authors and readers, practicing physicians and the general public.

Introduction

Several medical journals have recently published articles or editorials strongly warning against so-called predatory publishers of electronic journals that pretend to be scholarly peer reviewed ones [1, 2]. While predatory journals certainly constitute a real problem, focusing the debate on them diverts attention from the much broader context of a scholarly publishing system in transition from a business model shaped by the printed journal format to the new business model made possible by the Internet; Open Access. Predatory publishing is just the murky dark side of this on-going development which otherwise is very beneficial for the advancement of science.

Open Access (OA) means the free access, without subscription, payment or registration, to the full text of scientific journal articles. Anyone with Internet access is just one mouse-click away from a reference or the result of a Google search, whether a researcher, clinician, expert in the pharmaceutical industry, or a concerned patient. There are two variants of Open Access, just the technical OA which often is called “gratis”, and the more advanced “libre” Open Access [3]. In the latter case journals and article use licenses such as Creative Commons, which grant readers the right to reuse the text and data, provided only that the original authors and journals are attributed. Particularly important is that such licenses allow extensive automated data mining of the scholarly literature.

In addition to access to scholarly publications, there is also an increasing debate about Open Access to the research data that underpins empirical research. There are good arguments for Open Research Data, but this area is complex and will not be discussed in this article [4].

The basic moral argument behind Open Access (OA) is that the results of research globally costing an estimated 1,000 Billion USD of primarily public taxpayer money [5], should not be hidden behind pay walls, in order to protect the estimated 10 Billion USD subscription revenue [6] of scholarly journal publishers. While subscriptions were a necessity for paper journal printing and delivery, there are other revenue models for electronic publishing, which has essentially zero marginal cost per new copy delivered. In addition to this public good view, several studies have shown that Open Access funded via publication charges (APCs) would make the publishing and dissemination of scholarly journal articles cheaper than the currently dominating subscription model [7, 8]. Open Access would thus be in the interest of just about every stakeholder involved in the production and consumption of research articles, except for the leading subscription publishers.

Currently around 15 % of the articles indexed in the Web of Science are in full Open Access journals (extrapolated from [9]), and some leading journals, many of which in medicine, also make their content available with a short delay of 6-12 months. The main OA journal revenue model has increasingly become charging the authors for the publishing service, at least for journals published in English in the hard sciences. For authors in Biomedicine, financing the payment of an article processing charge (APC) of typically 1500 -3000 USD [10], is usually no big problem. In addition, around 10,000 subscription journals from the major publishers allow authors to open up their individual articles for a charge of typically 3,000 USD (so-called hybrid OA), but this option has not been so popular with authors. As an example Wellcome trust, which funds biomedical research, paid an average of 2,014 USD for article in full OA journals and 2,923 for articles in hybrid journals [11].

Although Open Access publishing of peer reviewed scholarly journals has been an alternative for around 20 years, so far the gradual conversion to OA has mainly been left to the “market forces”, and has been very slow, 1-2 % in the number of articles per annum. The major reason is the extremely comfortable financial situation of the leading commercial and society publishers, which control the vast majority of the leading journals in which authors want to publish and to which readers absolutely require access. With operating profit rate levels of 30-40 % [12], on a par with companies like Google and Apple, these publishers have so far had very little incentive for converting journals to OA funded with APCs. Instead the market growth has largely been via newly founded OA publishers like Public Library of Science and BioMedCentral.

In addition to the articles in OA journals and journals which make their content open after a short delay of typically one year, some 20-25 % of subscription journal articles can be found

openly in some format (published or manuscript version) in for instance PubMed Central, the institutional repositories of the authors' universities or sites like Research Gate. Some of the green copies are in accordance with the copyright rules of the publishers, while others clearly break them. This additional free access (advocates call it green OA in contrast to the gold OA of full OA journals) is very patchy and unsystematic and requires some active web searching on behalf of an interested reader lacking access to the subscription journal in question. All in all, the share of articles which can be found in some gold or green OA variant a couple of years after publication has been estimated to be around 50 % [13]. In addition, illegal copies of many articles can be found in sites like SciHub.

Green OA has been supported by OA policies by funders like NIH and Wellcome Trust or the mandates of individual universities, but the effect on accessibility has not been as strong as hoped for [14]. Many publishers have recently started to impose longer embargo periods for when self-archiving is allowed, in order tip the balance more towards authors using the paid hybrid option [15].

Table 1. The different options an author has for making his article openly accessible

Type of OA			Publisher	Example
GOLD OA: original article	All the journal's articles immediately Open Access	Free for author	Society, university departement	Revista Brasileira de terapia intensiva
		Journal charging fee for publishing	Quality publisher	PLOS Medicine
			Predatory publisher	American Journal of Medical and Dental Sciences
	Selective or delayed Open Access	Hybrid OA	≅ Around 10,000 journals	Internal and Emergency Medicine
		Delayed OA	≅ 500 high impact journals	New England Journal of Medicine
	GREEN OA: manuscript or article copy	Curated archival storage	Institutional repository	Most major universities
Subject Repository			NIH USA	PMC
Non-curated web posting		Academic social network	Commercial entities	ResearchGate
		Author home pages etc	Employer's web site etc.	

It's time to refocus the debate from fighting against predatory publishing, which admittedly is a nuisance, to trying to find constructive ways in which the positive effects of responsible Open Access publishing could be fully realized. In particular, this would involve co-operation between research funders, universities and their libraries, and the major publishers, who control most of the established journals in which scientists want to publish. Society publishers, whose core

mission is to advance science in their fields, should become active participants in these discussions.

There are many lenses through which the Open Access phenomenon can be observed. In the following we look at OA from the perspectives of a number of stakeholders in the scientific publishing process. These stakeholders are:

- The Funders of scientific research
- Scholarly publishers
- Universities and Institutes
- Academics as authors
- Academics as readers
- Students
- Practicing physicians
- Specialists working outside academia
- The general public

The rest of this article is structured according to this framework.

The Funders of scientific research

As already pointed out above in the introduction, the global expenditure for subscriptions to scholarly journals is only around 1 % of what governments and other institutional funders invest into research. Many funding organizations have realized this and have devised a number of ways in which academics can be steered in the right direction. The most important has been the decision of the National Institutes of Health (NIH, USA) to mandate that all article output from research they funded must become openly available either as gold or green OA at the latest 12 months after publication [16]. This policy has been supplemented by the creation of the PMC repository, where authors can deposit the manuscript version. Many journals in fact routinely put copies of the original article in PMC, which currently houses 4,1 million articles. PMC should not be confused with the bigger sister service PubMed, which only includes abstracts.

A different type of mechanism has been devised by the big private medical research funder Wellcome Trust. WT has already for years had a similar mandate to NIH, but has recently allocated an earmarked budget to pay the APCs. This money can only be used to pay for the article charges in full OA and hybrid journals and the payments are automatic. Research Councils UK has also started to a similar arrangement.

Wellcome Trust has also in collaboration with the Howard Hughes Medical Institute and the Max Planck Society provided substantial funding in the order of 50 million USD to set up the very high quality OA journal eLife [17], which aims at competing for articles with journals like Nature and Science.

Scholarly publishers

So far the major commercial and society publishers have been very cautious in embracing Open Access. For the big commercial publishers, it's based on purely commercial considerations, the bottom line. For the big scientific societies, it's also partly a question of not risking currently stable revenue streams, that can be used to subsidize other activities. They also often provide free or subsidized journals to members, and see a risk of dropping membership levels if they convert the journals to APCs. For medical journals in particular, many current subscribers are not potential sources of APCs, and it could be difficult to compensate for this loss of income. One possible solution, which was already tried by BMJ for a number of years, is to make the research articles free for on-line readers, but keep the other content for subscribers only. And the print version could still be produced for subscribers willing to pay the extra cost of this.

The key to more rapid development, more like the S-curve of innovation adoption, would be the massive conversion of current subscription journals. The new OA policies of many central research funders [18], in particular in the European Union might just be the game changer triggering this. In addition to only requirements to make an article OA in some version, possibly with a delay, these funders have also recently started to provide direct budget support for the funding of APCs. The effect of such earmarked funds, which in practice will be administered via universities, is to disconnect authors from even having to consider whether paying an APC is worthwhile or to find the required funding. This means that authors can go on publishing in the same journals as before. A possible negative effect is that there is less downward pressure on the level of the APCs. Such funding arrangements already seem to have had an impact on the share of articles available OA, in particular in hybrid journals, which for instance can be seen in the case of UK authors [19].

Some big publishers have found that the willingness of funders and universities to pay centrally for OA can be utilized in a new type of big deal, bundling subscription access to all their journals with “free” hybrid OA for all authors from the universities in question [20]. Such deals have already been made or are under negotiation on the national level in for instance the Netherlands, UK, Austria and Sweden. If such deals proliferate, and the share of hybrid OA articles rises rapidly, the publishers will after a critical mass has been reached start massively converting their journals to full OA. And the step from combined subscription-hybrid deals to deals also including paying for the publishing in full OA journals is short.

Universities and research institutes

There are a number of ways, in which universities are trying to promote OA. Firstly, by mandates stipulating that their faculty have to make OA version available of the articles they publish. Such mandates can only be effective if the universities provide the infrastructure of institutional repositories for the uploading of the manuscripts. Secondly by providing dedicated funds for the payment of APCs in gold or hybrid journals.

Repositories have proliferated in the past 15 years and the Directory of Open Access Repositories [21] currently indexes 2789 institutional repositories. But the share of the peer reviewed journal articles with authors from a university for which OA copies are downloaded to its repository are on average only around 15 %. In most cases these universities totally lack or have toothless mandates to upload green copies. In a few cases of strict mandate policies, the share has risen as high as 60 %. Nevertheless, there is a growing realization that the repository infrastructure is only at best a partial solution for achieving global OA. Nowadays a lot of authors prefer to upload article copies to academic social media like Research Gate, but this may not be a good long term solution.

Since many now believe that APC funded gold OA will be the dominant solution, a particular dilemma is receiving increasing attention. This is that fact that if future APC costs globally equal current subscription cost, the distribution over organizations will differ a lot. Research intensive universities with a lot of article output will end up paying more, and less research orientated one, not to mention non-research organisations, companies etc. will be free riders. National consortia library deals with big publishes, like the one Springer is currently starting to negotiate, solves this problem by distributing the cost over large numbers of universities of both types.

Academics as authors

Choosing where to submit your manuscript has never been easy. There are so many factors affecting the choice. What it comes down to is the level of service the journal can offer the author in terms of dissemination to the right kind of readers, likelihood of acceptance, speed of publication, prestige, etc. In the case of Open Access journals an additional factor is paying the APC and finding the funding for that.

The best OA journals are among the top journals in their fields and can compete with other factors than just the open availability. The drawback is that they charge authors. Unfortunately, such journals are available only in a few fields (for instance biomedicine).

For many authors who have been frustrated by the often very deficient peer review practices in journals they have submitted to (biased reviewers, the need to conform to mainstream scientific paradigms, the very fuzzy concept of “scientific contribution”) OA has spawned a new type of journal. So-called Megajournals only check that the scientific method applied is correct and the results are trustworthy, they don’t evaluate the “elusive” contribution, but let the readers decide [22]. They have acceptance rates of 50-70 %, a rapid cycle from submission to publications (they publish the articles directly when they are ready) and the APCs are moderate, typically around 1300 – 1500 USD. The pioneering *PLOS ONE* publishes around 30,000 articles a year and has an impact factor of around 3,0.

Academics in the leading western countries are usually not lured by the Siren songs of the predatory journals, and most of the authors are from Africa and Asia, from countries where advancement requires “international” publication, with no quality checks. For us working in North America and Europe the ranking order of journals is usually well established and known and publishing in unknown journals doesn’t count in the CV. Younger academics also usually closely follow the advice of their supervisors’ and seniors in selecting where to submit. If you are unsure don’t publish in journals that email you soliciting submissions (credible journals don’t do this). There are also two useful indexes which can be consulted. Beall’s list of predatory publishers is a “blacklist” of journals to be avoided [23]. And the Directory of Open Access Journals, DOAJ, is through its recent more restrictive inclusion policies trying to weed out predatory journals and to offer a “whitelist” of OA journals to be trusted [24].

One factor which is in favour of Open Access, whether in an OA journal or green self-archiving, is the increased readership and the citation advantage this brings, something academics cherish. There is no question that Open Access per se increases downloads, but many of these came from readers who don’t publish themselves and thus don’t provide citations. Most studies have shown widely varying degrees of increased citation rates of between zero and several hundred % [25, 26], but it is almost impossible to set up randomized controlled trials, which could provide more definitive answers.

Academics as readers

The fundamental idea behind OA is so simple, that its almost beautiful. You find a reference in another publication and its just one click away. Currently if I’m working outside the office, I may have to go through up to ten steps of logging in etc. to get to an article which my library actually has a subscription to. Not to mention paying 30 dollars with my credit card for access to a single probably worthless article, and then spending half an hour invoicing my department to get the money back. If my university doesn’t have a subscription I usually check whether there is a green OA copy somewhere (they show up nicely in Google Scholar on the right hand side), and if not I usually just give up. In rare cases I email the author to ask for a copy.

Most academics have access to the core literature in their specialty areas via their libraries, but often very poor access to literature in other areas. In principle many unavailable articles could be obtained via inter-library loan, but that is tedious and takes time, and the academics of today are used to instant access.

There are two particular benefits that universal OA access brings. Firstly, the cost saving in downloading the article. Given that millions of academics in the world track down hundreds if not thousands of references per year and researcher, even a saving of a couple of minutes per tracking multiplies to huge savings. Secondly and more importantly the opportunity cost (a term from economics), which is the loss of the possible positive effect the reading of that article could have had on somebody else’s research, lost because of the access barrier.

Practicing physicians

Medical journals differ from scholarly journals in other fields by their often big print circulation to practicing physicians in hospitals, or members of associations. Thus many MDs do have easy access to a few core journals they tend to follow, and which also include other content than pure research articles. The benefits of OA to this group is primarily in offering easy access to all the research literature outside these core journals. This is particularly true for those working outside the bigger university hospitals, who currently lack such access. And OA certainly benefits physicians working in developing countries. It not a coincidence that one of the most successful early journals from OA publisher BMC is *Malaria Journal*.

One challenge for clinicians could be to spot predatory journals and not trust the results presented in them. One good rule of thumb is only to trust journals published by the leading commercial or medical society publishers. To that can be added journals published by reputable Open Access publishers like PLOS and BMC. A further test is if the Journal is indexed by the Science Citation Index with a Journal Impact factor. But journals from unknown publishers where all the articles are OA are potentially from predatory publishers. Furthermore, articles in predatory journals very often are not competently language and copy edited.

Specialists working outside academia

This group is diverse and contains researchers in the pharmaceutical industry, those who work taking care of the elderly and disabled, government officials and elected representatives setting science policy, etc. This category of readers would benefit a lot from the easy and increased access. Currently many academics who have moved to industrial R&D, small spin-off companies etc. find that they are suddenly cut away from the good access they have enjoyed via the library intranets of their universities.

The general public

Making all scientific medical articles open to the general public is a two-edged sword. Googling for information about diseases and cures on the net is very common nowadays and many physicians are frustrated with patients who have self-diagnosed themselves, often falsely and increasing anxiety, a phenomenon dubbed “Cyberchondria” [27]. A particular risk could be that patients find articles from predatory OA journals, that have not undergone proper peer review and contain false conclusions, and trust them because the articles and sites look trustworthy.

As for the serious medical journals most members of the general public will lack the science literacy for fully understanding articles presenting the results of individual studies, but there is no harm in making the articles available. The general public will be better served by Open Access to systematic reviews of the state of the art in different areas, like Cochrane reports [28], or access to the practitioner guideline articles often published in national medical journals. There are also already many open sites like Medline Plus, offering vetted health information for lay people. Such information will complement the often useful information found in Wikipedia, and will counterbalance the drawbacks of the often faulty information found in discussion groups etc.

Conclusions

Open Access is in the longer run almost inevitable, because it is the optimal solution and in the interest of all stakeholders in the process. But due to the peculiar oligopolistic nature of the publishing industry the progress has so far been painstakingly slow. But now there are signs that major publishers are starting to convert journals to full OA, partly via the intermediate stage of hybrid OA. Big governmental research funders, national university library consortia and policy setting players like the EU are in key position to accelerate this development.

As readers, academics have no problems adjusting to OA. It just makes their work easier and enables them to check out and find relevant literature, which otherwise would be hidden behind paywalls. And they have the training to weed out articles published in predatory OA journals.

As article authors, they face a more complex situation. Firstly, they need to avoid falling for the temptations of easy publishing offered by predatory publishers. I don't think that is difficult, and I think the problem has been overemphasised. Academics who have published in such journals, I believe, have not been tricked into it but have knowingly taken a calculated risk to advance their careers. Secondly they need to be aware of the many different options available (full OA journals, hybrid journals, green OA). The most sensible solution is first to choose the best possible journal to submit to and then find out the OA options. If your research area is Molecular Biology or malaria the best option could directly be an OA journal, in most other cases a subscription journal. For medical researchers the best possible option for uploading a green version is the PMC repository, but the institutional repository of your university is also a viable option. And the best one for most other fields.

The basic ethos of science has always been openness, and building on the work of others. In few other publishing industries there has been such a strong case for open access to information.

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Conflict of interest

None

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