An open challenge

Open access and the challenges for scientific publishing

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In December 2001, proponents of open access (OA) to peer-reviewed literature established a new set of ideals for scientific communication. The model they proposed would make accepted scientific papers freely accessible on the world wide web and, to cover the costs for editorial services, would charge the authors instead of relying on traditional subscription-based income (Budapest Open Access Initiative). More than 3,000 journals now publish under this model, which is receiving growing support from public and private funders, libraries and research institutions. The intrinsic appeal of the OA philosophy and its supporter's efforts have also encouraged funding agencies, including the National Institutes of Health (NIH; Bethesda, MD, USA), and private foundations, such as the Wellcome Trust (London, UK), to institute policies that mandate public availability of the research they support in OA repositories. However, the impact and future of OA in scientific publishing and the economic sustainability of OA models are so far unclear. Other questions also remain: which journals are most likely to be affected—negatively or positively—by OA? If OA has to rely partly on subsidies from public or private funders to survive, and if legislation mandates authors to post accepted papers on government-run repositories, is there a danger that OA publishers could lose their independence?

Here, I review the history and current status of OA publishing, discuss its advantages and disadvantages, and consider the feasibility of interference from funding agencies. I will also discuss the possible medium- and long-term financial outlook for medical and scientific publishers, and propose a business model that both provides the public with access to user-friendly summaries of the latest research and allows authors to decide how their paper is to be published.

The initial support for the OA model of scientific communication came mainly from the scientific community and librarians, who are under financial pressure from increasing subscription prices for scientific journals (AAUP, 2007). Other supporters of OA hold that, on principle, results from taxpayer-funded research should be freely available to the taxpayer. In December 2001, a meeting of leading OA proponents gave rise to the Budapest Open Access Initiative (BOAI) on peer-reviewed research literature, which was immediately supported by the US Alliance for Taxpayer Access (Washington, DC, USA). As defined by BOAI, OA to peer-reviewed literature includes free online availability, and permission for any user to download and distribute full-text articles without barriers (www.soros.org/openaccess). To achieve this goal, two strategies were recommended: self-archiving and OA journals.

Shortly after the Budapest meeting, supporters of OA issued two other public statements in favour of OA to scholarly journal literature: the Bethesda Statement on Open Access Publishing and the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities, which were both issued in 2003. According to the Bethesda Statement, for a publication to be OA, "[t]he author(s) and copyright holder(s) grant(s) to all users a free, irrevocable, worldwide, perpetual right of access to [...] the work", and "[a] complete version of the work and all supplemental materials [...] in a suitable standard electronic format is deposited immediately upon initial publication in at

least one online repository" (www.pubmedcentral.nih.gov). In addition, scientists who support OA "agree to manifest their support for open access by selectively publishing in, reviewing for and editing for open access journals and journals that are effectively making the transition to open access". The statement has been endorsed by individuals—not necessarily representing their institutions—from the Howard Hughes Medical Institute (HHMI; Chevy Chase, MD, USA), the BMJ Publishing Group (London, UK), the Harvard Medical School (Cambridge, MA, USA), the American Society for Cell Biology (Bethesda, MD, USA), the Rockefeller Foundation (New York, NY, USA) and the Wellcome Trust. In addition, the similar Berlin Declaration, issued in October 2003, has been signed by more than 60 organizations including large national research institutions such as France's Centre National de la Recherche Scientifique (CNRS; Paris, France) and Germany's Max Planck Society (Munich, Germany), among others. So far, more than 3,000 journals have adopted the BOAI principles.

Although OA guarantees free online access to the published literature, it does allow a charge for printed versions. For example, a single printed issue of the OA journal *PLoS Medicine* costs US\$45, and a yearly print subscription costs up to US\$415. Typically, OA journals cover their editorial and production costs by a variable 'author-pays' model, for which the fees were—at the time of writing—US\$2,750 for *PLoS Medicine* and US\$2,310 for *BMC Medicine*. In practice, funders or institutions usually meet these fees, rather than individual scientists. Some funding agencies explicitly allow their grants to cover article-processing charges—these include the NIH, the US National Science Foundation (NSF; Arlington, VA), the British Medical Research Council (MRC) and National Health Service (both in London, UK), the Wellcome Trust, the Deutsche Forschungsgemeinschaft (Berlin, Germany), the French Institut National de la Santé et de la Recherche Médicale (INSERM; Paris, France) and the Spanish Consejo Superior de Investigaciones Científicas (CSIC; Madrid, Spain).

Various public funding agencies and large private foundations including the European Research Council (ERC; Brussels, Belgium), the Wellcome Trust and the HHMI have also instituted policies that mandate their grantees to make their research results publicly available in OA repositories. In 2005, the NIH requested submission of peer-reviewed manuscripts to the OA repository PubMed Central (PMC) "as soon as possible" after acceptance, but not later than 12 months (<http://publicaccess.nih.gov>; Drazen & Curfman, 2004; Steinbrook, 2005). However, with a low level of compliance—less than 5% of all NIH-funded scientists—the NIH Director Elias Zerhouni admitted that the voluntary approach had failed and asked law-makers to make public access within 12 months a condition of funding.

The outcome was Senate Bill 2695, introduced in 2006, which affects all federal agencies with an annual extramural research expenditure of more than US\$100 million. The Bill mandates that free public access to accepted manuscripts or published versions must be ensured "not later than 6 months after publication". Moreover, it requires the "long-term preservation of [...] published research findings" in a digital, federally maintained repository. Not surprisingly, this attempt to legally mandate OA publishing created a bitter debate between proponents

of OA and commercial and society publishers, who argued that the Bill would threaten their business model.

In 2007, the Association of American Publishers (AAP; Washington, DC, USA) hired a public relations (PR) firm to help it lobby Congress against the pro-OA legislation (Giles, 2007a). Shortly afterwards, the AAP was embarrassed when confidential e-mails and planning documents were leaked that outlined an aggressive and, some would say, dishonest strategy (Giles, 2007b). The plans by the PR company included setting up a lobbying group called Partnership for Research Integrity in Science and Medicine (PRISM) to target crucial audiences including congressmen, regulators, think-tanks, publishers, librarians and scientists with the messages that OA would bring an end to peer review, nationalize science, and promote government censorship of scientific publications. The leaks proved to be a PR disaster for the publishers and PRISM quickly moderated its language and tone—but the incident showed how intense the debate over OA had become.

In February 2007, in response to Senate Bill 2695, a coalition of 75 non-profit publishers expressed concerns about and opposition to, "any legislation that would abruptly end a publishing system that has nurtured independent scientific inquiry for generations" (Frank, 2007). They pointed out that undermining subscriptions would shift the cost of publication from the publisher to the researcher and would harm scientific societies that rely on the income generated by their journals. The group also emphasized that more journal articles were freely available worldwide now than at any time in the past.

Yet, on 8 November 2007, the US House of Representatives passed a spending bill that requires NIH-funded researchers to post the full text of their research papers on the publicly accessible PubMed Central (PMC) website within one year of publication. President George W. Bush vetoed the bill on 13 November and the House failed to override his veto two days later. President Bush finally signed the mandate into law on 26 December as part of the 2008 Appropriations Bill. It states that, "[t]he Director of the National Institutes of Health shall require that all investigators funded by the NIH submit or have submitted for them to the National

Library of Medicine's PubMed Central an electronic version of their final, peer-reviewed manuscripts upon acceptance for publication, to be made publicly available no later than 12 months after the official date of publication [...] the NIH shall implement the public access policy in a manner consistent with copyright law." The new policy—compliance with which is considered a statutory requirement, and a term and condition of the grant award—applies to all peer-reviewed articles that are accepted for publication on or after 7 April 2008. Furthermore, from 25 May 2008, anyone submitting an application or progress report to the NIH, "must include the PMC or NIH Manuscript Submission reference number when citing applicable articles that arise from their NIH funded research".

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The Wellcome Trust has approved an even stricter policy and mandates that electronic copies of accepted papers must be deposited in the PMC repository, and mirrored in the UK PMC, within six months of publication. If publishers do not allow the deposition of Wellcome-funded papers in PMC/UK or PMC within this deadline, authors "should not proceed with the submission to the journal for publication" (www.wellcome.ac.uk). The HHMI has also issued a similar policy: as of 1 January 2008, laboratory heads must ensure that each original, peer-reviewed research article of which they are a main author is freely available and downloadable online within six months of publication.

All of this would not have been possible without the internet, which is changing the business model not only of scientific publishing, but also of publishing in general because it omits the costs of printing and distributing, and enables instant global publication. As a result, new OA journals are springing up—in February 2008, 125 new titles were added to the Directory of Open Access Journals (DOAJ; www.doaj.org), which now represents more than 3,200 journals. In addition, some formerly subscription-based journals have made a full transition to OA, whereas

others have adopted a hybrid model under which the authors can choose the mode of publication.

There are some arguments in favour of OA publishing: authors like it because it is more compatible with the academic ethos, and educational or research institutions like it because they can obtain the scientific literature for free and thus reduce their budgets for journal subscriptions. In addition, the US Alliance for Taxpayer Access holds that publicly funded research should be efficiently disseminated and that the public should have access to it. Another argument in favour of OA, which has been attracting authors, is that OA publications potentially reach more readers and could thus receive higher citation rates. However, a comprehensive review of the recent bibliometric data and literature found little evidence that OA publication of articles increases their citation rates (Craig *et al.*, 2007). At present, it seems rather premature to draw conclusions about the citation level of these journals because many still have no impact factor.

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At a glance, it seems that OA online articles are cheaper to produce than printed articles. However, this does not take into account the editorial costs that increase with a journal's rejection rate. Richard Charkin, the ex-CEO of Macmillan (London, UK), which publishes *Nature*, for example, has estimated a charge of £10,000–30,000 per article under an author-pays model (House of Commons, 2004). Although this number remains contested, it would indeed cost authors more to publish in *Nature*, *Science* and other prestigious journals not only because of the enormous numbers of submissions dealt with by editorial staff, but also to support the manpower needed for improving accepted articles. *The Lancet*—a typical high-impact journal—employs various medical and scientific editors who review papers in-house, and coordinate external expert and statistical review, but it also has seven assistant editors for technical editing, which is seen as a crucial part of the peer-review process. One of the main arguments against OA

is therefore that, to survive mainly on author charges, OA journals will either have to have very high acceptance rates—thereby reducing quality—or find support from public or private institutions, which could jeopardize their independence.

In 2005, a study co-sponsored by the American Association for the Advancement of Science (AAAS; Washington, DC, USA), which publishes the journal *Science*, found that most OA journals undertake peer review and copy-editing in-house (Kaufman-Wills Group, 2005). Of the DOAJ-listed journals, 28% used editorial staff only for peer-review, whereas 72% carried out copy-editing in-house. In fact, the reported study states that “[the] lower rate of copy-editing among Full Open Access journals seemed to stem primarily from a BMC [Bio-Med Central] practice that does not include ‘formal’ copy-editing as part of its publishing service”. Some OA journals have most of the peer-review process carried out by their editorial boards, whose members are not necessarily employed or paid by the publisher. The study also revealed that traditional journals received ten times as many original article submissions as OA journals and, in general, had higher rejection rates. Furthermore, 41% of OA journals were reporting shortfalls, with only 24% breaking even.

It remains unclear whether OA journals could ever raise enough revenue to maintain the high standard of editing that is currently provided by high-quality subscription journals. PLoS, a non-profit publisher in San Francisco (CA, USA), which publishes high-quality, high-impact factor OA journals, reported a loss of US\$1.4 million on US\$5 million in revenue for the fiscal year ending September 2006 (Esposito, 2007). In addition, author charges for OA journals continue to rise as more authors submit their articles for publication, thus demanding more resources for peer review, layout and internet servers; as a result, some universities have recently ended their relationships with OA publishers. In August 2007, for example, Yale University's science and medicine libraries (New Haven, CT, USA) decided to discontinue their membership of BMC, citing skyrocketing costs; The University of North Texas' Health Science Center (Denton, TX, USA) also ended its BMC membership in July 2007.

Finally, the AAP stated that there might also be legal consequences with respect to intellectual property and copyright. The AAP argued that, “journal publishers who

have opposed the NIH mandatory policy will continue to pursue their concerns with Congress regarding the policy's negative impact on science publishing and the protection of related intellectual property rights”, adding that, “[changing] to a new mandatory policy that will require such submission eliminates the concept of permission and effectively allows the agency to take important publisher property interests without compensation” (AAP, 2008).

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Other, sometimes unsubstantiated, arguments against OA claim that the mandatory policy by the NIH and others will lead to the diversion of tax dollars from federal grants to database costs, the duplication of online journal content on publishers' and federal agencies' sites, incomplete repositories—selective deposition of government-funded research—and unnecessary burdens on authors submitting accepted papers to public databases. In addition, it will pose a threat to the intellectual freedom of authors who might have to avoid publication in journals refusing to accept articles that would be subject to the new mandate (AAP, 2007; Frank, 2007). Instead, publishers have been arguing for a voluntary policy, pointing out that close collaboration between the NIH and publishers might lead to greater rates of voluntary submissions to the repository.

Another argument against OA, namely that financial dependence on one or few funding agencies or organizations could threaten editorial independence, is not as far-fetched as it seems. There are many examples of how the current US administration has tried to meddle with scientific findings that do not support their political goals. One well-documented case of how politics trumped science is the attempt by top officials to ‘water down’ and delay publication of a report on second-hand smoke by the former US Surgeon General, which concluded that even brief exposure to cigarette smoke could cause immediate harm (Harris, 2007). Other examples include the Food and Drug Administration's

postponement of a decision about providing emergency contraception to women without prescription, the firing of Elizabeth Blackburn from the President's Council on Bioethics for her stance on embryonic stem-cell research, and attempts to edit and thus tone down scientific reports on anthropogenic climate change (Wood *et al.*, 2005; Blackburn, 2004; Revkin & Wald, 2007).

Time and time again, political appointees—often with no scientific background—have sought to censor government scientists or to undermine the independence of scientific advisory panels. A hearing in January 2007 by the House of Representatives Committee on Oversight and Government Reform revealed a widespread pattern of political interference in the operations of federal scientific activities, including censorship of federal scientists' speech and writing, the distortion and suppression of research results, and retaliation against those who protested (NCAC, 2007).

Other countries seem to share some of these problems, although not to the same degree as the USA. The UK Research Councils are currently not considering directing research funds to OA journals—as was proposed by the German Deutsche Forschungsgemeinschaft—reportedly because they fear offending government policy towards business. John Polanyi, Professor of Chemistry at the University of Toronto and winner of the 1986 Nobel Prize for Chemistry, has also warned about the increasing influence of government and industry with university research: "Government funds the universities and then asks the universities for professional advice [...] [but] are university faculty fearful of giving critical opinions on government policy?" he wrote in the Canada Foundation for Innovation's electronic magazine. "We have struggled for a long time to come to terms with the fact that our universities serve the public interest best when free of government interference in academic affairs. We have now to come to terms with the fact that these same institutions should, in everyone's interest, be substantially free from influence as to what is taught or thought, even by such an interested party as industry" (Polanyi, 2004).

Whether or not such problems will affect OA publishing is hard to say. At first glance, the possibility of governments interfering with science, although important, does not seem relevant to the OA debate. However, theoretically, an OA publication that depends on government funding might

encourage editors to commit self-censorship rather than jeopardizing their financial support, even if it were subtle and almost unconscious. Most journals have a choice of papers to publish and it is certainly easier to pick the least controversial—editorial justification of such decisions is rarely sought unless obviously blatant and rejection can usually be explained on scientific grounds.

However, this argument is not limited to OA journals. In fact, any publication—whether OA or subscription-based—might potentially be subject to commercial influence if its income relies partly on adverts and reprints. Moreover, some scientific and medical journals are owned by associations that have their own political and economic interests. Yet, the overall pressure on OA journals might be greater than on subscription-based journals as the latter have a guaranteed minimal income through their subscriptions that could partly shield them from commercial or other influence. In general, the polarization of the debate regarding whether scientific journals should be OA or not might create a long-term risk for two main sources of published research: government-funded papers in OA journals and industry-funded papers published by privately owned journals.

It is scholarly journals published by smaller societies, many of which depend on the journal's income to finance their activities, which are likely to be hurt by OA (Anderson, 2007). Charles Halsted, then Editor-in-Chief of the *American Journal of Clinical Nutrition* (AJCN), criticized the author-fee policy of some high-profile OA publishers, arguing that such a policy, "is likely to be attractive only to the well-funded scientific establishment and not to others whose science may be as good or better but who lack large-scale external funding" (Halsted, 2003). Halsted pointed out that the higher overall publication costs of not-for-profit scientific journals, such as the AJCN, are essential to "support the multiple, careful, methodical stages of scientific peer-review, rigorous technical editing to ensure internal accuracy of published data, and the ultimate publication costs of both print and online versions." He argued that "elimination of copyright and universal implementation of open access could essentially terminate the hundreds of non-profit scientific journals such as AJCN that, for the most part, are edited by dedicated, working academic scientists and the sponsoring scientific societies that depend on individual and

institutional journal subscriptions for their financial solvency" (Halsted, 2003).

A recent study of English scientific publications in Europe revealed differences in price and quality between learned societies and profit-oriented publishers (EC, 2006). For-profit journals are, on average, three times more expensive because their circulation is generally lower than that of society journals. Although commercial publishers have given new impetus to scientific publishing by launching journals to cover new scientific fields, not-for-profit publishers have focused on high-quality journals. In particular, commercial journals are, on average, of lower quality, as measured by citations, whereas some learned societies manage several highly successful long-standing journals—sometimes the best in their field—which are sold at relatively low prices. The study found that prices are positively correlated with quality: both non-profit and commercial journal prices are positively correlated with the number of citations they receive, and the coefficient is higher for commercial journals.

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So far, the OA movement does not pose much of a threat to the large subscription journals because both readers and authors continue to submit and subscribe to them, but these might have to compete harder with high-quality OA journals such as *PLoS Medicine* and *PLoS Biology*. A recent study revealed that free public availability might not be a sufficient incentive for authors to choose OA over subscription publications, unless the quality issue is also addressed (Warlick & Vaughan, 2007).

Aside from quality, various questions remain. In a statement on Senate Bill 2695, the AAP underlined that the proposed changes would significantly harm revenues, including those from individual article sales (AAP, 2006; Smith 2003, 2005). Reprints are a substantial source of income for many medical and clinical journals; for example, if a hypothetical government study shows that a particular rotavirus vaccine is effective, the vaccine manufacturer is likely to buy reprints. Under new OA rules, the

government, which paid for the study, will mandate the paper to be OA—and so will the vaccine maker—which would mean lost revenue for the publisher. This might be one fundamental reason why publishers wish to delay OA for at least 12 months; so that a company that plans to inform clinicians rapidly would still buy reprints for distribution. As it does not seem feasible for an author-pays model to generate the same revenue, solutions to compensate for these losses should be sought. This could involve new online advertising models, such as OncoSTAT, an Elsevier online portal that provides free access to various cancer journals and relies on advertising revenue.

...author charges for OA journals continue to rise as more authors submit their articles for publication, thus demanding more resources for peer review, layout and internet servers...

Conversely, proponents of OA might lack some perspective. Is it really essential and practical for taxpayers to have free, immediate access to the full contents of all publicly funded research findings published in peer-reviewed journals? A more pragmatic model could take into account the societal relevance of the information. For example, it is unlikely that a paper on the fundamental molecular mechanisms of a rare genetic disorder will immediately influence a physician's practice or be of great interest to the layman. It might be more useful to give the general public immediate, free access to user-friendly summaries of the latest research, such as patientINFORM, a partnership of publishers and voluntary health organizations.

With respect to subscription-based peer-reviewed journals, a dual publishing model, which provides both author-pays and reader-pays options, might be a more sensible approach. Although Blackwell, Springer,

Elsevier, Nature Publishing Group and Oxford University Press have recently introduced such a hybrid model, OA publishers might also add a subscription component in which the editor and author agree on the best option. Research findings with potential short- or medium-term clinical benefits could be published by OA, whereas more basic research articles would be available on a pay-per-view basis. Unfortunately, the former are the very articles for which, because they affect clinical practice, drug companies would want to buy the reprints.

CONFLICT OF INTEREST

The author declares that he has no conflict of interest.

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