Open access: implications for scholarly publishing and medical libraries

Karen M. Albert, MLS, AHIP, Director of Library Services, karen.albert@fccc.edu
Talbot Research Library, Fox Chase Cancer Center, Philadelphia, Pennsylvania 19111

Purpose: The paper reviews and analyzes the evolution of the open access (OA) publishing movement and its impact on the traditional scholarly publishing model.

Procedures: A literature survey and analysis of definitions of OA, problems with the current publishing model, historical developments, funding agency responses, stakeholder viewpoints, and implications for scientific libraries and publishing are performed.

Findings: The Internet's transformation of information access has fueled interest in reshaping what many see as a dysfunctional, high-cost system of scholarly publishing. For years, librarians alone advocated for change, until relatively recently when interest in OA and related initiatives spread to the scientific community, governmental groups, funding agencies, publishers, and the general public.

Conclusions: Most stakeholders acknowledge that change in the publishing landscape is inevitable, but heated debate continues over what form this transformation will take. The most frequently discussed remedies for the troubled current system are the ''green'' road (self-archiving articles published in non-OA journals) and the ''gold'' road (publishing in OA journals). Both movements will likely intensify, with a multiplicity of models and initiatives coexisting for some time.

INTRODUCTION

The scholarly publishing crisis, precipitated by long-standing, significant journal price increases, has seriously hampered the ability of libraries, universities, and investigators to acquire publications necessary for research and education. Open access (OA) publishing provides a mechanism for addressing this dilemma by offering what may be more cost-effective alternatives to the traditional publishing model [1]. This paper summarizes the background, history, and current events relevant to OA and includes an analysis of major stakeholders' views and the future impact of current initiatives on medical libraries.

Highlights

- This paper reviews the factors and events leading up to the open access (OA) movement in scholarly publishing, including the evolution and current status of the National Institutes of Health public access policy.
- Differing points of view of major stakeholders, such as publishers, librarians, scientists, funding agencies, and consumers are summarized.
- Open access has and will continue to impact traditional scholarly publishing, serials pricing, and medical libraries in general.

Implications for practice

- Open access issues may impact decision making in serials acquisition and management.
- Librarians should take a lead in communicating important OA-related developments to user groups and administration.
- Librarians can play major roles in connection with this new movement.

LITERATURE SURVEY

The author undertook a broad scan of the extensive OA literature, narrowing selections to the most relevant, reputable sources. Resources searched and regularly scanned included PubMed (search strategy: ''open access publishing OR open archiving OR institutional repositories''), Google (''open access publishing''), and ScienceDirect (''open access OR journal pricing''). The following print and online resources were also regularly scanned: the *SPARC Open Access Newsletter, Information Today, Journal of Electronic Resources in Medical Libraries, Library Journal,* and *The Scientist.* The Liblicense-L mailing list <http://www.library.yale.edu/~llicense/> was monitored, along with email updates from numerous publishers. Google was searched for supporting documentation in specialized areas such as historical journal pricing trends, the United States National Institutes of Health (NIH) proposal to enhance public access to NIH research (NIH public access policy), and varying stakeholder viewpoints.

WHAT IS OPEN ACCESS?

Multiple definitions of OA publishing exist. In general, OA publications are those made freely available online to anyone anywhere, with no charges imposed for ac-

cess. Commonly known as the three Bs, the Budapest, Berlin, and Bethesda public statements represent the most highly regarded definitions of OA, and all agree on the essentials [2]. Though differing slightly, the statements essentially note that OA allows users to read, download, copy, distribute, print, search, or link to the full text of works, permitting use for any lawful purpose, as long as Internet access to the material is possible. OA is not applicable to content for which authors expect financial compensation and functions within current copyright law by allowing authors to either retain the right to post their papers on institutional servers (''open archiving'') or transfer rights to publishers who allow free access to their work [1].

Two commonly discussed means for achieving the OA goal are articulated in the Budapest Open Access Initiative: (1) establishment of ''a new generation of journals,'' that do not charge subscription or access fees (known as the ''gold'' road), and (2) author self-archiving and/or commitment to deposit a digital copy of a publication to a publicly accessible Website (known as the ''green'' road) [3, 4].

OA publications generally maintain peer review to preserve their academic reputations, and many open access journals recover costs by charging an author publication fee. Examples of OA publishers include the Public Library of Science (PLoS) and BioMed Central (BMC).

PROBLEMS WITH THE TRADITIONAL PUBLISHING MODEL

While a great deal of Web-based medical information is freely available, barriers remain for access to most of the research published in scholarly journals. Peer-reviewed literature is often funded by taxpayer-supported government grants and is highly valued by consumers, researchers, and medical professionals alike. While scientists and clinicians provide free peer review, access is controlled by publishers who charge libraries and consumers hefty subscription and per-article fees to view this material.

Academic and research institutions cannot afford to subscribe to all needed journals, and providing reasonable collections is a challenge given large annual subscription price increases. Research libraries spent 2.7 times more for serials in 1998 to 1999 than in 1985 to 1986, yet purchased 6% fewer serial titles [5]. Journal prices increased 215% between 1986 and 2003, while the consumer price index rose just 68% [6]. As these statistics show, serial unit costs have been rising faster than inflation for almost two decades. Library journal subscriptions display extreme inelasticity of demand (i.e., price increases cause little change in demand), often to the detriment of other library budget items such as books and salaries [6].

Research libraries have struggled to keep pace with these increases, not only by transferring bigger portions of the library's budget to journals, but also by relying on ''big deals'' and consortial discounts. All libraries have lost ground and have been forced into cancellation of critical materials [1, 5]. Subscription price increases have persisted, with recent academic and medical journal prices escalating at an annual rate of approximately 8% to 10% [7].

In addition, the practice of imposing large price differentials between individual and institutional subscription rates continues unabated, as it has since the 1950s [8]. Dual pricing levels force libraries to routinely pay more than ten times the price charged individuals for the same subscription.

Global science, technology, and medicine (STM) publishing is a $7 billion industry, and, in 2002, scientific journals were the fastest-growing media subsector of the prior 15 years [9]. In recent years, commercial publisher profits have averaged in the 20% to 40% range [10, 11]. As part of a multibillion dollar industry, scholarly publishing corporations are motivated by profits and stockholder interests first. Reed Elsevier, one of the leading commercial STM publishers, had an operating margin of approximately 26% in 1997 [12], and a 2002 Morgan Stanley report on STM publishing listed a profit margin of 37% for Elsevier's core titles [9, 13].

Furthermore, numerous publisher mergers led to higher prices as competition decreased [14]. Though library associations communicated their concerns about this anticompetitive activity to the US Department of Justice, nothing was done to halt this disturbing trend. Past mergers included the 1991 purchase of Pergamon Press by Elsevier Science, the 1996 Thomson-West union, the 2001 Reed Elsevier purchase of Harcourt General [15], and the consolidation of Springer and Kluwer in 2004 [16].

In addition, publishers of major STM journals routinely charge authors significant page, figure reproduction, and reprint fees at the time of publication. Authors have also traditionally been required to surrender copyright to the publisher, thus limiting subsequent use of their own publications such as posting their own papers on a personal Website [17]. These restrictions do not satisfy authors who desire maximum exposure of their work [18], or researchers who need literature to build on, and the public who want ready access to important medical and scientific advances.

Further restricting access is US copyright law that imposes an institutional ''fair use'' ordering limitation of just five articles published in the last five years from any one journal. Once this maximum of five articles is reached, ordering any additional articles from the journal incurs significant copyright fees (averaging $30 per article) to be paid to the publisher, on top of interlibrary loan (ILL) and document delivery charges [19]. It is also now common for publishers in control of online site licenses to prohibit use of electronic subscriptions for ILL. As libraries cancel more print, the availability of copies for ILL will decline.

The sole winners appear to be commercial publishers and, to a lesser extent, society or nonprofit publishers, who often utilize income from journal subscriptions to fund association expenses. Researchers,

physicians, libraries, institutions, and the public all suffer the consequences of high costs and access barriers. Librarians also struggle with the complexities of subscription pricing models and licensing options, as well as uneven customer service support. Growing frustration with a dysfunctional scholarly communications system has gained global notice, with academic research institutions [20], governments, professional organizations, high-profile scientists, and the publishing community finally taking action to address these problems.

HISTORY OF OPEN ACCESS

The scientific journal was begun in 1665 to enable researchers to share their work quickly and widely and to establish the priority of researchers investigating the same problem. Because authors received intrinsic rewards from publishing, no financial remuneration was awarded. Early journals could not afford to pay authors anyway. As time passed, the tradition of writing for impact instead of payment continued. Journal articles today are still written to advance knowledge and professional status, and new scientific work depends on prior work. The scholarly journal article is unique in its lack of royalty generation. What remains important to scientific authors is wide dissemination and notice for their work, not financial reward, unusual in the world of intellectual property [21].

For the past quarter century, concerns about the current model of scholarly publishing and the accompanying ''serials crisis'' have been discussed and analyzed at length in the library literature. In the 1980s, library organizations studied the problem and concluded that the high prices were not solely the result of increased costs, but might have been motivated by profit-seeking publishers [22]. During this time, librarians sounded the lone voice of protest—in the face of strong demands from administrators to better control library budgets, as well as pressure from scientists and clinicians who were losing access to critically important journal literature.

The advent of the Internet made it possible for research to be shared in entirely new ways. Physicist Paul Ginsparg founded the Internet's first scientific preprint service, arXiv, in 1991, allowing scientists to share ideas prior to publication. Three years later, cognitive science professor Steven Harnad <http://www.ecs.soton.ac.uk/~harnad/> posted on the Internet what he called a ''subversive proposal,'' asking researchers to immediately start self-archiving—depositing papers in a publicly accessible, Internet-based archive—to maximize exposure to their work and eliminate subscription price barriers hampering research sharing worldwide. Harnad's proposal led to extensive debate and influenced subsequent events leading to the OA movement of today. Over the last decade, Harnad has served as a passionate voice for change, advocating author self-archiving (posting of pre- and post-prints on individual Websites), along with the creation of tools for creating interoperability and metadata standards to enable multiple, disparate archives to function as one searchable, freely accessible virtual archive [23].

The OA movement gained further momentum in 1998 with the founding of the Scholarly Publishing and Academic Resources Coalition (SPARC) <http://www.arl.org/sparc/>, a library-backed advocacy group that publishes alternative, lower-priced journals in selected subject areas. The biomedical science community joined the act in 1999 with the implementation of E-Biomed, the brainchild of Nobel laureate and then-director of the US National Institutes of Health (NIH), Harold Varmus. The aim of this life sciences version of arXiv was to provide a freely available, full-text online repository of electronic pre-prints and post-prints in all areas of biomedicine. Due to opposition from learned societies and commercial publishers, E-Biomed evolved into the less ambitious, but still important, PubMed Central, which currently houses full text for more than 160 journals. Many of these are freely available elsewhere [23]; however, PubMed Central stands to become even more important to the OA movement, because under the NIH public access policy, it serves as the repository for publications resulting from NIH-funded research [24, 25].

Varmus subsequently decided that more needed to be done to push the OA envelope. In 2000, he and fellow scientists Michael Eisen and Patrick Brown founded the Public Library of Science (PloS) <http://www.plos.org>, which began as a bold movement to persuade scientists to boycott editing or publishing in journals that did not make their content freely available in PubMed Central. Over 34,000 scientists worldwide signed a pledge to do so, but only a small number complied with the agreement [23]. Promotion and tenure requirements are not easily ignored.

Another major development was the creation of BioMed Central (BMC), an open access commercial publisher begun by Vitek Tracz, former chair of the Current Science Group. After selling off a number of publishing businesses to Elsevier, Tracz founded BMC, based on the ''author-pays'' model. Most of BMC's journals are free online and supported by author fees (approximately $600 to $1,800 per article) and institutional memberships. For those affiliated with organizations that join, publication charges are reduced. Today, BMC is a major player in the movement, having over 460 institutional members and publishing more than 110 OA journals [23].

In the last few years the OA movement has intensified, setting the following significant milestones:

1. Large universities say ''no'' to the big deal: In 2003, Cornell, Harvard, North Carolina (Research Triangle Institutions), Massachusetts Institute of Technology, and, for a time, the University of California, did not renew with Elsevier for the ''big deal'' involving bundles of titles and limits on canceling low-use titles [20].
2. Editorial board of commercially published journal defects: In January 2004, the editorial board of *Journal of Algorithms* left Elsevier for the Association for Com-

puting Machinery (ACM) to publish a competing journal instead [26].
3. Three major studies from financial analysts released: Investec, PNB Paribas, and Citigroup Smith Barney indicate that competition from OA journals should raise concerns for investors in commercial journal publishers [27–29].
4. PLoS Biology and PLoS Medicine launched: Two major, reputable OA journals were PloS's first offerings, with several more PLoS titles, including PLoS Clinical Trials, planned for 2006.
5. The United Kingdom's House of Commons Science and Technology Committee report isssued: The report recommended self-archiving, a proposal eventually rejected by the UK government [30, 31]. However, in 2005, the eight UK Research Councils issued a proposal mandating that grant recipients post papers resulting from their funding to either a free institutional or subject-based repository, as soon as possible after publication. Final action on this proposal was expected in early 2006 [32, 33].
6. Major journals implement OA: *Proceedings of the National Academy of Sciences (PNAS)* and *Nucleic Acids Research,* other journals, and publishers including Springer-Verlag, Blackwell, and Nature Publishing Group implemented a variety of OA features and options [34–38].
7. Library, governmental, nonprofit groups such as the World Summit on the Information Society (WSIS), the Medical Library Association (MLA), and International Federation of Library Associations (IFLA) [39–41] endorse OA.
8. Society publishers support the DC Principles <http://www.dcprinciples.org>: These publishers took a ''middle ground'' OA position by pledging to provide free full-text online access to their journals either immediately or within months [42].
9. France, Germany, Spain, and the Netherlands embrace OA and self-archiving initiatives [32, 43].
10. The Wellcome Trust, a major UK research funder, sets OA requirements: All grantees awarded funds after October 1, 2005, must make their published results freely available in PubMed Central no later than six months after publication [44, 45].

National Institutes of Health public access proposal

Announced in February 2005, the forward-thinking NIH policy to broaden access to the biomedical literature was implemented in response to a 2004 Congressional directive. The NIH was asked to develop a plan for providing free access to all publications resulting from NIH-funded research. The original plan *mandated* deposit of publications into PubMed Central (PMC), but, after significant publisher protest, the final version, effective May 2005, was changed to a *voluntary request* for manuscript submission. Further concessions to publishers were made by increasing the maximum time delay for posting to PubMed Central from six to twelve months after publication [24]. This compromise plan affects only a small percentage (10%–11%) of the literature in PubMed Central and therefore may not have much impact on library subscription costs. However, it is a bold move that could influence other funding agencies to follow suit. It provides the taxpaying public with open access to some biomedical literature, albeit with up to a one-year post-publication delay.

As of December 2005, the number of papers posted to PubMed Central under the new policy was extremely low, a mere 2% to 3% of the total possible [46, 47]. In a related development, the US American Center for Cures Act was introduced in the US Senate to mandate OA for all Department of Health and Human Services–funded biomedical research, requiring deposit of resulting journal articles to PubMed Central within six months of publication [48]. It remains to be seen if action will by taken by the US Congress, the NIH, OA enthusiasts, or the library community to facilitate compliance.

STAKEHOLDER VIEWS OF OPEN ACCESS

Commercial publishers

Commercial publishers' main arguments against OA involve economics, editorial quality, and advocacy of the existing system. In discussing OA economics, STM publishers emphasize high production costs for current journals, significant investments in electronic technologies, and development of publications in new subject areas. They challenge the economic viability of the ''author-pay'' model, noting studies showing that current OA journals need to either raise author fees or develop alternative revenue streams to remain sustainable in the long term. PLoS's $9 million grant is cited as supporting evidence [49, 50].

The ''grassroots memo,'' from the Professional Scholarly Publishing (PSP) Division of the Association of American Publishers (AAP) details further cost-related anti-OA arguments, stating that the NIH plan ''risks undermining the economic foundation of established journals in favor of an unsubstantiated open access agenda.'' Not only does this memo imply that publishers would be forced to implement author fees to compensate for cancelled subscriptions, but it also warns that US taxpayers would pay for scientific journal content that low-publishing institutions like drug companies could access at no cost [51].

Ethical concerns are also commonly cited by commercial publishers when arguing against OA [52]. They note the possibility of bias favoring author publication rather than filtering or peer review, because the OA system would depend financially on author, not reader, payments [53]. One publisher representative expressed further concern that peer-review quality could be threatened, because the overriding goal would be to publish a larger proportion of submitted articles to generate more funds [54].

Publisher support for providing free journal content online to developing countries via the Health InterNetwork Access to Research Initiative (HINARI) and Access to Global Online Research in Agriculture (AGORA) programs is touted as evidence for the current system's success in opening access [55, 56]. Commer-

cial publishers acknowledge that change is afoot and many—like Springer Verlag, Nature Publishing Group, and Oxford University Press—are experimenting with OA-based alternatives.

In response to pressures from the OA movement, biomedical commercial and society publishers recently crafted a collaborative plan to provide more full-text access to literature for the general public. They joined with several patient advocacy groups (the American Cancer Society, the American Diabetes Association, and the American Heart Association) to make the content of hundreds of current journal articles freely available online through the groups' Internet sites. Interpretive text, furnished by experts from the associations, accompanies the links to full-text articles. Launched in 2005, patientINFORM provides access to articles the patient groups select [57, 58].

Society and nonprofit publishers

Like their commercial counterparts, most nonprofit publishers argue against OA, predicting that scientific societies will fold if their journals are forced to adopt this publishing model [59, 60]. These groups' profit margins are low, and they blame commercial publishers for most of the excessive price increases, noting that ''big deals'' exacerbate the problem. Nonprofit publishers also cite their opening of access to journal content six to twelve months after publication as evidence that more open access is not necessary [50, 61].

To host and develop Websites for online journal content, many of these publishers use the services of Stanford University-based HighWire Press, a major player in the online scholarly publishing world. HighWire claims to have the ''world's largest collection of open access, high-impact scholarly research online,'' thanks to these publishers offering free access to backfiles, usually after a six to twelve-month embargo period. This open archive covers a wide range of not-for-profit titles and contains twice as much content as PubMed Central [62]. Over fifty-three of these society and university press publishers have endorsed the DC Principles, which advocate providing free content online ''within months of publication,'' as determined by the needs of the individual publisher involved [42]. In October 2005, this same group proposed changing the NIH public access policy to have PMC link directly to journal articles at their publishers' Websites, instead of relying on authors to request posting of final (unfinished) manuscripts [63]. In November, the Royal Society, Britain's national academy of sciences and journal publisher, issued a position paper criticizing OA, warning that it could threaten the viability of traditional journals and learned societies who depend on subscription income [64]. This statement sparked heated responses from OA advocates, as well as forty-six fellows of the Royal Society itself [65].

Consumer groups

In recent years, consumer groups have voiced strong support for OA, especially through endorsements of the NIH proposal. Patient organizations like those in the Alliance for Taxpayer Access <http://www.taxpayeraccess.org> believe that open access to government-funded literature is an US taxpayer entitlement [66]. Large disease-specific patient advocacy organizations, like the American Cancer Society and American Diabetes Association, originally favored the NIH proposal's goal but, due to their publishing interests, requested that more research and analysis be conducted before moving forward [67]. Most consumer groups at least support the idea of increasing online availability for the general public.

Librarians

Librarians have long been calling for change in the current system, and they and their organizations (MLA, Association of Research Libraries, and the American Library Association) applaud the goals of OA. Many of these groups partnered in 2003 to form the Information Access Alliance <http://www.informationaccess.org>, dedicated to promoting government antitrust review of the numerous proposed mergers in the serials publishing industry. While they were unsuccessful in stopping the sale of BertelsmannSpringer to Cinven and Candover, most of these same organizations joined taxpayers, patients, physicians, researchers, and institutions in the Alliance for Taxpayer Access in supporting the NIH public access proposal [68]. Most library groups expressed their belief that this plan would expand access to much needed information, while giving publishers time to explore alternative journal models.

Some librarians question the economic viability of the author-pays model and wonder if OA or the NIH proposal will alleviate the journal pricing crisis [69]. Librarians at several large universities have concluded that switching to an all author-pays system would actually cost their institutions substantially more than the current subscription system, thanks to their high publication rates. They further note the inequality inherent in an OA system, in which low-publishing, for-profit institutions like pharmaceutical companies would obtain a ''free ride'' for journal access, while academics shouldered most of the author fees and cost burden [70, 71]. Many librarians recognize that even if the OA movement does not provide immediate budgetary relief, it may at least galvanize current players to seek alternatives and compromise solutions that could lead to improved information access.

Researchers, institutions, and funders

The average researcher has traditionally aimed to publish in the highest quality journals to gain a wide audience and secure prestige and recognition in support of tenure, promotion, and grant-funding success. These goals could motivate researchers to pursue OA publishing to obtain wider exposure for their work. However, many researchers oppose the idea of paying more than a nominal fee for publishing [53], and some academics still believe that online publication is less

professionally impressive than print. On the other hand, groups of scientists have led major OA initiatives, such as PLoS.

The climate may be ripe for encouraging researchers to self-archive, but educating scientific authors regarding the benefits of OA and author self-archiving initiatives remains a challenge [72]. A recent study completed for the UK's Joint Information Systems Committee (JISC) confirms that while most scientific authors embrace the idea of OA journals to broaden exposure to their work, many have difficulty identifying suitable OA journals in their fields of interest. A majority (81%) would willingly adhere to a self-archiving requirement from an employer or funder. Absent a mandate, many remain reluctant to post papers to institutional or subject repositories due to time pressures and worries about copyright infringement. However, almost half of the study's participants have self-archived at least one article in the last three years, and posting to institutional repositories has doubled over the last year [73]. More universities are encouraging faculty to submit publications to OA journals and to self-archive on individual Web pages or institutional repositories [74].

Academic and research institutions generally support the OA concept to increase availability and lower costs of access to scholarly literature. The Association of American Medical Colleges and the Association of American Universities offered a qualified endorsement of the NIH proposal, suggesting that the initial submission of the accepted manuscript be replaced by deposit of the published version to avoid confusion [67]. Though traditionally not exercised, research institutions, universities, and government grant agencies could assert their legal rights to their employees' works and prohibit their authors from transferring copyright to publishers [75–77]. This action could force publishers to accept opening of access through self-archiving or posting to a free archive like PubMed Central.

The NIH publications policy indicates research funders' support for increasing access to scientific output. Other funding agencies like the UK's Wellcome Trust and US Howard Hughes Foundation have already enacted pro-OA policies [44, 78]. The UK's Research Councils, who fund British investigators, may soon implement a new policy requiring grantees to make their journal publications freely available online in an electronic print repository (possibly a UK version of PubMed Central) [32, 33, 79].

WHAT HAPPENS NEXT?

With the exception of STM publishers, most players in the scholarly publishing world agree that the current system is in need of a serious overhaul. As the *Financial Times* noted:

> Researchers are frustrated by a lack of access to research, since no library can afford to subscribe to all relevant journals . . . the pressure on librarians to subscribe only to ''core'' journals limits cross-fertilisation between disciplines. Meanwhile, funders get less return on their investment because researchers are working without adequate access to previous research. Finally, the public is denied access to reliable peer-reviewed research findings—especially ironic in the case of medical research, where so much dubious information is openly accessible on the net. [52]

Many credit libraries for drawing attention to the excessive cost of the current system, but some OA advocates say their protests highlighted a bigger problem: the decreased impact of important research caused by lack of access to the entirety of the world's literature, or the ''article access/impact'' problem [4]. Two possible remedies most frequently suggested are the ''green'' road (self-archiving articles published in a non-OA journal) and the ''gold'' road (publishing in an OA journal). Each road has advantages and disadvantages, and some advocate for a merger of the two [80].

The ''green'' road is possible now because many publishers have changed their policies to permit authors' self-archiving of post-prints. With the development of interoperability or search tools like OAIster <http://oaister.umdl.umich.edu/o/oaister/>, the power of open archiving could be harnessed. Also, search engines like Google and Yahoo are crawling OA content, including Open Archives Initiative (OAI)–compliant repositories. Companies like ProQuest/Bepress and BioMed Central are selling repository creation and hosting services to institutions who want to outsource these labor-intensive jobs [81].

To date, only a small percentage of all articles have been self-archived, but universal online access could be achieved if research funders and employers mandated this activity [4]. The success of this road depends on maintaining traditional publisher peer review, as well as publisher permission to self-archive. Even if research funders mandate OA, traditional publishers might simply withdraw from the market or rescind their self-archiving authorization if their businesses are sufficiently threatened [72, 80].

BMC and PLoS, major players in pursuit of success via the ''gold'' road to OA, have yet to demonstrate the economic sustainability of their business models, although they have gained significant notice in scientific circles and the mainstream media. In fact, BMC altered its membership model to generate more revenue—giving discounts but no longer waiving article processing fees for authors affiliated with member institutions [82]. Of the approximately 1,400 OA journals in existence, only a few are able to rely solely on author fees for financial security. Most rely on outside grants or institutional sponsorship. Institutional memberships obviate authors' paying the full price for each paper they publish. However, institutional and author fees can hit library budgets, exacerbating journal affordability problems, as several recent studies have shown [70, 71].

The ''gold'' road still has a long way to go in terms of finding approval among the majority of scientific authors. Misconceptions and lack of understanding prevail [81], and some real disincentives hinder author

acceptance of OA. Author charges, lack of journal prestige, and loss of author copyright control remain barriers to OA success [69]. However, recent statistics point to the definitive citation impact advantage (around 300% higher) of OA articles [4], and self-archiving in institutional repositories is definitely on the rise [73].

The question remains: Will either of these roads overtake the current system? Perhaps the two roads will converge, or an alternative path may emerge. In the short term, the journal affordability dilemma remains. Although many tout the merits of OA, none have identified a viable solution to the serials cost crisis, which is what initially drew the attention of researchers, governments, funders, institutional administrators, and the public at large. While a significant move, the NIH public access policy will likely open access to a relatively small percentage of the world's research papers. Libraries will need to retain most subscriptions to support scientists' need for literature. Should publishers experience loss of revenue due to subscription cancellations, they are likely to compensate for these losses as they often have in the past, by raising prices.

Librarians remain caught in the maze of complexities and frustrations inherent in the current system and proposed resolutions. However, as highly knowledgeable mediators of the scholarly communication world, librarians are uniquely positioned to further the success of any possible solution. As one nonprofit publisher representative suggests:

> if OA is to become the future of scholarly publishing, it needs skilled and responsible management, and librarians clearly possess the talents for this . . . they may also become crusaders, educators, investors, aggregators, and developers, all with the ultimate goal of supporting an easily accessible, interconnected international network of quality research, available to all who might need to use it. [83]

Traditional publishers, both commercial and nonprofit, will likely continue to battle against the forces favoring OA and self-archiving. To address criticism and counterbalance the ''gold'' and ''green'' road initiatives, publishers are also likely to continue experimenting with OA models, even though author article charges might be set fairly high. All stakeholders expect movement toward OA to persist, yet reliance on the traditional system will remain, along with continuing journal price increases.

In the longer term, a combination of the following may occur to resolve the serials pricing crisis:

1. development of more OA (''gold'' road) and SPARC-type (lower subscription cost) journals, that over time gain in stature and impact to provide true competition with traditional established titles
2. increased implementation of institutional repositories (IRs) and self-archiving, enabled by further development of effective finding tools like OAIster and Google Scholar
3. more funders mandating deposit of grant-supported manuscripts in free archives like PubMed Central

These steps might lessen commercial publishers' current stranglehold. The key is to reduce large profits collected by publishers without destroying peer review and high-quality journals. Society publishers will also need to reduce dependency on journal profits to support organizational operations. In addition, thought should be given to how corporate entities (like drug and chemical companies) could help support open access efforts, because they benefit from free access while contributing only a small subset of scientific articles and author fees overall.

Different publishing models and trends will likely coexist for some time. Publishers may rail against change, but some alteration of the current structure is inevitable. What remains largely unknown is how all the various experiments, proposals, business models, and governmental actions will ultimately fare and exactly how changes will impact the future of libraries and scholarly publishing.

REFERENCES

1. Association of Research Libraries. Framing the issue: open access. [Web document]. Washington, DC: Association of Research Libraries, Office of Scholarly Communication, 2004. [cited 16 Dec 2004]. <http://www.arl.org/scomm/open_access/framing.html>.
2. Suber P. Praising progress, preserving precision. SPARC Open Access Newsl. [serial online]. 2004 Sep 2(77). [cited 19 Jun 2005]. <http://www.earlham.edu/~peters/fos/newsletter/09-02-04.htm>.
3. McKiernan G. Open access and retrieval: liberating the scholarly literature. In: Fowler DC, ed. E-serials collection management: transitions, trends, and technicalities. New York, NY: Haworth Information Press, 2004:197–220.
4. Harnad S, Brody T, Vallieres F, Carr L, Hitchcock S, Gingras Y, Oppenheim C, Stamerjohanns H, Hilf ER. The access/impact problem and the green and gold roads to open access. Ser Rev 2004;30(4):310–4. (Available from: <http://www.sciencedirect.com/science/article/B6W63-4DS8FN9-F/2/8604ea015ea3f8c71f055271f050255a>. [cited 19 Apr 2006].)
5. Kyrillidou M. Journal costs: current trends & future scenarios for 2020. ARL Bimonthly Rep 2000 Jun;210. (Available from: <http://www.arl.org/newsltr/210/costs.html>. [cited 19 Apr 2006].)
6. Kyrillidou M, Young M. ARL statistics 2002–2003. [Web document]. Association of Research Libraries, 2004. [cited 21 Dec 2004]. <http://www.arl.org/stats/pubpdf/arlstat03.pdf>.
7. EBSCO Information Services. Five year journal price increase history (2000–2004). [Web document]. Birmingham, AL: EBSCO Information Services, 2004. [cited 21 Dec 2004]. <http://www.ebsco.com/home/printsubs/priceoverview.pdf>.
8. Okerson A. Periodical prices: a history and discussion. Adv Ser Manage 1986;1:101–34.
9. Gooden P, Owen M, Simon S. Scientific publishing: knowledge is power. Morgan Stanley, 2002 Sep 30. (Available from: <http://www.econ.ucsb.edu/~tedb/Journals/morganstanley.pdf>. [cited 19 Apr 2006].)
10. University of California Office of Scholarly Communication. The facts: the economics of publishing. [Web document]. 2004. [cited 23 Dec 2004]. <http://osc.universityofcalifornia.edu/facts/econ_of_publishing.html>.

11. Create Change, Association of Research Libraries, Association of College and Research Libraries, Scholarly Publishing and Academic Resources Coalition. Frequently asked questions: serials. [Web document]. Create Change, 2000. [cited 23 Dec 2004]. <http://www.createchange.org/faculty/faq/serials.html>.
12. Wyly BJ. Competition in scholarly publishing? what publisher profits reveal. ARL Newsl 1998 Oct;200. <http://www.arl.org/newsltr/200/wyly.html>.
13. Committee on Electronic Scientific Technical and Medical Journal Publishing and Its Implications, US Committee on Science Engineering and Public Policy, US National Academies. Electronic scientific, technical, and medical journal publishing and its implications: report of a symposium. Washington, DC: The National Academies Press, 2004.
14. Create Change, Association of Research Libraries, Association of College and Research Libraries, Scholarly Publishing and Academic Resources Coalition. Overview of the issues: scholars under siege: the scholarly communication crisis. [Web document]. 2000. [cited 23 Dec 2004]. <http://www.createchange.org/faculty/issues/quick.html>.
15. Case MM. Information access alliance: challenging anticompetitive behavior in academic publishing. Coll Res Libr News 2004 Jun;65(6):1. (Available from: <http://www.ala.org/ala/acrl/acrlpubs/crlnews/backissues2004/june04/iaa.htm>. [cited 19 Apr 2006].)
16. Springer. Merger of Springer science+business media and Kluwer academic publishers to begin spring 2004. [Web document]. Berlin, Germany: Springer, 2003. [cited 21 Dec 2004]. <http://www.springeronline.com/sgw/cda/frontpage/0,11855,5-109-2-100048-0,00.html>.
17. Guernsey L. A provost challenges his faculty to keep copyright on journal articles. Chron High Educ 1998 Sep 18;45(4):A29. (Available from: <http://chronicle.com/colloquy/98/copyright/background.htm>. [cited 19 Apr 2006].)
18. Prosser DC. The next information revolution—how open access repositories and journals will transform scholarly communications. LIBER Q 2004;14(3/4):23–36. (Available from: <http://eprints.rclis.org/archive/00001181/01/LIBER.htm>. [cited 19 Apr 2006].)
19. Fister B. Go ahead, book me. Libr J 2004 15 Nov;129(19):26–8.
20. Van Orsdel L, Born K. Periodicals price survey: 2004: closing in on open access. Libr J 2004 Apr 15;129(7):45–50. (Available from: <http://www.libraryjournal.com/article/CA408358.html>. [cited 19 Apr 2006].)
21. Suber P. A primer on open access to science and scholarship. Against the Grain 2004 Jun;16(3):56–9. (Available from: <http://www.earlham.edu/~peters/writing/atg.htm>. [cited 19 Apr 2006].)
22. Cornet M, Vollaard B. Tackling the scientific journal crisis. CPB Rep 2000;(2):13–6.
23. Poynder R. Ten years after. Info Today 2004 Oct;21(9):1,23–4,44. (Available from: <http://www.infotoday.com/it/oct04/poynder.shtml>. [cited 19 Apr 2006].)
24. Suber P. NIH public-access policy: frequently asked questions. [Web document]. 2005. [cited 28 Dec 2004]. <http://www.earlham.edu/~peters/fos/nihfaq.htm>. [cited 19 Apr 2006].
25. US Department of Health and Human Services, National Institutes of Health. Public access. [Web document]. Bethesda, MD: 2004. [cited 28 Dec 2004]. <http://publicaccess.nih.gov>.
26. Read B. Editor ial board of scientific journal quits, accusing Elsevier of price-gouging. Chron High Educ-Dly Rep [serial online]. 9 Feb 2004. [cited 19 Jun 2005]. <http://chronicle.com/daily/2004/02/2004020904n.htm>. Subscription required.
27. newratings.com. Reed Elsevier initiated with ''Underperform''. [Web document]. New York, NY: New Ratings, Westerburg, Germany: Aktiencheck, 2003. [cited 14 Jun 2005]. <http://www.newratings.com/new2/beta/article.asp?aid=341832>.
28. Wray R. Free access may constrain Reed. Guardian Unlimited. [serial online]. Manchester, UK: Guardian Newspapers, 1 Nov 2003. [cited 19 Jun 2005]. <http://www.guardian.co.uk/print/0,3858,4787521–103676,00.html>.
29. Suber P. Another financial analyst acknowledges promise of open access. Open Access News [serial online]. 30 Dec 2003. [cited 19 Jun 2005]. <http://www.earlham.edu/~peters/fos/2003_12_14_fosblogarchive.html>.
30. Wray R. Confused decision on science publishing. Guardian Unlimited. [serial online]. Manchester, UK: Guardian Newspapers, 9 Nov 2004. [cited 30 Dec 2004]. <http://www.guardian.co.uk/business/story/0,1346605,00.html>.
31. UK House of Commons Science and Technology Committee. Scientific publishing: free for all? [Web document]. London, UK: House of Commons, The Stationery Office Limited, 2004. [cited 12 Feb 2005]. <http://www.publications.parliament.uk/pa/cm200304/cmselect/cmsctech/399/399.pdf>.
32. Vogel G, Enserink M. Information sharing. Europe steps into the open with plans for electronic archives. Science 2005 Apr 29;308(5722):623–4. (Available from: <http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=15860604>. [cited 19 Apr 2006].)
33. UK Research Councils. Access to research outputs. [Web document]. The Councils. [cited 5 Oct 2005]. <http://www.rcuk.ac.uk/access/>.
34. Cozzarelli NR. An open access option for PNAS. Proc Natl Acad Sci U S A 2004 Jun 8;101(23):8509. (Available from: <http://www.pnas.org/cgi/content/full/101/23/8509>. [cited 19 Apr 2006].)
35. Oxford University Press. Nucleic acids research: NAR's open access experiment. [Web document]. Oxford University Press, 2004. [cited 30 Dec 2004]. <http://www3.oup.co.uk/nar/special/14/default.html>.
36. Choice? Springer ups the ante on open access. LibraryJournal.com [serial online]. 2004 Jul 13. [cited 23 Jun 2005]. <http://www.libraryjournal.com/article/CA435175.html?display=searchResults&text=ante>.
37. Albanese A. Blackwell offers open access plan. LibraryJournal.com [serial online]. 2005 Apr 1. [cited 23 Jun 2005]. <http://www.libraryjournal.com/index.asp?layout=articlePrint&articleid=CA512200>.
38. Macmillan Publishers. News: Embo and NPG announce a new online publication: molecular systems biology. [Web document]. Basingstoke Hampshire, England, UK: Nature Publishing Group, 7 Sep 2004. [cited 23 Jun 2005]. <http://www.macmillan.com/07092004emboandnpg.asp>.
39. World Summit on the Information Society. Plan of action. [Web document]. Geneva, Switzerland: World Summit on the Information Society, 12 Dec 2003. [cited 29 Dec 2004]. <http://www.itu.int/wsis/docs/geneva/official/poa.html>.
40. Medical Library Association. MLA statement on open access. [Web document]. Chicago, IL: The Association, 2003. [cited 29 Dec 2004]. <http://www.mlanet.org/government/info_access/openaccess_statement.html>.
41. International Federation of Library Associations and Institutions. IFLA statement on open access to schol-

arly literature and research documentation. [Web document]. The Hague, Netherlands: The Association, 2004. [cited 29 Dec 2004]. <http://www.ifla.org/V/cdoc/open-access04.html>.
42. DC PRINCIPLES COALITION. Washington DC principles for free access to science. [Web document]. Washington, DC: The Coalition, 2004. [cited 29 Dec 2004]. <http://www.dcprinciples.org>.
43. BIOMED CENTRAL. Press release: Spain embraces open access with BioMed Central membership. [Web document]. London, UK: BioMed Central, 3 Jun 2005. [cited 20 Jun 2005]. <http://www.biomedcentral.com/info/about/pr-releases?pr=20050603>.
44. WELLCOME TRUST. Wellcome Trust position statement in support of open and unrestricted access to published research. [Web document]. The Trust, Sep 2005. [cited 5 Oct 2005]. <http://www.wellcome.ac.uk/doc_WTD002766.html>.
45. SUBER P. The Wellcome Trust OA mandate takes effect. SPARC Open Access Newsl [serial online]. 2005 Oct 2(90). [cited 5 Oct 2005]. <http://www.earlham.edu/~peters/fos/newsletter/10-02-05.htm#wellcome>.
46. HARNAD S. Daser 2 IR meeting and NIH public access policy. [Web document]. 5 Dec 2005. [cited 16 Jan 2006]. <http://openaccess.eprints.org/index.php?/archives/50-DASER-2-IR-Meeting-and-NIH-Public-Access-Policy.html>.
47. SUBER P. First fruits of the NIH public-access policy. SPARC Open Access Newsl [serial online]. 2005 Aug 2(88). [cited 5 Oct 2005]. <http://www.earlham.edu/~peters/fos/newsletter/08-02-05.htm>.
48. SUBER P. The U.S. Cures Act would mandate OA. SPARC Open Access Newsl [serial online]. 2006 Jan 3(93). [cited 16 Jan 2006]. <http://www.earlham.edu/~peters/fos/newsletter/01-02-06.htm>.
49. DRYBURGH A. Personal view: open access—time to stop preaching to the converted? Learned Publishing 2004;17(1): 69–70. (Available from: <http://www.alastairdryburgh.co.uk/pdfs/stoppr.pdf>. [cited 19 Apr 2006].)
50. FRANK M, REICH M, RA'ANAN A. A not-for-profit publisher's perspective on open access. Ser Rev 2004; 30(4):281–7. (Available from: <http://www.sciencedirect.com/science/article/B6W63-4DS8FN9-6/2/9d29fb5a9114eb25519944936211b4cf>. [cited 19 Apr 2006].)
51. ASSOCIATION OF AMERICAN PUBLISHERS, PROFESSIONAL SCHOLARLY PUBLISHING DIVISION. NIH open access—grassroots memo. [Web document]. The Association, 2004. [cited 5 Jan 2005]. <http://www.pspcentral.org/publications/grassroots_email.doc>.
52. COCKERILL M, ENDERBY J. Internet upstarts v traditional publishers. Financ times. [serial online]. London, UK: The Financial Times, 25 Nov 2004. [cited 3 Dec 2004]. <http://news.ft.com/cms/s/1ea23b3e-3f15-11d9-8e70-00000e2511c8,ft_acl=,s01=1.html>. subscription required.
53. ROWLANDS I, NICHOLAS D, HUNTINGDON P. Scholarly communication in the digital environment: what do authors want? [Web document]. London, UK: Centre for Information Behavior and the Evaluation of Research, Department of Information Science, City University, 18 Mar 2004. [cited 3 Jan 2005]. <http://ciber.soi.city.ac.uk/ciber-pa-report.pdf>.
54. REGAZZI J. The shifting sands of open access publishing, a publisher's view. Ser Rev 2004;30(4):275–80. (Available from: <http://www.sciencedirect.com/science/article/B6W63-4DS8FN9-C/2/7b52ea79ef5f462b692c11b969ef68de>. [cited 19 Apr 2006].)
55. CRAWFORD BD. Open-access publishing: where is the value? Lancet 2003 Nov 8;362(9395):1578–80. (Available from: <http://www.sciencedirect.com/science/article/B6T1B-49YDP9W-10/2/503b2a46162097b5843a76da8b85a458>. [cited 19 Apr 2006].)
56. KATIKIREDDI SV. HINARI: bridging the global information divide. Br Med J 2004 May 15;328(7449):1190–3. (Available from: <http://bmj.bmjjournals.com/cgi/content/full/328/7449/1190>. [cited 19 Apr 2006].)
57. WYSOCKI B, JR.Medical publishers propose data sharing. Wall Street J 2004 Dec 8;244(112):D6. (Available from: <http://online.wsj.com/article_print/0,SB110245962444893713,00.html>. subscription required. [cited 19 Apr 2006].)
58. patientINFORM. Voluntary health organizations, publishers announce major information initiative. [Web document]. patientINFORM.com, 8 Dec 2004. [cited 19 Apr 2006]. <http://www.patientinform.org/press-releases/2004/12/8/voluntary-health-organizations-publishers-announce-major-information-initiative-december-8-2004.html>.
59. GUTERMAN L. Research & publishing—the promise and peril of ''open access.'' Chron High Educ 2004 Jan 30;50(21): A10. (Available from: <http://chronicle.com/free/v50/i21/21a01001.htm>. [cited 19 Apr 2006].)
60. MORRIS S. Open access: how are publishers reacting? Ser Rev 2004;30(4):304–7. (Available from: <http://www.sciencedirect.com/science/article/B6W63-4DS8FN9-7/2/63dd0991b8496ff428d6a97b934c22f7>. [cited 19 Apr 2006].)
61. AMERICAN ACADEMY OF PEDIATRICS. AAP studies pros, cons of NIH-proposed ''open archive'' to research. AAP News 2004;25(5):269–71. (Available from: <http://aapnews.aappublications.org/cgi/content/full/25/5/269>. [cited 19 Apr 2006].)
62. HIGHWIRE PRESS. Free ejournal archive passes the 3/4 million mark. [Web document]. Stanford: Stanford University, HighWire Press, 29 Nov 2004. [cited 5 Jan 2005]. <http://highwire.stanford.edu/inthepress/stories/FBI780K.dtl>.
63. DC PRINCIPLES COALITION. Not-for-profit scientific publishers' proposal for improving compliance and achieving NIH goals—letter. [Web document]. 17 Oct 2005. [cited 16 Jan 2006]. <http://www.dcprinciples.org/linkingproposal.pdf>.
64. THE ROYAL SOCIETY. Royal society position statement on ''open access.'' [Web document]. 2005. [cited 16 Jan 2006]. <http://www.royalsoc.ac.uk/page.asp?id=3882>.
65. MACLEOD D. Royal society attacked for ''negative'' open access stance. Guardian Unlimited. [serial online]. 2005 Dec 7. [cited 30 Dec 2005]. <http://education.guardian.co.uk/print/0,3858,5350515-108233,00.html>.
66. QUINT B. NIH requires open access for its funded medical research. Newsbreaks & Wkly News Dig [serial online]. Medford, NJ: Info Today, 13 Sep 2004. [cited 3 Nov 2004]. <http://www.infotoday.com/newsbreaks/nb040913-1.shtml>.
67. KAISER J. Scholarly publishing. NIH flooded with comments on public access proposal. Science 2004 Nov 26; 306(5701):1451. (Available from: <http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=15567819>. [cited 19 Apr 2006].)
68. AMERICAN LIBRARY ASSOCIATION. Open access to research. [Web document]. Washington, DC: The Association, 12 Nov 2004. [cited 7 Jan 2005]. <http://www.ala.org/ala/washoff/WOissues/copyrightb/openaccesstoresearch/accessresearch.htm>.
69. ANDERSON R. Author disincentives and open access. Ser Rev 2004;30(4):288–91. (Available from: <http://www.sciencedirect.com/science/article/B6W63-4DS8FN9-4/2/04aa18c8edd5e5e7ca8d15e7e5559e08>. [cited 19 Apr 2006].)
70. STERN D. Open access or differential pricing for journals: the road best traveled? Online 2005 Mar/Apr;29(2):31–5.

(Available from: <http://www.infotoday.com/online/mar05/Stern.shtml>. [cited 19 Apr 2006].)
71. DAVIS P, EHLING T, HABICHT O, HOW S, SAYLOR JM, WALKER K. Report of the Cornell University Library task force on open access publishing. [Web document]. Ithaca, NY: Cornell University, Task Force on Open Access Publishing, 9 Aug 2004. [cited 23 Jun 2005]. <http://dspace.library.cornell.edu/bitstream/1813/193/3/OATF_Report_8-9.pdf>.
72. POYNDER R. No gain without pain. Info Today 2004 Nov; 21(10):1,50–2. (Available from: <http://www.infotoday.com/it/nov04/poynder.shtml>. [cited 19 Apr 2006].)
73. SWAN A, BROWN S. Open access self-archiving: an author study. [Web document]. Truro, UK: JISC Committee for the Information Environment; Open Access Institute; Key Perspectives, May 2005. [cited 12 Jun 2005]. <http://www.jisc.ac.uk/uploaded_documents/Open%20Access%20Self%20Archiving-an%20author%20study.pdf>.
74. EPRINTS.ORG. Registry of open access repository material archiving policies. [Web document]. Southampton, UK: University of Southampton, 2002–2004. [cited 7 May 2005]. <http://www.eprints.org/signup/fulllist.php>.
75. PACKARD A. Copyright or copy wrong: an analysis of university claims to faculty work. Commun Law Policy 2002 Summer;7:275–316.
76. CRAWFORD W. Library access to scholarship. Cites & Insights 2005 Mar;5(4):1–4. (Available from: <http://cites.boisestate.edu/civ5i4.pdf>. [cited 19 Apr 2006].)
77. GASAWAY LN. Drafting a faculty copyright ownership policy. Technology Source [serial online]. Michigan Virtual University, Mar/Apr 2002. [cited 13 Mar 2005]. <http://technologysource.org/article/drafting_a_faculty_copyright_ownership_policy>.
78. ZANDONELLA C. Economics of open access. Scientist-Dly News [serial online]. 2003 Aug 22. [cited 19 Jun 2005]. <http://www.biomedcentral.com/news/20030822/02/>.
79. MAYOR S. Research councils' requirements could bankrupt academic journals. Br Med J 2005 Apr 23;330(7497):923. (Available from: <http://bmj.bmjjournals.com/cgi/content/full/330/7497/923-a>. subscription required. [cited 19 Apr 2006].)
80. GUEDON JC. The ''green'' and ''gold'' roads to open access: the case for mixing and matching. Ser Rev 2004; 30(4):315–28. (Available from: <http://www.sciencedirect.com/science/article/B6W63-4DS9WC0-2/2/3030f75c26987f4e18212f39fd7b0263>. [cited 19 Apr 2006].)
81. SUBER P. Open access in 2004. SPARC Open Access Newsl [serial online]. 2005 Jan 2;(81). [cited 19 Jun 2005]. <http://www.earlham.edu/~peters/fos/newsletter/01-02-05.htm>. [cited 19 Apr 2006].
82. BIOMED CENTRAL. BioMed Central membership. [Web document]. 2005. [cited 6 Oct 2005]. <http://www.biomedcentral.com/info/libraries/membership>.
83. GEDYE R. Open access is only part of the story. Ser Rev 2004;30(4):271–4. (Available from: <http://www.sciencedirect.com/science/article/B6W63-4DS8FN9-3/2/b85cd44a022b41a6f9870304662b0b95>.[cited 19 Apr 2006].)

Received August 2005; accepted February 2006