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## SCIENTIFIC COMMUNICATION

# Scholarly Publishing in the Wake of COVID-19

Robert C. Miller, MD, MBA, FASTRO, FRSA,\* and C. Jillian Tsai, MD, PhD<sup>†</sup>



\**Department of Radiation Oncology, University of Maryland School of Medicine, Baltimore, Maryland; and* <sup>†</sup>*Department of Radiation Oncology, Memorial Sloan Kettering Cancer Center, New York City, New York*

Received Jun 21, 2020. Accepted for publication Jun 22, 2020.

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The speed at which the COVID-19 pandemic spread across the globe and the accompanying need to rapidly disseminate knowledge have highlighted the inadequacies of the traditional research/publication cycle, particularly the slowness and the fragmentary access globally to manuscripts and their findings. Scholarly communication has slowly been undergoing transformational changes since the introduction of the Internet in the 1990s. The pandemic response has created an urgency that has accelerated these trends in some areas. The magnitude of the global emergency has strongly bolstered calls to make the entire research and publishing lifecycle transparent and open. The global scientific community has collaborated in rapid, open, and transparent means that are unprecedented. The general public has been reminded of the importance of science, and trusted communication of scientific findings, in everyday life. In addition to COVID-19–driven innovation in scholarly communication, alternative bibliometrics and artificial intelligence tools will further transform academic publishing in the near future. © 2020 Elsevier Inc. All rights reserved.

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## Introduction

Scholarly publishing in the second decade of the 21st century, despite the rise of the Internet, electronic publishing, and a host of novel applications across the research-publishing cycle, remains at its core largely indistinguishable from scholarly publishing 70 years ago. Investigators present their findings in a single, narrative manuscript that is evaluated by editors and anonymous peer reviewers before being formally entered into the literature and indexing systems.

Despite expectations that the ubiquitous adoption of the Internet would end traditional journal publishing, scholarly publishing continues to resist transformation. The 1970s saw the introduction of analog cataloging of journal articles, followed by the creation of digital objects and online journals in the 1990s, and then the integration of social

networks and novel methods of research assessment such as altmetrics in the 2000s.<sup>1</sup> These have added value and expanded ease and access to research knowledge, but the underlying infrastructure and workflows supporting scholarly communication and ownership of that knowledge have remained stable.

Criticisms are numerous of this stagnation. Academic publishing is slow, with articles taking weeks to months or longer to complete peer review, and they are expensive, with university library budgets increasingly devoted to package deals with large commercial publishers. Peer review is often arbitrary. Research findings are primarily shared in the medical realm in the form of PDFs, electronic documents that replicate a static paper page containing a written narrative, making aggregation of metadata difficult. Despite increasing adoption of open access, much of the highest-quality scientific literature remains off-access to

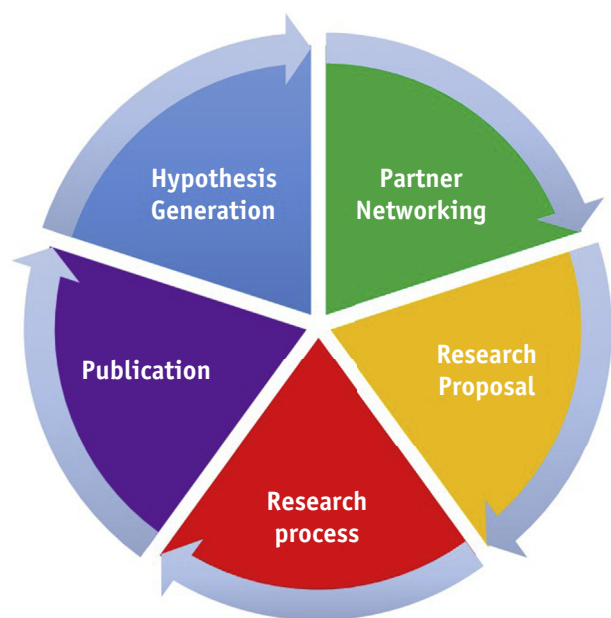
Corresponding author: Robert C. Miller, MD, MBA, FASTRO, FRSA; E-mail: [RobertMiller@umm.edu](mailto:RobertMiller@umm.edu)

Disclosures: Dr Miller reports personal fees from ASTRO, outside the submitted work.

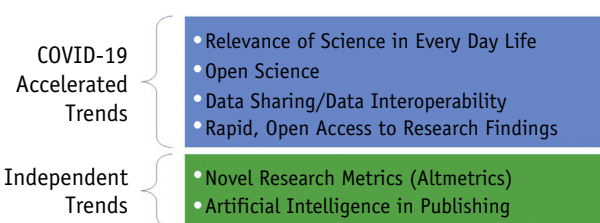
those without sufficient resources. Free sharing of data remains the exception rather than the norm.<sup>2,3</sup>

J.A. Schumpeter, an early theorist in entrepreneurship and innovation, famously wrote of the cyclical appearance of “gales of creative destruction” that transformed industries and economies: “[What matters is] competition from the new commodity, the new technology, the new source of supply, the new type of organization ... competition which ... strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives.”<sup>4</sup> Technological and social changes were already driving change in scholarly communication before COVID-19, but the pandemic created conditions to accelerate the transformation of academic publishing and research. The speed at which the COVID-19 pandemic spread across the globe and the accompanying need to rapidly disseminate knowledge have highlighted the inadequacies of the traditional research/publication cycle, particularly the slowness and the fragmentary access globally to manuscripts and their findings. Figure 1 illustrates the research/publishing lifecycle, starting with hypothesis generation and ending with publication before starting the cycle over. The COVID-19 pandemic has forced a re-evaluation of the tools and methodology used to support this cycle and raised questions about the value of the traditional methods of scholarly communication. Most pressing, the pandemic has forced a reconsideration of the speed at which the cycle processes research output.

The relatively gradual transformation of the scholarly communication model has not caught up with rapid technological advances in information technology over the last 20 years. The COVID-19 pandemic has only accelerated some of these changes in an unexpected way. Figure 2



**Fig. 1.** The research/publishing life cycle. (Adapted from Tenopir et al.<sup>23</sup>)



**Fig. 2.** The impact of COVID-19 on scholarly publishing.

summarizes these trends. The response to the COVID-19 pandemic has led to widespread demand for open scientific collaboration and open access to the scientific manuscripts. In particular, the pandemic has led to a greater awareness of the relevance of science in everyday life for everyone’s safety and security.

## Publishing and the COVID-19 Pandemic

The COVID-19 pandemic generated an unprecedented surge in scholarly output that strained the publishing system. The American Society for Radiation Oncology’s (ASTRO) *Advances in Radiation Oncology* received a normal year’s worth of submissions within less than a 3-month period. Anticipating demand for knowledge of best practices in radiation oncology as the pandemic unfolded in China and Europe, we initially solicited manuscripts from authors practicing in the virus’s early hotspots: Wuhan, Shanghai, Northern Italy, Seattle, and New York City in the first weeks of March.<sup>5</sup>

Recognizing the importance of swift dissemination of knowledge during a fast-expanding pandemic, the 3 ASTRO journals—*International Journal of Radiation Oncology • Biology • Physics*; *Practical Radiation Oncology*; and *Advances in Radiation Oncology*—began expediting their decision cycles for publishing scholarly articles, accelerating the traditional processes that proved to be too slow to meet the demands for updated knowledge as the crisis evolved. On March 14, the Red Journal published its first COVID-19 rapid communications, 3 days after the World Health Organization declaration of the pandemic. From March 14 to March 31, 17 manuscripts from international radiation oncology communities were accepted for publication in the 3 journals. There were 39 additional accepted manuscripts from April to May. The majority of these were published in *Advances in Radiation Oncology*, where a small subset of our editorial team, working at times late into the evenings of late March and early April, provided initial review within 24 hours of receipt. Traditional print academic journals operate with yearly page limit budgets not designed to take in large quantities of manuscripts in a short period of time. As an online journal, *Advances in Radiation Oncology* is completely scalable without page limits and provided a platform to rapidly publish COVID-19–related papers without compromising or limiting the publication of non–COVID-19–related research.

The first submissions focused on single-institutional experiences and opinions from regions most affected by COVID-19, partly because it was initially unclear how widespread and long-lasting the pandemic would eventually become. As countries worldwide became more uniformly affected by COVID-19, we began to see multi-institutional collaborations detailing changing treatment indications and fractionation concerns with joint ASTRO/European Society for Radiotherapy and Oncology guidelines. More recent submissions also began to have emerging data on using radiation simulation information to detect COVID-19 infection as well as exploratory analysis of risk factors associated with COVID-19 patients receiving radiation therapy.<sup>6-9</sup>

Before COVID-19, China had recently overtaken the United States as the greatest producer of research manuscripts, producing 19% of the world's output. COVID-19 focused the world's attention on Chinese research in the early weeks of the pandemic. Chinese spending in research will likely surpass that of the United States before the end of the decade. Chinese participation in global scholarly communication forums will continue to grow post-COVID-19.<sup>10</sup> At ASTRO's *Advances in Radiation Oncology*, with a single click readers can now share the article they are reading directly to the Chinese social media site Sina Weibo (Fig. 3).

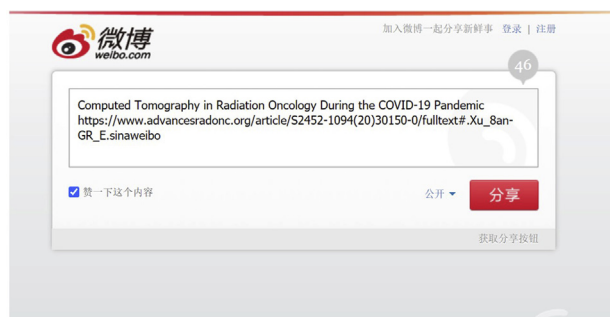
The long-term impact of COVID-19 and accompanying curtailment of research activities on university campuses is unclear. Some have noted a trend of female authors being disproportionately underrepresented during the COVID-19 crisis, citing trends in authorship in preprints.<sup>11</sup> COVID-19 has increased the call for greater openness and transparency surrounding research and publishing, and the shift to remote and online work may exacerbate underlying disparities between high-privilege and low-privilege segments of society in gaining access to digital content.<sup>12</sup> The economic impact of COVID-19 may affect the scholarly landscape, with declining enrollment leading to curtailment of library budgets and journal access. Small society publishers may not survive the economic downturn, further concentrating market share in the large corporate publishers.<sup>13</sup>

## Open Science/Open Access After COVID-19

The biggest shift in the publishing landscape and one that may have lasting impact has been the publishers' efforts to make COVID-19 information rapidly available and free of charge. The majority of *Advances in Radiation Oncology* articles published had the publication fees waived. Calls for a transition to open science and the move from print, always delayed by weeks to months from completion of a manuscript, to electronic-only publishing have increased.<sup>13,14</sup> Preprint publishing of manuscripts online have had their profile significantly raised during the pandemic. Preprint servers have allowed for immediate global access to emerging scientific data. It is potentially disruptive technology in scholarly publishing, arising as a low-cost, low-complexity alternative to traditional publishing that offers products that the proponents of preprints find irrelevant and only add cost.<sup>15</sup> Preprints offer an immediate solution to advance open science, but no clear mechanism exists to limit in a comprehensive fashion the presentation of inaccurate information or prevent appropriation of the works of others without attribution. Crowdsourcing of reviews allows for high-profile papers to be rapidly discredited if such is warranted, but crowdsourcing cannot ensure systematic review of the vast majority of preprints. Peer review, with all of its flaws, remains a vital tool that limits academic misconduct, although even the most prestigious journals have seen lapses in their editorial review processes in the last 2 months.<sup>16</sup> As noted previously, the COVID-19 pandemic has increased trust in science in broad segments of the general population.<sup>12</sup> Peer review, with its transparent process but confidential review, remains a central tenet of ensuring that published findings continue to be trusted and have been vetted for accuracy and thoroughness of attribution.<sup>17</sup>

## Data Sharing

The magnitude of the global emergency has strongly bolstered calls to make the entire research and publishing lifecycle transparent and open—"An open exchange of ideas accelerates scientific progress towards solving humanity's most persistent problems."<sup>18</sup> One significant positive impact of the pandemic was the immediate move to do away with journal paywalls for COVID-19-related manuscripts. *Advances in Radiation Oncology*, as a completely open-access journal, was part of this movement. Novel research collaborations, such as the World Health Organization's Solidarity trials for vaccines and treatment, have arisen globally with unprecedented speed in the effort to find new means to diagnose and treat COVID-19.<sup>13</sup> In industry, many companies have participated in the Open COVID Pledge, agreeing "to make our intellectual property available free of charge for use in ending the COVID-19 pandemic and minimizing the impact of the disease."<sup>19</sup>



**Fig. 3.** Posting an *Advances in Radiation Oncology* paper on Sina Weibo.

After the pandemic is over, the arguments for greater collaboration and openness will remain valid.

## Non—COVID-19—Driven Changes in Publishing

Technological change will continue to alter the nature of scholarly communication beyond the impact of the pandemic. There is broad agreement that traditional journal impact factors are a poor measure of the importance of any given research paper. New measures, broadly described as “altmetrics,” will continue to grow in importance. These novel bibliometrics provide measures of an article’s impact using a variety of sources, from citations to downloads to social media focus. In addition to using a richer variety of data compared with the impact factors’ focus on citations only, they can provide an immediate measure of impact rather than a delayed measure of journal citations that can take months to years to accrue. In this regard, altmetrics are providing a measuring tool more fitting for the rapidly accelerating research/publishing cycle than traditional print publishing time frames.<sup>20</sup>

The integration of artificial intelligence (AI) and machine learning has lagged in scholarly publishing compared with commercial use. Researchers, authors, and readers will increasingly have AI assistance available for content curation and interpretation. Editors may have AI guidance in matching manuscript submissions and peer reviewers.<sup>21</sup>

## Conclusions

The urgency of providing an effective response to the COVID-19 pandemic has changed scholarly publishing with unprecedented speed. Attitudes toward openness and collaboration have shifted toward transparency. Data sharing will increasingly be viewed as a necessary part of the research/publishing lifecycle. The ASTRO journal family had taken an initial step toward this before the pandemic in our statement on data sharing calling for “transparency, openness, and reproducibility.”<sup>22</sup>

To remain relevant, academic publishing will need to speed up. Peer review plays a critical role in establishing legitimacy, but it cannot be allowed to continue as before at a leisurely pace. The accelerated platform of communication in scientific journals may also have to be maintained in the long run to allow efficient exchange of knowledge beyond the current pandemic.

Preprints will grow in popularity. A mechanism to integrate them fully into the research/publishing lifecycle is critical to fully exploit their added value in scholarly publishing.

Much of the knowledge transfer between continents early in the pandemic was relationship-driven, between individuals at first and then through cooperation between ASTRO and European Society for Radiotherapy and Oncology in producing COVID-19—specific treatment guidelines. Looking forward, a structured emergency

framework needs to be in place among international radiation oncology professional societies to streamline knowledge transfer for future crises. Individual relationships between physicians and scientists around the world that transcend borders, nationality, and cultures should also be encouraged and strengthened. Finally, although rapid communication can be advantageous and often originate from prestigious institutions, we should ensure that the voices of those with fewer resources in the radiation oncology community are also heard.

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