Declarations of interest

CSW is a minor shareholder in SaferSleep LLC, a company that manufactures an anaesthesia record system. JMW is a member of the editorial board of the *British Journal of Anaesthesia*.

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Preprints in perioperative medicine: immediacy for the greater good

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Medical and scientific journals spread developing knowledge by facilitating communication between physicians and scientists. Authors, readers, and the public rightfully expect rapid publication of rigorously reviewed high-quality papers. The COVID-19 pandemic has highlighted the importance of rapid dissemination and has put unprecedented demands on journals. There is genuine urgency to complete medical research and place the findings expeditiously into the public domain after expert peer review so that new findings can be used to improve patient care as soon as possible. The process of peer review is often a slow process, but is essential to ensure that changes in patient care are informed by careful and definitive research. Thus, journal editors must balance the potentially competing goals of immediacy and quality control.

One of the ways publishing is evolving to bridge this gap involves the use of preprint servers that put research in the public domain while the data are scrutinised by experts before publication in their final form. The COVID-19 pandemic has revealed both the value and limitations of innovative forms of scientific communication, including preprints.[1] The immediate sharing of research results has led to rapid progress in therapies and vaccine development. However, the absence of peer review has also led to a number of preprints being taken down following concerns raised by the research community.[2] The *British Journal of Anaesthesia* embraces the unprecedented opportunities for rapid dissemination of new discoveries afforded by electronic preprints, provided we follow best practices, as outlined below.

Benefits of preprints

Preprints, or online publication of scientific reports before peer review, facilitate rapid dissemination of research and feedback from the research community while establishing priority of discoveries. Poignant examples of the critical role of such novel means of scientific communication in the COVID-19 pandemic include the initial dissemination of the SARS-CoV-2 genome sequence in a Tweet from Eddie Holmes (https://twitter.com/edwardcholmes/status/1255682137845456897) with a link to a web discussion forum (virological.org), and the early dissemination of the results from the Randomised Evaluation of COVID-19 Therapy (RECOVERY) trial in medrXiv.[3] This is a relatively new medium for communication in the medical and biomedical sciences, but is common to other academic disciplines that have leveraged this approach to facilitate rapid dissemination of research findings, gain feedback from colleagues in the research community, and establish priority of discoveries. Physical scientists led the way with one of the first preprint hosting and distribution servers, known as arXiv (arXiv.org), in 1991. The biological sciences followed suit in 2013 with the launch of bioRxiv (bioRxiv.org), which is supported by the Cold Spring Harbor Laboratory, the Lourie Foundation, and latterly the Chan Zuckerberg Initiative. In 2019, medRxiv (medRxiv.org) followed, also supported by the Cold Spring Harbor Laboratory along with the *British Medical Journal* and Yale University as partners.

Both the bioRxiv and medRxiv preprint servers focus on original data; they do not publish narrative reviews and hypotheses, case reports, editorials, commentaries, opinions, protocols, or correspondence articles that lack original data. Despite the absence of peer review, these preprint servers have rigorous quality controls, including requirements for ethics approvals, consents, and appropriate institutional archiving. Authors must submit the appropriate research reporting checklists defined by the EQUATOR network as supplementary files.[4] Clinical trials must be registered with an internationally recognised trial registry with the trial ID included. Authors must also include a competing interest statement using the International Committee of Medical Journal Editors disclosure form, including disclosure of whether the authors or their institutions received payments or services in the past 36 months from a third party that could be perceived to influence the submitted work. Many researchers in the life sciences advocate the use of preprints to facilitate professional networking and rapid feedback. Given the rigour and efficacy of preprint servers, it is perhaps surprising they have generated so much controversy in medicine compared with the sciences.

The future of academic publishing?

Major grant awarding bodies in both the UK and USA now embrace access to detailed research through preprints. Reviewers and readers often value the opportunity to access data in more detail than word-limited funding applications permit. For competitive areas of investigation, preprints may reduce 'scooping' (earlier publication by a competitor), particularly when competitive journals often take months to review and publish papers. Free open access of preprints raises immediate public awareness of health and medical research, including in developing nations where researchers struggle to gain institutional funds to publish, read, and subscribe to many scientific journals. The potential for preprints to dovetail with other forms of social media has also generated an exciting and stimulating research culture in many areas.

The requirements for preprint deposition are the same as for peer-reviewed journals. An increasing number of high-impact journals, led by *eLife*, now ask authors to deposit their manuscripts in a preprint server, such as bioRxiv or medRxiv, upon submission to make their results freely and widely available before review.[5] This 'publish, then review' model, enabled by the internet and preprinting, is intended to replace the legacy 'review, then publish' model of the paper journal era.[6] In this model, *eLife* will eventually only review and publish papers already posted on a preprint server, and will eventually make peer review reports publicly available, even for rejected papers, combining the benefits of preprints and open peer review. A number of other journals facilitate posting of manuscripts on preprint servers during the submission process, and allow submission of manuscripts by direct transfer from servers such as bioRxiv and medRxiv (e.g. the PLoS family journals).

Downsides of preprints?

Nevertheless, abuses of the process of disseminating scientific learning occur, in both preprint and conventional publications, driven by politicians, the media, and sadly by scientists themselves. Too many have seen the pandemic as an opportunity to advance their own careers or public profile, even in the midst of a crisis.[7] The retraction of numerous articles relating to COVID-19 that originally appeared as preprints (14 of 39 articles listed) highlights this risk.[2,8] Scientific journals play a key role in policing these abuses, but are under similar pressures to publish research findings quickly. Notably, these corrections of the literature occur in a matter of days compared with the usual months to years taken for traditional publication, as the scientific community scrutinises and critiques the data, reducing the negative impact of problematic reports.[8] Journals are of course conflicted by the ambition to be the first to publish the most important research with the greatest impact. Because of this risk, a few journals and publishers have taken the position not to publish scientific papers that have already been placed in the public domain in the form of a preprint.[9] Most journals do not consider preprints as prior publication; however, a few do, including the journal *Anesthesiology*.[10] A recent study reported that 86% of the 100 top-ranked clinical journals based on journal impact factor (median 12.9) will publish research that has already been released as a preprint.[11] Although a strict prohibitive policy will prevent many of the problems associated with preprints, it simultaneously leaves unresolved the fundamental challenges of immediacy and early public access to research

findings so essential to catalysing translation of research to improvements in care.

The path forward

Best scientific practice is steadily moving towards ever greater expediency, openness, and transparency. It is now common to publish study protocols and statistical analysis plans online, even in peer-reviewed journals. When it comes to publication of original research, there is a range of guidelines to promote the full and objective reporting of all the information necessary to appraise the work and adopt the findings.[6] It seems inevitable that preprints will likewise become an established tool in delivering open science, whilst not eliminating the requirements for patient protection, including prior trial registration and informed consent.

Preprint publication does not abrogate the critical role of peer review in the publication process. Peer review will continue in its important quality control function by providing an opportunity for revisions and editing to improve manuscripts that meet criteria for acceptance (only ~20% of submitted manuscripts in selective journals). Preprint servers are addressing these concerns on their websites: medRxiv states that 'Preprints are preliminary reports of work that have not been certified by peer review. They should not be relied on to guide clinical practice or health-related behaviour and should not be reported in news media as established information'.[12] Where preprints are cited in peer-reviewed journal publications, they must be clearly indicated as such and remain under press embargo until published in a journal. Preprints are but another step for studies on the way to publication in a journal following peer review, a step that puts the methods and findings in the public view with a goal towards analysis and revision before final publication. We cautiously accept the role preprints will play in medical science, but we strongly emphasise the onus that this practice places on researchers to ensure the integrity of their work without the watchful protection afforded by advice from editors and peer reviewers.

If some journals decline to publish scientific reports that have already been released as preprints, but others do not, authors will be left with difficult choices in how best to publish their work. Elsevier, publisher of *The Lancet*, *Cell*, and other leading journals (including the *British Journal of Anaesthesia*), has taken a different position in permitting the use of preprints, but with guidance on best practices to avoid misleading journal readers (see Box 1). The *British Journal of Anaesthesia*, one of two anaesthesia journals in the top 5% of all journals, has embraced the position of our publisher Elsevier, in keeping with the benefits afforded by preprints. This is now indicated in our updated *Instructions to authors*.[13] We recognise the role that free, public, independent, not-for-profit preprint servers play in the prompt dissemination of important research, while the sometimes lengthy peer review and publication process proceeds.[1] However, this approach places significant responsibilities on the authors who choose to publish preprints of original research submitted to our journal. The *British Journal of Anaesthesia* will consider publication of high-quality original research that is already available in preprint form, but we expect the use of preprints to be indicated and justified, and best practice to be carefully followed. We recognise and support the openness and transparency provided by preprints, including avoidance of duplicated efforts and the immediacy of rapidly posted preprints communicating important findings.

Box 1 Summary of Elsevier guidance on preprints.

- Authors can share their preprint anywhere at any time.
- If accepted for publication, authors should link from the preprint to their formal publication *via* its digital object identifier (DOI). Millions of researchers have access to the formal publications on ScienceDirect, and so links will allow users to find, access, cite, and use the best available version.
- Authors should update their preprints on bioRxiv, medRxiv, or RePEc with their accepted manuscript.
- Preprints should not be added to or enhanced in any way to appear more like, or to substitute for, the final versions of published articles.

Authors' contributions

All authors contributed to the concept, writing, and editing of this editorial, and are solely responsible for its content.

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