The Economist

Research publishing

Taking the online medicine

Old-fashioned ways of reporting new discoveries are holding back medical research. Some scientists are pushing for change

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"NEVER tried sharing data like this before," said the tweet. "Feels like walking into a country for the first time. Exciting, but don't know what to expect."

David O'Connor of the University of Wisconsin-Madison was announcing his decision on February 14th to post online data from his laboratory's latest experiment. He and his team had infected macaques with the Zika virus and were recording the concentrations of virus in the monkeys' bodily fluids every day. Researchers know that Zika is transmitted principally by infected mosquitoes. But if the virus appears in saliva and urine then these might also be sources of infection.

Dr O'Connor and his colleagues published their results every day to a publicly accessible website. They hoped this would be useful to others working on the disease and, ultimately, to health authorities striving to contain it. They did not expect to garner much attention. But they did.

Within days, researchers from all over the world started contacting them, making suggestions and asking for samples to conduct work that Dr O'Connor's lab was ill-equipped to carry out. He describes the experience of data-sharing as "universally positive". But as his tweet suggests, such openness is far from routine.

Careers in medical research hang on publishing papers in prestigious journals such as *Nature*, *Science* and *Cell*. Even in emergencies such as the recent Zika outbreak, or the earlier epidemic

of Ebola fever in west Africa, biologists are reluctant to share data until their work is published.

Once a paper is submitted to a journal, though, its findings can languish unseen for months as it goes through a vetting process known as peer review. Reviewers can ask for substantial changes, further experiments and also suggest the journal reject the paper outright. If several journals turn down a paper before it is published, it may be years before the results become public.

Left in the dark in this way, other practitioners may waste time and money conducting unnecessary experiments. In cases where the unpublished work might warn of things like unsafe treatments, the cost of the delay could be measured in lives. Dr O'Connor's response is part of a reaction against this delay.

Peerless publishing

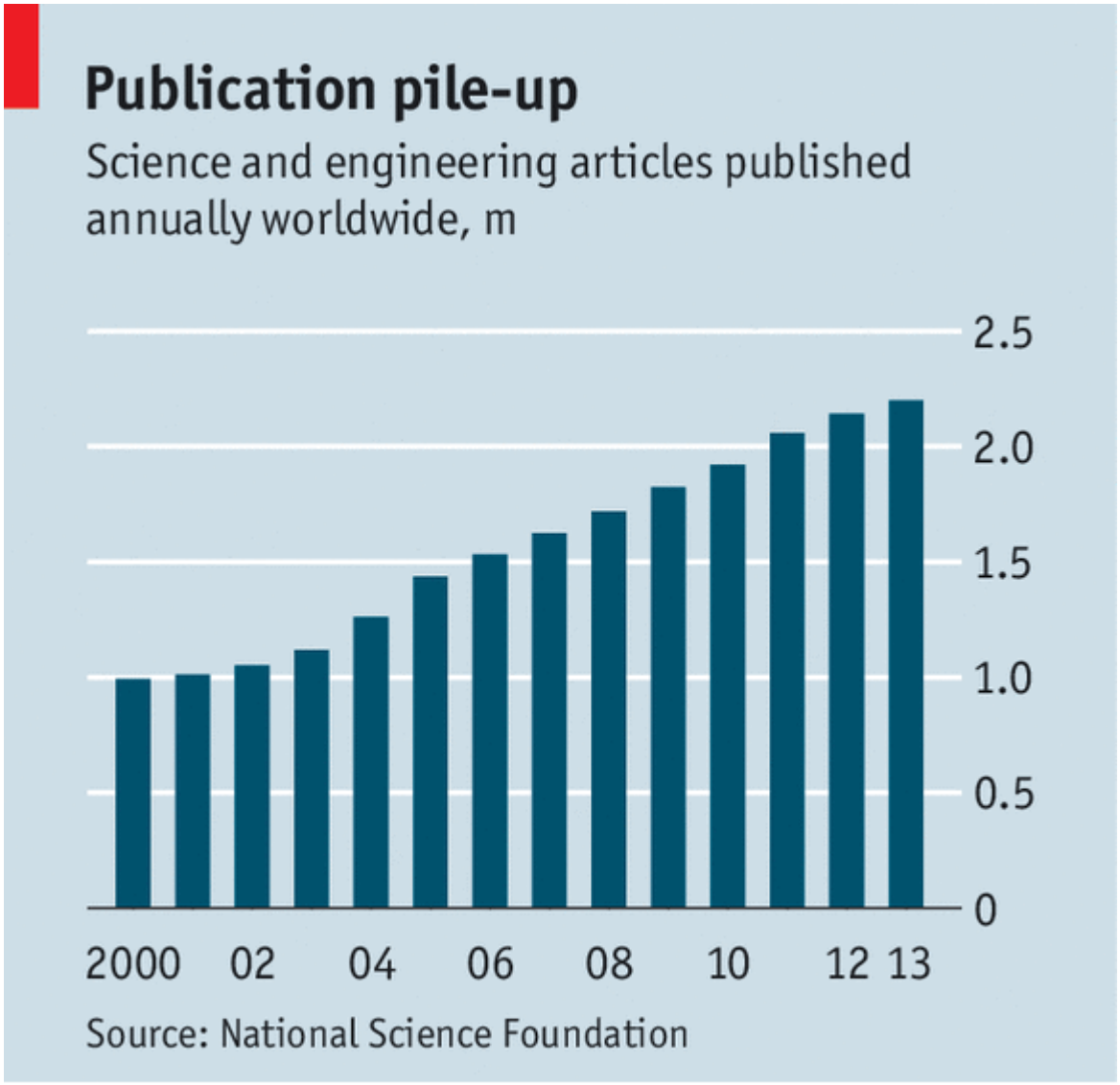
He is not alone. On February 10th, prompted by concerns that vital data on the Zika epidemic could be held up by journal peer review, scientific academies, research funders and a number of academic publishers urged researchers "to make any information available that might have value in combating the crisis". The publishers promised that posting a paper online as a so-called preprint would not disqualify it from publication in a journal later.

But not all publishers signed up to the agreement, and it raises many questions. As Stephen Curry of Imperial College London noted in a blog post for the *Guardian*, a British daily newspaper, if the approach is valid for Zika, then why not for other infectious diseases, including malaria or HIV/AIDS, which kill millions every year?

The problem is not new. But an increase in spending on biomedical research has led to a surge in scientific publication. The number of research articles published each year has doubled since 2003 (see chart), with the biomedical sciences accounting for about 40% of the total.

That has tightened the bottleneck at elite journals, which publish no more papers than they did 30 years ago and demand that more research be crammed into each submission. As Ronald Vale of the University of California, San Francisco, noted last year in *Proceedings of the National Academy of Sciences*, an average biology paper in 2014 required two to fourfold more data than a paper published 30 years earlier. Graduate students at his institution now take about a year longer, on average, than they did to publish their first paper.

"The problem is our CV is lagging behind our productivity," says Jessica Polka, a postdoctoral researcher at Harvard. To convince people to embrace preprints, Dr Polka, Dr Vale and other biologists organised ASAPbio, a meeting held on February 15th-16th in Chevy Chase, Maryland. Their aim is to get more biomedical researchers to emulate physics, a field in which a preprint repository has existed since 1991. The arXiv, as this repository is known, now hosts over a million preprints, a large proportion of which have been published eventually by physics



journals.

Yet, although a poll of nearly 400 scientists attending ASAPbio revealed 90% are dissatisfied with the state of publishing in biology, biomedical researchers seem reluctant to follow the example of those in the physical sciences. About 8,000 preprints a month are now uploaded to arXiv. By contrast, bioRxiv, a similar repository for biology founded in November 2013, holds only around 3,000 in total.

Several things prevent biology and medicine from catching up. First, there is the fear of disqualification from publication in an elite journal. While many such journals, including *Nature* and *Science*, do allow work to be published to preprint servers before submission, others do not. *Cell*, for example, considers them on a case-by-case basis, asking authors to contact them before posting online. The *Journal of the American Medical Association*, in general, bars such papers from consideration altogether.

A second worry for researchers who post their research online is that they may be scooped by rivals who could copy their methods and publish the work in a journal first. This concern could be resolved if funders and institutions recognised a preprint as the first report of a discovery, rather than recognising only journal articles. In physics that is already the case.

Thirdly, there is the danger of non-validated, erroneous findings in a preprint misleading researchers. However, this has not proved a significant problem in the physical sciences. Manuscripts submitted to arXiv (and bioRxiv) are checked to ensure that they are not crank science. And, as Paul Ginsparg, who founded arXiv, noted in a talk at ASAPbio, researchers are more careful to check un-peer-reviewed papers before making them public. Furthermore, journal peer review is not infallible: poor science routinely slips through the net.

In any case, there is no reason to prevent a preprint from being reviewed after it is uploaded. One example of this is *Discrete Analysis*, a mathematics journal launched on March 1st by Tim Gowers of the University of Cambridge. This is an "overlay" journal, a sort of stripped-down online publication which provides links to papers in arXiv and sends submitted manuscripts out for peer review at no cost to the author (the administration cost of around $10 per submission is covered by the journal).

Agency of change

Michael Eisen of the University of California, Berkeley, a zealous proponent of open science, argues that the traditional publication model is outmoded. Researchers are far more likely to use keyword searches in Google to find papers relevant to their work than to leaf through printed journals. Preprints, he says, put researchers back in the driving seat: "Instead of being told by journals what papers to review, we review papers useful to us."

There are signs that researchers might be tiring of the grip that the elite journals have on the biomedical sciences. Over 12,000 people have so far signed the San Francisco Declaration on Research Assessment (DORA), which began in 2012 as a commitment for research to be assessed "on its own merits rather than on the basis of the journal in which the research is published". If the science community takes this notion seriously, more researchers might be persuaded of the value of publishing preprints (because journal publications will be less important). A report to the British government on open access to research, published in February by the Department for Business, Innovation and Skills, recommends all universities in the country now sign DORA.

The wide adoption of preprints, however, depends ultimately on paymasters and interview panels moving away from judging the worth of a scientist by the number of publications in elite journals that appear on his CV. While few funding agencies consider preprints to be formally published work, some have at least made tentative moves towards assessing a scientist's research more broadly. Medical research groups in America, Britain and Australia, for example, have

emphasised that scientific work will be judged by its quality, not by the reputation of the journal it is published in. That will certainly be more onerous for committees than counting up the "right" sort of papers. But if more researchers feel comfortable about uploading their work to preprint servers, it will break the stranglehold of elite journals on biomedical science and accelerate discovery. That would save millions of dollars. More importantly, it would save lives.

From the print edition: Science and technology