Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Proliferation of Papers and Preprints During the Coronavirus Disease 2019 Pandemic: Progress or Problems With Peer Review?

Caitlyn Vlasschaert, Joel M. Topf, and Swapnil Hiremath

The coronavirus disease 2019 (COVID-19) pandemic has spread exponentially throughout the world in a short period, aided by our hyperconnected world including global trade and travel. Unlike previous pandemics, the pace of the spread of the virus has been matched by the pace of publications, not just in traditional journals, but also in preprint servers. Not all publication findings are true, and sifting through the firehose of data has been challenging to peer reviewers, editors, as well as to consumers of the literature, that is, scientists, healthcare workers, and the general public. There has been an equally exponential rise in the public discussion on social media. Rather than decry the pace of change, we suggest the nephrology community should embrace it, making deposition of research into preprint servers the default, encouraging prepublication peer review more widely of such preprint studies, and harnessing social media tools to make these actions easier and seamless.

Key Words: Preprints, Peer review, Critical appraisal, Blog posts, Twitter, COVID-19

> "Is there anywhere on earth exempt from these swarms of new books?"
>
> —Erasmus, 1508

The goal of research in medicine consists not just to conduct experiments and clinical studies to expand knowledge, but also to have that knowledge change and improve clinical practice. For research to matter it must go beyond knowledge generation and include knowledge dissemination and translation. The coronavirus disease 2019 (COVID-19) pandemic is a case study for how these ever-changing aspects of medical research are accelerating. New information is emerging at lightning fast pace, creating the world's first infodemic.[1,2] The face of primary literature is evolving with the emergence of preprints alongside peer-reviewed journal articles, all of which is discussed and debated publicly and privately over internet-based communication channels including social media such as Twitter, YouTube, podcasts, and blog posts. The need for speed in disseminating data as soon as it is generated is indeed very high, but the responsibility for critical analysis of the data before translating into action is just as high. How do we tread through the emerging evidence to update the collective medical knowledge base while ensuring safe, timely communication of important updates to the public? In this review, we examine publishing in the COVID-19 era: from emerging data and clinical challenges, to new resources and public outreach measures. Social media has enhanced our collective understanding of this disease and allowed us to better communicate with people living with kidney disease.

SCIENTIFIC COMMUNICATION DURING COVID-19: THE ROLE OF PREPRINTS

Never before has our collective scientific focus been so concentrated and the output so voluminous. As shown in Figure 1A, nearly 20,000 unique manuscripts have been published on COVID-19 as of June 2020, with the ongoing addition of more than 2000 papers every week. This growing body of literature includes both papers published in traditional journals—some having undergone rapid peer review—and preprinted material. Preprints are non-peer-reviewed manuscripts that are publicly posted on the Internet in order to more rapidly disseminate important findings to the scientific community. In theory, these preprints can undergo prepublication peer review, with a comment section open to everyone for providing feedback. Most journals, including in nephrology, do accept preprints and do not consider them as prior publications.[3] Preprints can make data available essentially as soon as it is generated, to everyone, including fellow scientists, healthcare workers, and the general public, all without any paywall or subscription fees. During the COVID-19 pandemic, expediting data availability has enabled early epidemiological modeling[4,5] and accelerated our understanding of COVID-19 pathogenicity.[6]

Preprints are not new. The first preprint server, arXiv (pronounced "archive"), was created in 1991 as a repository for physics, computer science, and mathematics papers. Many fields (and some countries) now have dedicated preprint servers, including bioRxiv[7] for the biological sciences and medRxiv[8] for clinical and health sciences. Although preprints had been gaining steady traction prior to the COVID-19 pandemic[9]—including in kidney disease research[10]—they have drawn

From the Department of Medicine, Queen's University, Kingston, ON, Canada (C.V.); Department of Medicine, Oakland University William Beaumont School of Medicine, Rochester, MI (J.M.T.); and Division of Nephrology, Department of Medicine, University of Ottawa, Ottawa, ON, Canada (S.H.).

Financial Disclosure: The authors declare that they have no relevant financial interests.

Address correspondence to Swapnil Hiremath, MD, MPH, Division of Nephrology, Department of Medicine, University of Ottawa, 1967 Riverside Drive, Ottawa, ON, Canada K1H7W9. E-mail: shiremath@toh.ca

1548-5595/$36.00

https://doi.org/10.1053/j.ackd.2020.08.003

unprecedented attention in the last few months. They are open, fast, and free, which does create a different set of problems.

The speed at which preprinted manuscripts become available is counterbalanced by a lack of peer review and of editorial discretion about packaging of the knowledge without making extraordinary claims. Indeed, the ease of uploading a manuscript to a preprint server has been misused to postulate bold claims without sufficient supporting evidence, such as a preprint purporting that 4 inserts in the COVID-19 virus were similar to the human immunodeficiency virus-1 and hence unlikely to be "fortuitous."[11] Critiques of this preprint on microblogging websites such as Twitter and Sina Weibo, as well as on independent peer-review platforms,[12] led to its swift withdrawal; however, it is quite likely that many other erroneous findings abound.[13] Another issue is that preprints can lead outside investigators to double count the results. If a researcher is trying to collate research as part of a narrative or quantitative synthesis and counts a peer-reviewed article, they should ignore the associated preprint to avoid overweighting that cohort. Ideally, preprint servers identify when the paper gets published, but this automatic linking depends on the title and authors remaining the same, and may fail if these change from preprint to peer review. Similarly, the journal concerned should identify the preprint version as part of the publication record, which should, but does not always happen.[14]

MedRxiv has screening measures to mitigate the spread of medical misinformation,[15] which include barring in silico drug prediction work.[16] In silico work uses computer modeling to suggest possible drug therapies for a disease, and can hence be quite misleading. Until the COVID-19 pandemic, preprint uptake in the medical field had been slow, with only a handful of early adopters. Hence, the problem of critical appraisal and data quality had not been a major concern. Now, given the flood of data, interest in COVID-19 concerns about medical misinformation are both valid and critical. This needs to be addressed by the wider scientific community. A study on preprint usage, itself posted on a preprint server, provides some more data, and potentially reassurance about proliferation of preprints during this pandemic.[17] The study reports that approximately 40% of all articles published during the COVID-19 pandemic (6000 of 16,000) have been initially uploaded to a preprint server. The rate of publication of preprints was also several magnitudes higher than previous epidemics (2527 in the initial 4 months on 2 servers compared to 78 for Zika and 10 for Ebola). Intriguingly, COVID-19 preprints were 2711 words shorter in length than non-COVID-19 preprints (median, 3432 vs 6143; $P < 0.001$). The authors hypothesize that this supports anecdotal observations, in that preprints are being used to share more work-in-progress data than a complete story. About 4% of the preprints had been published in traditional journals by the end of the study period (end of April 2020), with little change between the preprint version and published version. They also note that the preprint on human immunodeficiency virus and COVID-19, which was quickly retracted, had 127 comments, suggesting controversial data are being rapidly and publicly scrutinized. Some preprints, purporting that COVID-19 poses less of a threat than vehicular accidents[18] or inferring an infection fatality rate of COVID-19 so low, as to fail to account for the obviously high mortality seen in New York,[19] have received so many comments that they might never get published in a traditional journal, quite appropriately. See Table 1 for a comparison of preprints and traditional research publications.

CLINICAL SUMMARY

- The COVID-19 pandemic has been accompanied by a surge of research being posted on preprint servers, before peer review in traditional journal publications.
- Preprint manuscripts have typically not undergone peer review, but offer key critical advantages such as open access, easy feedback, and faster dissemination.
- Blog posts have been a critical aspect of providing a continuing update of the fast-evolving COVID-19 research literature.
- Social media discussions such as on Twitter provide a valuable service for critical appraisal of peer-reviewed literature and preprints alike, and also help with faster dissemination during times of crisis such as the pandemic.

SUMMARIZING THE LITERATURE: BLOG POSTS AS NARRATIVE REVIEWS

Review articles serve to synthesize the primary literature into a sometimes coherent overview of all the data. Systematic reviews and meta-analyses provide a quantitative synthesis of the published data, and narrative reviews provide a qualitative synthesis, altogether helping the reader make sense of the knowledge in any particular field. With the explosion in data becoming available for COVID-19, these reviews are sorely needed and will be valuable for most readers, who cannot sift individually through the treasure trove of preprints and published papers. Ongoing systematic reviews on certain hot topics abound; for example, at the time of writing, there are over 200 registered protocols for systematic reviews on the therapeutic options in COVID-19 on the International Prospective Register of Systematic Reviews. However, by the time these systematic reviews are completed, peer reviewed, and published, the major waves of the COVID-19 pandemic might be over. On the other hand, even reviews performed quickly may be out of date by the time they are published, given the speed at which new data are emerging.

Social media, in particular blog posts, can fill in this niche for narrative reviews quite nicely. A blog post is open, freely available, and shareable, and most importantly, it can be updated with new data coming to light. As an example, the NephJC workgroup put together a blog

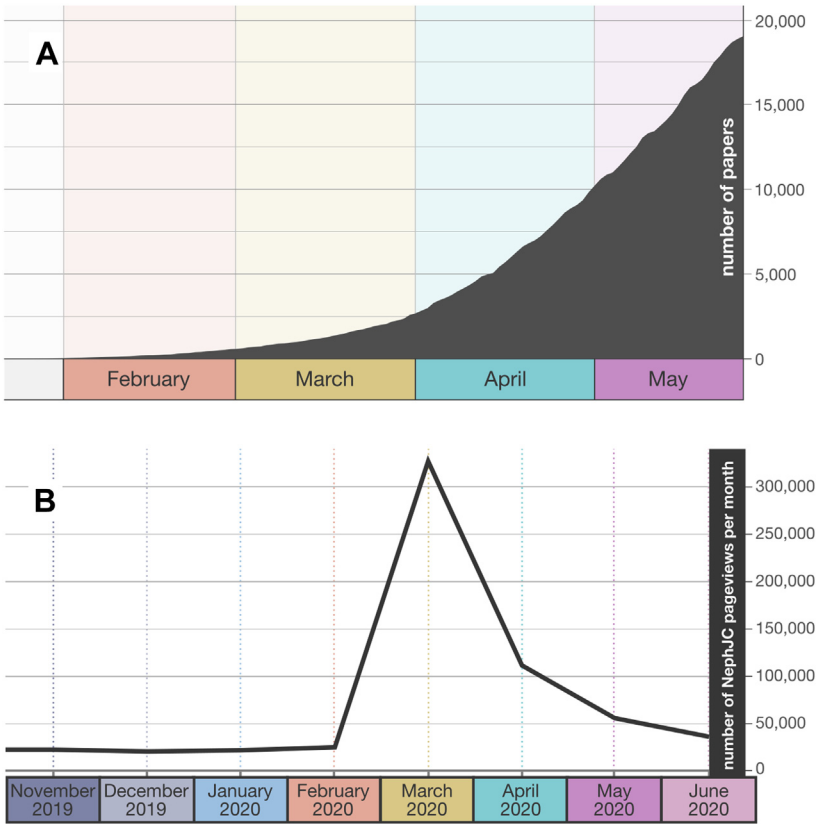

Figure 1. (A) Research publications on COVID-19, from https://covid19primer.com/dashboard, accessed on May 26, 2020. (B) Accession data for pageviews for the NephJC blog page (www.nephjc.com) on a monthly basis for the last 12 months. The blog posts for COVID-19 received more than 300,000 pageviews in 1 month alone.

post on the risk of acute kidney injury (AKI) with COVID-19 on March 21st.[20] At that time, the published literature, mostly from China, seemed to suggest that the incidence of AKI was low, at about 2%-5%. Hence the initial focus in the pandemic preparation for hospitals was more around ventilator shortages and not dialysis. However, data out of New York and Louisiana suggested otherwise, and a shortage of dialysis machines, supplies, and manpower became apparent in April.[21,22] As the preprints and publications from these centers came online, the NephJC blog post was updated to reflect the much higher incidence of AKI: approximately 20% of critically ill patients need kidney replacement therapy.[23]

As with preprints, a common criticism is that blog posts are not peer reviewed. Indeed, this is true for the vast majority of blog posts. On the other hand, for reputable sources in the nephrology blogosphere, such as the Renal Fellow Network, NephJC, and the American Journal of Kidney Diseases Blog, the blog posts are peer reviewed by one or more reviewer/editor. In addition, a common element of blog posts is the possibility of easy comments, or feedback via Twitter. Changes can be made and revisions incorporated in an updated version relatively painlessly.

THE REACH OF SOCIAL MEDIA: FROM SCIENTISTS TO THE GENERAL PUBLIC

The worldwide acute public interest in novel coronavirus information[1,24,25] adds a challenging layer of complexity to the assimilation and dissemination of new knowledge. The virtual emotional contagion[26] of COVID-19-related fear can be nearly as viral as the virus itself,[27] lending to a thirst for information. Varied interpretations of new health research findings are reported via traditional media (journal articles and news broadcasts) and social media (Twitter, Facebook, LinkedIn, Sina Weibo, etc.). Although these social media platforms have begun censoring potentially harmful content[28] (and sometimes accidently deleting helpful posts[29]), information is spread at staggering rates: 22 COVID-19-related Tweets were shared per *second* as of early April 2020.[30] But whose voices are the loudest and which ones are accurate? Beyond social media, the concern with research being posted on preprint servers is that with lay people sifting through these sources, they could take the published results at face value, which could be a greater problem with interventional studies of pharmacotherapy.

Perceived trustworthiness and expertise of a message's source correlate with the influence it will have.[31,32] Health

Table 1. Brief Explanation of the Differences Between Preprints and Traditional Research Papers

Characteristics	Preprints	Traditional Research Papers
Speed (ie, time from submission to availability)	Instantaneous, posted online usually within 48 h of submission	Usually weeks to months
Access	Free, open	Depends; often subscription and/or paywall. Many journals are making articles temporarily free during the COVID-19 pandemic period
Peer review	Typically no external peer review before posting Mechanism for open peer review (comments, social media, direct e-mail)	Peer reviewed by 2-4 reviewers typically in addition to editorial team; quality may vary
Trustworthiness	High variance; depends on authors since manuscript only undergo a quality check prior to being posted	Varies; Peer review and editorial process often, but far from always, picks up errors
Other aspects	Can mitigate "scooping"; allows citation of early work in grant applications	

professionals can amplify credible work[33] and dispel misinformation through steadfast media presence.[31,34] Numerous healthcare agencies and government officials[35] including nearly all G7 world leaders[36] regularly use social media to communicate COVID-19 updates. Occasionally, messages reflect opinions on controversial topics, such as when the French health minister advised against the use of nonsteroidal anti-inflammatory drugs in a tweet mid-March[37] despite limited to no evidence to support this claim.[38] Hence, appeal to eminence and authority are not sufficient. The tools of social media, however, provide thoughtful and capable health communicators to reach a much wider swathe of the population than one would foresee, as we discuss in a couple of examples in the next section.

In early March 2020, a group of American physicians from disparate specialties worked together to cut through the media confusion and present clear, fundamental information about COVID-19 and what people could do to prevent mass infections. The article promoted staying at home and practicing social distancing[39] and was published almost a week before the first stay at home order.[40] The information was posted on Howard Luks' personal blog and on KevinMD.com, the latter being perhaps the longest running medical blog with a large footprint. It was promoted on Facebook as well. It quickly became viral and was ultimately seen by 8 million people (personal communication with Howard Luks, May 22, 2020). Physicians with no access to traditional amplification tools such as news media or medical journals thus could reach a large population due to the ability of social media platforms to spread what people are reading.

Around the same time, a heated debate ignited about the safety of antihypertensive medications that inhibit the renin-angiotensin system (RAS), including angiotensin-converting enzyme (ACE) inhibitors and angiotensin receptor blockers (ARBs). Early reports had suggested a possible association between chronic hypertension and COVID-19 mortality.[41] Given that severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) uses ACE2 as a portal of cell entry in the lung, some groups speculated in high-impact journal publications that RAS blockade could increase the risk of serious infection and openly pondered whether ACE inhibitors/ARBs should be discontinued in those with COVID-19.[42-44] This discussion mobilized the online nephrology community, NephJC, to review the science, which clearly did not support the speculation, and present the data on a blog page.[45] It lead to the formation of a "COVID-19 and ACE2 in Cardiovascular, Lung, and Kidney Working Group" (hereon referred to as simply the COVID and ACE2 Working Group), which has since published response papers[46-48] and continues to compile emerging evidence on hypertension therapies in COVID-19 onto the NephJC blog. The blog has had over 300,000 pageviews just in the month of March 2020 (Fig 1B), supporting both the widespread interest in this topic, and the ability of a free, easily accessible blogpost to satisfy this hunger for information. More than 10 major professional societies in nephrology and cardiology have also responded, issuing statements recommending that patients prescribed these medications should continue taking them. Subsequent observational studies have reported no increase in morbidity or mortality for ACE inhibitors and ARBs in COVID-19,[49-52] and several RCTs are ongoing. This message, summarized in a recent World Health Organization Scientific Brief,[53] has been echoed in physicians blog posts that have been shared widely on social media.[54]

COALESCENCE OF NEW KIDNEY-RELATED INFORMATION DURING COVID-19

For over 10 years, the online nephrology community has been pioneering different modalities to virtually assemble and discuss topics in nephrology.[55,56] These include NephMadness,[57] the yearly, friendly nephrology competition, and NephJC,[58,59] a Twitter-based journal club that typically occurs over 3 spaced sessions to ensure global accessibility. Unsurprisingly, healthcare professionals obtain most of their updates regarding COVID-19 via social media.[60] With its numerous active members, the nephrology Twittersphere (NephTwitter) organically transformed into space to discuss kidney-related COVID-19 content.

Early in the pandemic, anecdotal reports of AKI and hyperkalemia in COVID-19 arose. This is a common use of

medical Twitter: consulting remote colleagues about a new, challenging, or rare issue for which published literature and guidelines are not available (in nephrology, these crowd-sourcing inquiries are frequently tagged with #AskRenal in order to reach the intended audience). A first comprehensive report on the topic,[61] made available online on March 5th, compiled the limited evidence available early in the pandemic regarding the pathophysiology and management of AKI in COVID-19. This anchor piece provided fodder for organized online discussion, including during a special NephJC chat on March 17th and 18th—the highlights of which are pictured in Supplemental Figure 1. Topics discussed included kidney care of patients with COVID-19 and etiology of COVID-19-related AKI, the ACE2/RAS inhibitor debate, and ongoing challenges in the care of hemodialysis and transplant patients.[62] Content hubs were created for each of these topics on the NephJC website. These pages feature information framed as frequently asked questions from physicians and patients. Curated content is regularly updated by several members of the COVID and ACE2 Working Group (Table 2). Other groups maintain parallel curated pages on kidney disease and dialysis issues in COVID-19, such as on UpToDate[63] and in a living systematic review in the Annals of Internal Medicine.[64]

A second #NephJC discussion focused on the initial report of AKI in COVID-19.[65,66] In sum, the nephrology community has united through social media to critically appraise published and non-peer-reviewed literature, culminating in the dissemination of pertinent information and focused advocacy efforts.

PROBLEMS WITH PEER REVIEW

The concerns about the quantity and quality of preprints also apply to the peer-reviewed literature, especially during these times. Many journals have responded to the pandemic by fast-tracking COVID-19 research, which is a laudable goal, but can lead to errors slipping by the peer reviewer and editors. As an example, a single center, peer-reviewed and published study from Wuhan reported no AKI from COVID-19,[67] despite data from preprints from the same institute reporting mortality from AKI.[68,69] Another large database study, peer reviewed and published in the Lancet, reported a 15% higher absolute all-cause mortality with hydroxychloroquine usage in COVID-19.[70] Largely through Twitter and blogs,[71] the findings of this study were critiqued as being implausible, with one correction, a subsequent expression of concern, and a retraction,[72] all within 14 days (in contrast to 12 years for another infamous retraction[73]). Another paper from the same purported database on the use of ACE inhibitors and ARBs also got flagged with an expression of concern[74] followed by a retraction.[75] These 2 studies were published in the medical journals with the highest impact factors, and were peer reviewed. The findings of these studies aligned with the establishment a priori beliefs (on the roles of RAS blockade and hydroxychloroquine in COVID-19). The skepticism of these data arose not in the peer-reviewed traditional media or in the letters to editors section, but on social media, on blogs, and in Twitter discussions. Traditional prepublication peer review is most often done by 2-4 selected individuals sitting alone by themselves under a tight deadline. The social media driven post-publication peer review is quite different.[76,77] Not only is it open, but it brings in people of diverse expertise, viewpoints, and often people who have little prior beliefs or biases with respect to the subject matter. Critical appraisal of papers on social media, performed openly and in a nonformal style seems jarring to the uninitiated.[78] However, it allows for a crowdsourced critique, brainstormed by conversations and discussion. This process is inherently unpredictable and requires a paper of interest and a critical mass of discussants. Such critiques have been frowned upon, but the experience with these prominent studies in prominent journals being brought down by the social media plebeians supports a greater role for post publication paper review. Going forwards, these efforts could be harnessed and encouraged in a systematic fashion rather than critiqued.

As of the writing of this manuscript, the Retraction Watch blog has already noted 25 retractions, 3 temporary retractions, and 1 expression of concerns, just for COVID-19-related publications (including 8 preprints and 21 traditional publications).[79] More importantly, the traditional peer-review process is notoriously opaque, so a study appropriately rejected from one journal may be published unchanged in another, because the second journal did not have access to the first one's peer-review reports. This duplication of peer review also leads to redundancy and loss of an estimated 15 million hours of reviewer time each year.[80] Most importantly, errors in the published literature are harder to correct; the traditional process of writing letters to editors is slow, with little incentive or accountability for the original authors and editors to respond beyond the duty of being faithful to the truth and science. Interestingly, some groups have taken to using a preprint repository to publicly post critical appraisals which serve as "letters to editor" albeit at a different source.[81]

CONCLUSION

COVID-19 has led to a surge of primary literature. It has readily exposed the benefits and pitfalls of various communication modalities, including the traditional publishing model, preprint servers, and social media. The uptake of preprint servers and the scientific discussion on social media have both been accelerated during the pandemic. The scientific community would be better served by letting go of simple heuristics of "peer-reviewed" literature as higher quality and preprints as of lower quality (see Supplemental Fig 2 for a schematic of traditional and the current model of research dissemination). Similar to the quote from Erasmus and the explosion of books, a perceived problem which was quickly solved by the creation of libraries, the problem of preprints, and peer review can be resolved by embracing them and providing open critical appraisal. In this regard, harnessing social media tools such as Twitter and blogs, to reach

Table 2. NephJC Content Hub Pages and Associated Activity Metrics

Content Hub Page	Contributing Members	Number of Pageviews	Number of Revisions	Number of Times Cited
Main COVID page (http://www.nephjc.com/covid19)	Matthew A. Sparks, MD, Duke University Joel Topf, MD, Detroit, Michigan Swapnil Hiremath, MD, MPH, University of Ottawa	50,988	10	4
ACE2 and hypertension (http://www.nephjc.com/news/covidace2)	Matthew A. Sparks, MD, Duke University Swapnil Hiremath, MD, MPH, University of Ottawa Andrew South, MD, MS, Wake Forest School of Medicine, Brenner Children's Hospital Paul Welling, MD, Johns Hopkins Matt Luther, MD, Vanderbilt University Jordy Cohen, MD, MSCE, University of Pennsylvania Brian Byrd, MD, MS, University of Michigan Louise M. Burrell, MD, University of Melbourne, Austin Health, Australia Daniel Batlle, MD, Northwestern University Laurie Tomlinson, MD, London School of Hygiene & Tropical Medicine, UK Vivek Bhalla, MD, Stanford University María José Soler, MD, PhD, Hospital del Vall d'Hebron, Barcelona, Spain Sundar Swaminathan, MD, University of Virginia April Pettit, MD, MPH, Vanderbilt University Javid Moslehi, MD, Vanderbilt University Adam Bress, PharmD, MS, University of Utah Ricky Turgeon, PharmD, University of British Columbia	300,313	26+	37
AKI (http://www.nephjc.com/news/covidaki)	Steve Coca, DO, MS, Mt Sinai, New York Swapnil Hiremath, MD, MPH, University of Ottawa, Canada Jay Koyner, MD, University of Chicago, Chicago Illinois, USA Jennie Lin, MD, MTR, Northwestern University, Chicago Roger Rodby, MD, Rush University, Chicago Anitha Vijayan, MD, Washington University in St. Louis, St. Louis, MO, USA Paul Welling, MD, Johns Hopkins, Baltimore, MD Linda Awdishu, PharmD, MAS, University of California, San Diego, San Diego, CA Dan Batlle, MD, Northwestern University, Chicago, IL Manasi Bapat, MD, California Anna Burgner, MD, MEHP, Vanderbilt University Medical Center, Nashville, Tennessee Edward Clark, MD, MSc, University of Ottawa, Canada Amanda Dijanic Zeidman, MD, Mt Sinai Hospital, New York, NY Michael Heung, MD, University of Michigan at Ann Arbor, Michigan Raymond Hsu, MD, UCSF, California Nikhil Shah, MBBS, DNB, University of Alberta, Edmonton, Canada Matthew A. Sparks, MD, Duke University Sinead Stoneman, MD, Cork, Ireland Joel Topf, MD, Detroit, Michigan Juan Carlos Q Velez, MD, Ochsner Health, New Orleans, LA	35,197	12	5

(*Continued*)

Table 2. NephJC Content Hub Pages and Associated Activity Metrics (*Continued*)

Content Hub Page	Contributing Members	Number of Pageviews	Number of Revisions	Number of Times Cited
Dialysis and CKD (http://www.nephjc.com/news/2020/3/23/covid-and-the-kidney-dialysis-edition)	Graham Abra, MD, Stanford University and Satellite Healthcare, San Jose, CA Neiha Arora, Kaiser Permanente Northern California, Fremont, CA Manasi Bapat, MD, East Bay Nephrology Medical Group, Berkeley, CA Divya Bajpai, MD, KEM Hospital, Mumbai, India Todd Bruno, Kaiser Permanente Northern California, Vacaville, CA Anna M. Burgner, MD, MEHP, Vanderbilt University Medical Center, Nashville, TN Gates B. Colbert, MD, FASN, Texas A&M Health Science Center, Dallas, TX Pablo Garcia, MD, Stanford University, Palo Alto, CA Francesco Iannuzzella, MD, Arcispedale Santa Maria Nuova, Reggio Emilia, Italy Jessica B. Lapasia, Kaiser Permanente Northern California, San Francisco, CA Edgar V. Lerma, MD, FASN, University of Illinois at Chicago/Advocate Christ Medical Center, Oak Lawn, IL Ali Poyan Mehr, MD, Kaiser Permanente Northern California, San Francisco, CA Devika Nair, MD, MSCI, Vanderbilt University Medical Center, Nashville, TN Vandana Dua Niyyar, MD, Emory University, Atlanta, GA Sayna Norouzi, MD, Baylor College of Medicine, Baylor, TX Carmen A. Peralta, MD, MAS, Cricket Health and University of California, San Francisco, CA Roger Rodby, MD, Rush University, Chicago, IL Anoop Shah, Brown University, Providence, RI Nikhil Shah, MBBS, DNB, University of Alberta, Edmonton, Canada Ilan Zawadzki, Kaiser Permanente Washington, Seattle, WA	9542	8	1
Transplant (http://www.nephjc.com/news/covidtx)	Bea Concepcion, MD, Vanderbilt University Medical Center, Nashville, TN Mona Doshi, MD, University of Michigan, Detroit, MI Samira Farouk, MD, MS, FASN, Icahn School of Medicine at Mount Sinai, New York Swapnil Hiremath, MD, MPH, University of Ottawa, Canada Syed Husain, MD, Columbia University, New York, NY Michelle Lim, Dundee, Scotland Ian Logan, Newcastle Hospitals, Newcastle, UK Olivia Kates, Infectious Disease Fellow, University of Seattle, Seattle, WA Edoardo Melilli, Catalonia, Spain Paul Phelan, Royal Infirmary, Edinburgh Cathy Quinlan, Royal Children's Hospital, Melbourne, Australia Roger Rodby, MD, Rush University, Chicago Silvi Shah, MD, MS, FASN, University of Cincinnati, Ohio Laura Slattery, BSc, BMBS, Cork University Hospital, Ireland Beje Thomas, MD, MedStar Georgetown Transplant Institute, Washington, DC Tiffany Truong, University of Southern California, Los Angeles, CA	5121	6	2
Pediatrics	Catherine Quinlan, MD, Royal Children's Hospital, Australia Michelle N. Rheault, MD, University of Minnesota, Minneapolis, MN Caoimhe Costigan, MD, Pediatric Specialist Registrar, Dublin, Ireland Joseph T. Flynn, MD, MS, University of Washington/Seattle Children's Hospital, Seattle, WA Michelle Starr, MD, MPH, Indiana University School of Medicine, Indianapolis, IN	1971	6	0
Total	68 contributors	403,132	68	49

Data as of July 22, 2020. Pageviews data for the NephJC blog from Squarespace (hosting site); citation count obtained from Google Scholar.

beyond mere consumption of medical knowledge, but for provision of critical appraisal is a natural fit. Every crisis presents an opportunity, and COVID-19 is one such with potential to revolutionize and democratize the dissemination of scientific research.

REFERENCES

1. Rovetta A, Bhagavathula AS. COVID-19-related web search behaviors and infodemic attitudes in Italy: infodemiological study. *JMIR Public Health Surveill.* 2020;6(2):e19374.
2. Zarocostas J. How to fight an infodemic. *The Lancet.* 2020;395(10225):676.
3. Vlasschaert C, Giles C, Hiremath S, Lanktree MB. Preprint servers in kidney disease research: a rapid review. *CJASN.* 2020;15(8). CJN.03800320.
4. Majumder MS, Mandl KD. Early in the epidemic: impact of preprints on global discourse about COVID-19 transmissibility. *The Lancet Glob Health.* 2020;8(5):e627-e630.
5. Park M, Cook AR, Lim JT, Sun Y, Dickens BL. A systematic review of COVID-19 epidemiology based on current evidence. *J Clin Med.* 2020;9(4):967.
6. Covid-19 is reshaping the world of bioscience publishing - STAT. Available at: https://www.statnews.com/2020/03/23/bioscience-publishing-reshaped-covid-19/. Accessed May 9, 2020.
7. Callaway E. Preprints come to life. *Nat News.* 2013;503(7475):180.
8. Rawlinson C, Bloom T. New preprint server for medical research. *BMJ.* 2019;365:l2301.
9. Kaiser J. The preprint dilemma. *Science.* 2017;357(6358):1344-1349.
10. Vlasschaert C, Giles C, Hiremath S, Lanktree M. Preprint servers in kidney disease research: a rapid review. *Clin J Am Soc Nephrol.* 2020. https://doi.org/10.2215/CJN.03800320.
11. Pradhan P, Pandey AK, Mishra A, et al. Uncanny similarity of unique inserts in the 2019-nCoV spike protein to HIV-1 gp120 and Gag. *Biorxiv.* 2020. https://doi.org/10.1101/2020.01.30.927871.
12. Johansson MA, Saderi D. Open peer-review platform for COVID-19 preprints. *Nature.* 2020;579(7797):29.
13. Oransky I, Marcus A. Quick retraction of coronavirus paper was good moment for science. STAT. Available at: https://www.statnews.com/2020/02/03/retraction-faulty-coronavirus-paper-good-moment-for-science/. Accessed February 23, 2020.
14. Re: Clinical characteristics of 113 deceased patients with coronavirus disease 2019: retrospective study. https://www.bmj.com/content/368/bmj.m1091/rr-6. Accessed June 1, 2020.
15. Opinion | a study said Covid wasn't that deadly. The right seized it. The New York Times. Available at: https://www.nytimes.com/2020/05/14/opinion/coronavirus-research-misinformation.html#click=https://t.co/Q8KoiaEckU. Accessed May 17, 2020.
16. Kwon D. How swamped preprint servers are blocking bad coronavirus research. *Nature.* 2020;581:130-131.
17. Fraser N, Brierley L, Dey G, Polka JK, Pálfy M, Coates JA. Preprinting a pandemic: the role of preprints in the COVID-19 pandemic. *Biorxiv.* 2020. https://doi.org/10.1101/2020.05.22.111294.
18. Ioannidis JPA, Axfors C, Contopoulos-Ioannidis DG. Population-level COVID-19 mortality risk for non-elderly individuals overall and for non-elderly individuals without underlying diseases in pandemic epicenters. *medRxiv.* 2020. https://doi.org/10.1101/2020.04.05.20054361.
19. Ioannidis J. The infection fatality rate of COVID-19 inferred from seroprevalence data. *Medrxiv.* 2020. https://doi.org/10.1101/2020.05.13.20101253.
20. Acute kidney injury. NephJC. Available at: http://www.nephjc.com/news/covidaki. Accessed May 9, 2020.
21. Hirsch JS, Ng JH, Ross DW, et al. Acute kidney injury in patients hospitalized with COVID-19. *Kidney Int.* 2020;98(1):209-218.
22. Mohamed MM, Lukitsch I, Torres-Ortiz AE, et al. Acute kidney injury associated with coronavirus disease 2019 in urban New Orleans. *Kidney360.* 2020;1(7):614-622.
23. Ronco C, Reis T, Husain-Syed F. Management of acute kidney injury in patients with COVID-19. *Lancet Respir Med.* 2020;8(7):738-742.
24. Abd-Alrazaq A, Alhuwail D, Househ M, Hamdi M, Shah Z. Top concerns of tweeters during the COVID-19 pandemic: infoveillance study. *J Med Internet Res.* 2020;22(4):e19016.
25. Han X, Wang J, Zhang M, Wang X. Using social media to mine and analyze public opinion related to COVID-19 in China. *Int J Environ Res Public Health.* 2020;17(8):2788.
26. Kramer ADI, Guillory JE, Hancock JT. Experimental evidence of massive-scale emotional contagion through social networks. *PNAS.* 2014;111(24):8788-8790.
27. Depoux A, Martin S, Karafillakis E, Preet R, Wilder-Smith A, Larson H. The pandemic of social media panic travels faster than the COVID-19 outbreak. *J Trav Med.* 2020;27(3):taaa031.
28. Facebook, Reddit, Google, LinkedIn, Microsoft, Twitter and YouTube issue joint statement on misinformation. TechCrunch. Available at: https://social.techcrunch.com/2020/03/16/facebook-reddit-google-linkedin-microsoft-twitter-and-youtube-issue-joint-statement-on-misinformation/. Accessed May 9, 2020.
29. Koetsier J. Facebook deleting coronavirus posts, leading to charges of censorship. Forbes. Available at: https://www.forbes.com/sites/johnkoetsier/2020/03/17/facebook-deleting-coronavirus-posts-leading-to-charges-of-censorship/. Accessed June 2, 2020.
30. Brand communications in time of crisis. Available at: https://blog.twitter.com/en_us/topics/company/2020/Brand-communications-in-time-of-crisis.html. Accessed May 9, 2020.
31. Limaye RJ, Sauer M, Ali J, et al. Building trust while influencing online COVID-19 content in the social media world. *Lancet Digit Health.* 2020;2(6):e277-e278.
32. Bavel JJV, Baicker K, Boggio PS, et al. Using social and behavioural science to support COVID-19 pandemic response. *Nat Hum Behav.* 2020;4(5):460-471.
33. Yammine S. Going viral: how to boost the spread of coronavirus science on social media. *Nature.* 2020;581:345-346.
34. O'Connor C, Murphy M. Going viral: doctors must tackle fake news in the Covid-19 pandemic. *BMJ.* 2020;369:m1587.
35. Ting DSW, Carin L, Dzau V, Wong TY. Digital technology and COVID-19. *Nat Med.* 2020;26(4):459-461.
36. Rufai SR, Bunce C. World leaders' usage of Twitter in response to the COVID-19 pandemic: a content analysis. *J Public Health (Oxf).* 2020;42(3):510-516.
37. Olivier Véran on Twitter. #COVID—19 | La prise d'anti-inflammatoires (ibuprofène, cortisone, …) pourrait être un facteur d'aggravation de l'infection. En cas de fièvre, prenez du paracétamol. Si vous êtes déjà sous anti-inflammatoires ou en cas de doute, demandez conseil à votre médecin. Twitter Twitter. Available at: https://twitter.com/olivierveran/status/1238776545398923264. Accessed May 9, 2020.
38. Day M. Covid-19: European drugs agency to review safety of ibuprofen. *BMJ.* 2020;368:m1168.
39. COVID-19 update; a message from concerned physicians. Available at: https://www.howardluksmd.com/sports-medicine/covid-19-update-3-14-2020-concerned-physicians-unite/. Accessed June 1, 2020.
40. Mervosh S, Lu D, Swales V. See which states and cities have told residents to stay at home. The New York Times. Available at: https://www.nytimes.com/interactive/2020/us/coronavirus-stay-at-home-order.html. Accessed July 4, 2020.
41. Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *The Lancet.* 2020;395(10229):1054-1062.
42. Fang L, Karakiulakis G, Roth M. Are patients with hypertension and diabetes mellitus at increased risk for COVID-19 infection? *Lancet Respir Med.* 2020;8(4):e21.

43. Kuster GM, Pfister O, Burkard T, et al. SARS-CoV2: should inhibitors of the renin-angiotensin system be withdrawn in patients with COVID-19? *Eur Heart J.* 2020;41(19):1801-1803.
44. Guo J, Huang Z, Lin L, Lv J. Coronavirus disease 2019 (COVID-19) and cardiovascular disease: a viewpoint on the potential influence of angiotensin-converting enzyme inhibitors/angiotensin receptor blockers on onset and severity of severe acute respiratory syndrome coronavirus 2 infection. *J Am Heart Assoc.* 2020;9(7):e016219.
45. ACE2 and HYPERTENSION. NephJC. Available at: http://www.nephjc.com/news/covidace2. Accessed July 4, 2020.
46. We need sound science and clinical trials, not simplistic and misleading algorithms. Available at: http://www.bmj.com/content/369/bmj.m1313/rr-6. Accessed May 10, 2020.
47. South AM, Tomlinson L, Edmonston D, Hiremath S, Sparks MA. Controversies of renin–angiotensin system inhibition during the COVID-19 pandemic. *Nat Rev Nephrol.* 2020;16(6):305-307.
48. Sparks MA, South A, Welling P, et al. Sound science before quick judgement regarding RAS blockade in COVID-19. *CJASN.* 2020;15(5):714-716.
49. Li J, Wang X, Chen J, Zhang H, Deng A. Association of renin-angiotensin system inhibitors with severity or risk of death in patients with hypertension hospitalized for coronavirus disease 2019 (COVID-19) infection in Wuhan, China. *JAMA Cardiol.* 2020;5(7):1-6.
50. Zhang P, Zhu L, Cai J, et al. Association of inpatient use of angiotensin converting enzyme inhibitors and angiotensin II receptor blockers with mortality among patients with hypertension hospitalized with COVID-19. *Circ Res.* 2020;126(12):1671-1681.
51. Reynolds HR, Adhikari S, Pulgarin C, et al. Renin–angiotensin–aldosterone system inhibitors and risk of Covid-19. *New Engl J Med.* 2020;382(25):2441-2448.
52. Mancia G, Rea F, Ludergnani M, Apolone G, Corrao G. Renin–angiotensin–aldosterone system blockers and the risk of Covid-19. *New Engl J Med.* 2020;382(25):2431-2440.
53. COVID-19 and the use of angiotensin-converting enzyme inhibitors and receptor blockers. Available at: https://www.who.int/news-room/commentaries/detail/covid-19-and-the-use-of-angiotensin-converting-enzyme-inhibitors-and-receptor-blockers. Accessed May 10, 2020.
54. Quinlan C. COVID19 and ACE inhibitors. *Don't Forget The Bubbles.* 2020. https://doi.org/10.31440/DFTB.24225.
55. Colbert GB, Topf J, Jhaveri KD, et al. The social media revolution in nephrology education. *Kidney Int Rep.* 2018;3(3):519-529.
56. Dave NN, Sparks MA, Farouk SS. An introduction and guide to becoming a social media savvy nephrologist. *Nephrol Dial Transpl.* 2020. https://doi.org/10.1093/ndt/gfaa067.
57. NephMadness: Lessons from seven years on the leading edge of social media medical education. European Medical Journal. Available at: https://www.emjreviews.com/nephrology/article/nephmadness-lessons-from-seven-years-on-the-leading-edge-of-social-media-medical-education/. Accessed May 9, 2020.
58. Topf JM, Sparks MA, Iannuzzella F, et al. Twitter-based journal clubs: additional facts and clarifications. *J Med Internet Res.* 2015;17(9):e216.
59. Topf JM, Sparks MA, Phelan PJ, et al. The evolution of the journal club: from Osler to Twitter. *Am J Kidney Dis.* 2017;69(6):827-836.
60. Bhagavathula AS, Aldhaleei WA, Rahmani J, Mahabadi MA, Bandari DK. Knowledge and perceptions of COVID-19 among health care workers: cross-sectional study. *JMIR Public Health Surveill.* 2020;6(2):e19160.
61. Naicker S, Yang C-W, Hwang S-J, Liu B-C, Chen J-H, Jha V. The Novel Coronavirus 2019 epidemic and kidneys. *Kidney Int.* 2020;97(5):824-828.
62. NephJC. NephJC transcript: COVID and the kidneys. Available at: https://static1.squarespace.com/static/535bcb2fe4b05fe61b320c51/t/5e76806c087a892473673ac8/1584824434401/%23NephJC+COVID19+Chat+March+17th+2020.pdf. Accessed May 10, 2020.
63. Palevsky P, Radhakrishnan J, Townsend RR. Coronavirus disease 2019 (COVID-19): issues related to kidney disease and hypertension. Available at: https://www.uptodate.com/contents/coronavirus-disease-2019-covid-19-issues-related-to-kidney-disease-and-hypertension. Accessed May 10, 2020.
64. Mackey K, King VJ, Gurley S, et al. Risks and impact of angiotensin-converting enzyme inhibitors or angiotensin-receptor blockers on SARS-CoV-2 infection in adults. *Ann Intern Med.* 2020;173(3):195-203.
65. Su H, Yang M, Wan C, et al. Renal histopathological analysis of 26 postmortem findings of patients with COVID-19 in China. *Kidney Int.* 2020;98(1):219-227.
66. Batlle D, Soler MJ, Sparks MA, et al. Acute kidney injury in COVID-19: emerging evidence of a distinct pathophysiology. *JASN.* 2020;31(7):1380-1383.
67. Wang L, Li X, Chen H, et al. Coronavirus disease 19 infection does not result in acute kidney injury: an analysis of 116 hospitalized patients from Wuhan, China. *AJN.* 2020;51(5):343-348.
68. Shi Q, Zhao K, Yu J, et al. Clinical characteristics of 101 COVID-19 nonsurvivors in Wuhan, China: a retrospective study. *Medrxiv.* 2020. https://doi.org/10.1101/2020.03.04.20031039.
69. Silver SA, Clark EG, Hiremath S. Misleading numbers: is the risk of acute kidney injury with COVID-19 truly this low? *AJN.* 2020;51(7):574-575.
70. Mehra MR, Desai SS, Ruschitzka F, Patel AN. Hydroxychloroquine or chloroquine with or without a macrolide for treatment of COVID-19: a multinational registry analysis. *The Lancet.* 2020. https://doi.org/10.1016/S0140-6736(20)31180-6.
71. This one's for the Lancet editorial board: a trolley problem for our times (involving a plate of delicious cookies and a steaming pile of poop) «Statistical Modeling, Causal Inference, and Social Science. Available at: https://statmodeling.stat.columbia.edu/2020/06/01/this-ones-the-lancet-editorial-board-a-trolley-problem-for-our-times-involving-a-plate-of-delicious-cookies-and-a-steaming-pile-of-poop/. Accessed June 1, 2020.
72. Retraction: Hydroxychloroquine or chloroquine with or without a macrolide for treatment of COVID-19: a multinational registry analysis. Available at: https://www.thelancet.com/lancet/article/s0140673620313246. Accessed June 5, 2020.
73. Wakefield AJ, Murch SH, Anthony A, et al. RETRACTED: Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children. *The Lancet.* 1998;351(9103):637-641.
74. Rubin EJ. Expression of concern: Mehra MR et al. Cardiovascular disease, drug therapy, and mortality in Covid-19. *N Engl J Med.* 2020;382:2464.
75. Mehra MR, Desai SS, Kuy S, Henry TD, Patel AN. Retraction: cardiovascular disease, drug therapy, and mortality in Covid-19. *New Engl J Med.* 2020;382:2582.
76. Topf JM, Hiremath S. Social media, medicine and the modern journal club. *Int Rev Psychiatry.* 2015;27(2):147-154.
77. Teixeira da Silva JA, Al-Khatib A, Dobránszki J. Fortifying the corrective nature of post-publication peer review: identifying weaknesses, use of journal clubs, and rewarding conscientious behavior. *Sci Eng Ethics.* 2017;23(4):1213-1226.
78. Robert Califf and the rise of medicine's peanut gallery. 33 Charts. Available at: https://33charts.com/robert-califf-peanut-gallery/. Accessed June 3, 2020.
79. Retracted coronavirus (COVID-19) papers. Retraction Watch. Available at: https://retractionwatch.com/retracted-coronavirus-covid-19-papers/. Accessed June 2, 2020.
80. Peer review: how we found 15 million hours of lost time | AJE. Available at: https://www.aje.com/arc/peer-review-process-15-million-hours-lost-time/. Accessed June 1, 2020.
81. Dahly D, Gates S, Morris T. Statistical review of hydroxychloroquine and azithromycin as a treatment of COVID-19: results of an open-label non-randomized clinical trial. *Zenodo.* 2020. https://doi.org/10.5281/zenodo.3724167.