Shortcomings of Rapid Clinical Information Dissemination

Lessons From a Pandemic

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Abstract

The coronavirus disease 2019 (COVID-19) pandemic has led to an acceleration of clinical information dissemination to unprecedented speeds, a phenomenon only partially explained by formal efforts of the scientific community. These have ranged from the establishment of open-source platforms for review of article preprints to the elimination of journal paywalls for COVID-19–related publications. In addition, informal efforts that rely on various modern media platforms that promote, repackage, and synthesize information have played substantial adjunctive roles, many of which did not exist during the severe acute respiratory syndrome pandemic of 2003. Although these latter efforts have greatly bolstered the speed of knowledge dissemination, their unregulated nature subjects them to risk for facilitating the spread of misinformation. In our opinion, the role of modern media in influencing clinical knowledge dissemination was not adequately examined even before the pandemic and therefore remains largely unchecked. In this article, we examine the spread of information in the field of COVID-19 and neurologic disorders, develop a simple model that maps various modern media tools on to the dissemination pipeline, and critically examine its components. Through this exercise, we identify opportunities for the scientific community to regulate and safeguard the clinical knowledge dissemination process, with implications both for the pandemic and beyond.

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The coronavirus disease 2019 (COVID-19) pandemic has led to an acceleration of clinical knowledge dissemination at all levels of the scientific community to equip frontline clinicians with decision-making support. Many journal editorial teams have established pathways for expedited peer review,¹ built open-source platforms for quick review of preprints,² and removed paywalls for COVID-19–related publications.³ Clinical leaders have rapidly released consensus statements in conjunction with academic societies specific to their field of influence.^{4,5} Others have contributed rapid reviews that summarize available literature and detail their frontline experiences.⁶

In addition to these journal-based efforts, information flow has also been bolstered by various web-based media and social media–based resources. Examples include online article repositories,⁷ infographics that repackage information into simplified formats,⁸ social media platforms that promote web-based clinical resources,⁹ and many others. It is notable that the infrastructures supporting many of these resources did not exist during the severe acute respiratory syndrome pandemic of 2003, such as Facebook (created in 2004), Twitter (created in 2006), and podcasts (popularized in the 2000s),¹⁰ whereas others have matured

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greatly in the interim, including smartphones and the World Wide Web itself. Online media oftentimes propel information in interconnected ways. For instance, a scientific article may be referenced in a web-based consolidation resource, which is promoted on a podcast, which is in turn advertised on an online clinician forum.

The complexity of inter-referencing has precluded efforts to characterize clinical knowledge dissemination in the digital age. Prior works have attempted to model information flow as complex networks using journal articles and citations as nodes,¹¹ but some studies have found poor correlation between model strength and topography, suggesting that this method may be impractical.¹² Others have attempted to use principles of dissemination and implementation science, but these tend to focus on health systems as targets of knowledge transfer rather than individuals, which may limit its ability to characterize social influence by new media.¹³ However, we believe that we can use these 2 methods complementarily to generate a simple model describing how clinicians access scientific literature, empirically derived from a snapshot of the intersection between COVID-19 and neurologic disorders. Such a model would allow us to critically evaluate the components of the knowledge dissemination pipeline in the digital age.

A Simple Model of Clinical Knowledge Dissemination

Design

On May 1, 2020, we searched PubMed for primary literature on COVID-19 and neurologic disorders using the search entry “(COVID-19 or SARS-CoV-2 or coronavirus or severe acute respiratory syndrome) AND (neurology or neurologic or neurological or neuro or brain or nerve or muscle or Guillain-Barre or stroke or seizure or meningitis or encephalitis or meningoencephalitis).” We augmented our list by reviewing the reference lists of these articles, relevant online article collections, and the reference lists of the online neurology inpatient protocols maintained at our institution (covidneurology.org).¹⁴

We found 18 articles considered primary literature consisting of case reports, case series, and retrospective observation studies on neurologic disorders and COVID-19 published between February 25 and May 1, 2020, as shown in the table. The lag time between patient presentation and article publication ranged from 16 to 69 days; it was not possible to establish a median due to ambiguity regarding dates of presentation, especially for case series and retrospective studies. For each article, an exact Google search of its title found a median of 398 references from online resources and a median of 1.5 references from academic journal articles. We mapped the online resources for each article as a network, with an example shown in figure 1 that depicts select media-based resources referencing the *New*

England Journal of Medicine editorial on large-vessel strokes in young patients with COVID-19, published on April 28, 2020.¹⁵ Unilateral arrows indicate the direction of referencing, such as the NEJM Journal Watch referencing the article on April 28, the day it was published. Some referencing connections between resources were established before article publication.

Description

We found that all online resources may be classified into the categories of article collections (e.g., American Academy of Neurology [AAN] COVID-19 Neurology Resource Center⁷), medical knowledge repositories (e.g., Medscape¹⁶), new media (e.g., *Neurology*® podcast¹⁷), point-of-care knowledge consolidation resources (e.g., UpToDate¹⁸), rapidly developed clinical protocols (e.g., Brigham and Women’s COVID-19 protocols¹⁹), journal-based social media platforms, institutional social media platforms, clinician-specific online forums, informal online forums, personal social media accounts, and news articles for lay audiences. By examining the relationships between these resources as a network with unidirectional relationships, we collapsed them into 4 domains based on their primary purpose: repository, synthesis, formal promotion, and informal promotion, as shown in figure 2.

Repository Resources

Repository resources are article repositories that provide minimal or no commentary on publications. During the pandemic, they have been critical for directing clinicians to specialty-specific literature, such as the COVID-19 Neurology Resource Center: Articles and Publications maintained by the AAN.⁷ In general, article collections are managed by academic societies, such as the American College of Physicians Journal Club,²⁰ or scientific journals that house specialty collections, such as the Neurology Specialty Collection of The Lancet.²¹ Uncommonly, journal-based article repositories may feature publications of competing journals in the case of small academic fields.²²

Synthesis Resources

Synthesis resources are online tools that aggregate scientific literature, often with the goal of generating clinical recommendations. During the pandemic, the need for rapid knowledge synthesis has seen the emergence of online clinical protocols, which summarize available literature and make recommendations using a combination of limited evidence, evolving frontline experience, and expert opinion. These protocols are typically written by groups of experts at an academic society or institution and are disseminated quickly and updated continuously, bypassing journal peer review. Examples include protocols on the outpatient management of neurologic disorders in patients with COVID-19 by the Association of British Neurologists²³ and those on inpatient management by neurologists at Boston Medical Center.¹⁴ Before the pandemic, online synthesis tools were generally reserved for point-of-care knowledge acquisition, such as the popular consolidation resource UpToDate.²⁴ They are

Table Primary Literature on Neurologic Disorders and COVID-19 Published From February 25 to May 1, 2020, Inclusive

Ref.	Location	Neurologic manifestation	Journal	Publication date	Date of case presentation	No. of cases	Search results: Total hits; total citations
43	Wuhan, China	Dizziness; headache; impaired consciousness; acute cerebrovascular disease; ataxia; seizure; skeletal muscle injury; nerve pain; impaired taste, smell, or vision	<i>JAMA Neurology</i>	February 25, 2020 (preprint); April 10, 2020 (journal publication)	January 16, 2020, to February 19, 2020	78	1,970; 119
44	Wuhan, China	Acute ischemic stroke; cerebral venous sinus thrombosis; cerebral hemorrhage	<i>Lancet Neurology</i>	March 13, 2020 (preprint)	January 16 to February 29, 2020	13	351; 27
45	United States (Detroit)	Acute hemorrhagic necrotizing encephalopathy	<i>Radiology</i>	March 31, 2020 (preprint)	Unspecified	1	1,120; 32
46	Wuhan, China	Guillain-Barré syndrome	<i>Lancet Neurology</i>	April 1, 2020	January 23, 2020	1	11,500; 17
47	Yamanashi, Japan	Meningitis; encephalitis	<i>International Journal of Infectious Diseases</i>	April 3, 2020 (preprint)	March 2020 (date unspecified)	1	2,060; 21
48	Wuhan, China	Encephalitis	<i>Brain, Behavior, and Immunity</i>	April 10, 2020	February 10, 2020	1	125; 2
49	Strasbourg, France	Agitation; corticospinal tract findings; dysexecutive syndrome; confusion	<i>New England Journal of Medicine</i>	April 15, 2020	March 3, 2020, to April 3, 2020	49	2,050; 7
50	Sari, Iran	Guillain-Barré syndrome	<i>Journal of Clinical Neuroscience</i>	April 15, 2020	Unspecified	1	233; 2
51	Wuhan, China	Encephalopathy	<i>Journal of Medical Virology</i>	April 15, 2020	February 10, 2020	1	91; 0
52	Madrid, Spain	Guillain-Barré syndrome (Miller-Fisher syndrome)	<i>Neurology</i>	April 17, 2020 (preprint)	Unspecified	2	1,040; 1
53	United States (Los Angeles)	Meningitis; encephalitis	<i>Brain, Behavior, and Immunity</i>	April 17, 2020	April 1, 2020	1	74; 0
54	Northern Italy	Guillain-Barré syndrome	<i>New England Journal of Medicine</i>	April 17, 2020	February 28 through March 21, 2020	5	Title is same as Virani article: 6,570; 5
55	China (Hubei, Sichuan, and Chongqing Provinces)	Seizure-like events	<i>Epilepsia</i>	April 18, 2020	January 18, 2020, to February 18, 2020	2	398; 0
56	United States (Pittsburgh, PA)	Guillain-Barré syndrome	<i>IDCases</i>	April 18, 2020	Unspecified	1	Title is same as Toscano article: 6,570; 0
57	Piacenza, Italy	Guillain-Barré syndrome	<i>Journal of Neurology</i>	April 24, 2020	March 28, 2020	1	29; 0
15	United States (New York)	Stroke	<i>New England Journal of Medicine</i>	April 28, 2020	March 23, 2020, to April 7, 2020	5	2,200; 0
58	Monza, Italy	Guillain-Barré syndrome	<i>Neurology: Neuroimmunology & Neuroinflammation</i>	April 29, 2020	Unspecified	1	79; 0
59	Bilbao, Spain	Stroke	<i>European Journal of Neurology</i>	April 30, 2020	Unspecified	1	1; 0

uncommon outside of point of care, as clinicians tend to rely on their peer-reviewed journal-based counterparts.

Formal Promotion Resources

Formal promotion resources are online media that draw attention to content without modification, including the official social media platforms of scientific journals, academic societies, and medical institutions. During the pandemic, many landmark articles have been shared widely on institutional social media platforms.^{9,25} Before the pandemic, 1 study correlated the social media presence of a journal with its impact as measured by its Klout score and SCImago Journal Rank,²⁶ and another correlated the number of tweets about an article with its eventual number of citations,²⁷ both demonstrating correlation without causation. Some social media promotions are bolstered by the use of infographics, which are minimalist visual representations of article content to boost popularity, previously found to increase Altmetric scores and abstract views.²⁸ Some researchers believe that article promotion on social media will soon become an expectation,^{8,29} with advent of social media-specific impact metrics such as a Twitter impact factor³⁰ or twimpact factor.²⁷

Another form of formal promotion is podcasts that feature interviews with authors of recent publications.³¹ Examples

include the weekly *Neurology* podcast managed by the AAN¹⁷ and the *AANEM presents Nerve & Muscle Junction* podcast managed by the American Association of Neuro-muscular & Electrodiagnostic Medicine,³² the former featuring several special reports on COVID-19 and neurology during the pandemic. Formal promotion resources may reference scientific literature directly but may also reference repository and synthesis resources, as shown in figure 2.

Informal Promotion Resources

Informal promotion resources are online tools analogous to traditional word of mouth, including official academy-based forums, unofficial interest-based forums, and personal social media. During the pandemic, there has been a surge of online discussions on COVID-19-related information and resources via clinician-specific forums, such as the Synapse AAN Online Communities platform.³³ This type of promotion may reach clinicians in a unique way during their leisure time through personal or social networks or engage clinicians who are less proactive in seeking information by formal means. Informal promotion resources may reference scientific literature directly or the media-based resources of any of the other 3 domains, as shown in figure 2.

Figure 1 Select Media-Based Resources Referencing the *New England Journal of Medicine* Editorial on Large-Vessel Strokes in Young Patients With COVID-19, Published on April 28, 2020¹⁵

Unilateral arrows indicate direction of referencing material, for example, the Neurocritical Care Society referencing the article directly. All arrows are equivalent; dotted arrows are used when crossing other elements of the figure for clarity. Dates when a reference is created are shown if known. Note that the dates marked with an asterisk indicate that connections are made predating journal publication on April 28. For example, the BMC protocols were promoted on AAN Synapse weeks before adding a reference to the journal article. AAN = American Academy of Neurology; BMC = Boston Medical Center; NEJM = *New England Journal of Medicine*; Promotion (F) = formal promotion; Promotion (I) = informal promotion.

Figure 2 Proposed Model of Modern Clinical Knowledge Dissemination as Influenced by Modern Media Tools

Unilateral arrows indicate direction of referencing material, for example, an article collection referring a scientific article. All arrows are equivalent; dotted arrows are used when crossing other elements of the figure for clarity. Note that informal promotion resources may reference any of the other 3, formal promotion resources may reference the remaining 2, and the others may only reference a journal article directly. Promotion (F) = formal promotion; Promotion (I) = informal promotion; RCT = randomized control trial.

We acknowledge several limitations to our simple model, such as its focus on only non–point-of-care knowledge acquisition, given that point-of-care knowledge acquisition is a complex study of its own beyond the scope of this model or article. We also excluded print resources as there is increasing evidence that textbooks and other print media may be falling out of favor.^{34,35} Our model was also derived from a snapshot of a narrow field using PubMed with limited search terms and web engine searches that are known to be imperfect with redundancies and inaccuracies. However, we believe that its overall framework is valid and sufficiently detailed for the purpose of scrutinizing its components.

Implications

Our bird’s-eye view model draws attention to 3 major shortcomings of the current state of modern clinical information dissemination. First, examining the category of synthesis resources reveals that it uniquely features only 2 subtypes: point-of-care knowledge consolidation resources and rapid clinical protocols developed by task forces, the former usually of high quality as there are only few that are commercially successful.¹⁸ Meanwhile, the latter differs greatly from the resources in the other 3 domains, as they do not simply promote or redirect information but add to it in a scientific, theoretically rigorous way. Although they afford a speed of dissemination that may be necessary during the

pandemic, their nature of bypassing journal peer review has potential negative consequences—oversimplifying complicated topics at best and spreading misinformation at worst. During the pandemic, rapidly developed and disseminated online clinical protocols emerged out of necessity. Although this format has not been scrutinized in the literature, the synthesis component likely has the same drawbacks as the rapid reviews, traditionally criticized for poor quality when evaluated against standards of evidence synthesis for meta-analyses and systematic reviews.^{36,37} The recent unfortunate retraction of a scientific journal article on hydroxychloroquine or chloroquine as treatment of COVID-19 highlights the risks of incomplete peer review at the level of primary data in a database.³⁸ The scientific community would do well to standardize the development of online protocols and to establish uniform evaluative criteria. One group in Brazil proposed a regimented process involving multiple parallel systematic reviews in alignment with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols³⁹ for use during the pandemic. Such standardization would be especially important if this format of information synthesis is needed in future crises.

The second shortcoming is that there is a high level of redundancy in web-based resources, especially evident when examining the types of resources under repository and formal promotion resources. We identified only 18 scientific

articles considered primary literature at the intersection of neurology and COVID-19, yet each was referenced by a median of 398 web-based sources, the majority of which shared identical purposes and promoted information without adding any meaningful value. Although this is not detrimental in terms of inaccuracy of knowledge propagation, it does suggest a very high level of accumulated wasted effort among many stakeholders in the dissemination pipeline, from individual academics to hospital centers to academic societies. We argue that academic institutions at the highest levels have the responsibility to consolidate media-based efforts that propagate knowledge such that its members do not need to rely on niche online resources. A recent example is the journal article–based assessment option for recertification piloted by the American Board of Psychiatry and Neurology, which has seen warm reception thus far⁴⁰ as expected, given that critics have long called for modernization and digitalization of continuing medical education.⁴¹ The communication technologies that spawned complex networks of unregulated influences on knowledge acquisition can also be used to facilitate collaboration between reputable academic societies to consolidate efforts at the highest levels.

The final shortcoming is that our model showcases the very central role social media plays on how clinicians access scientific literature, pointing them toward any of the types of resources in the other 3 domains. Social media is largely unregulated by definition, its contents random and components oftentimes distracting. Its effects are far-reaching, and erroneous information is easily propagated. Examples in which incorrect information spreads through social media is admirably acknowledged are rare⁴²; we assume that in the vast majority of cases, inaccurate information is propagated unnoticed. In addition, the pervasiveness of social media in society has called into question its effects on the attention span of the present generation. Its increasing encroachment on clinicians' academic lives may also blur the line between one's social and professional identities. As the influence of social media is expected to only grow stronger with advent of new technologies, further examination may be necessary from a sociotechnological standpoint, requiring the expertise of researchers outside our field to study how the clinician community acquires knowledge in the digital age.

Although we may use our new understanding of modern clinical knowledge dissemination to accelerate parts of the process (e.g., journal editorial teams may create podcasts, and researchers may design infographics to accompany their published works), the more important application is to address key problematic areas relevant to the pandemic and beyond. Urgent next steps include standardizing methods of rapid knowledge synthesis, consolidating redundant efforts to avoid collective waste, and regulating the influence of social media on knowledge dissemination. Certainly, these efforts are likely to be met with some opposition, as various stakeholders in the knowledge dissemination pipeline may be

resistant to change, including those engaged in rapid dissemination of information wishing to bypass the laborious process of peer review or creators of web-based niche resources who wish to remain relevant. Nonetheless, modern media is changing the landscape of clinical information flow faster than we are able to understand. We must continually examine the process to mitigate the risks of misinformation and optimize the ways clinicians interact with scientific literature such that they are best supported in the practice of evidence-based medicine.

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Appendix Authors

Name	Location	Contribution
K.H. Vincent Lau, MD	Boston University School of Medicine, MA	Designed and conceptualized commentary and drafted the manuscript
Pria Anand, MD	Boston University School of Medicine, MA	Designed and conceptualized commentary and drafted the manuscript

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