Teaching Deliberation and Restraint in Interpreting a Tempest of COVID-19 "Information"

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It is astonishing with how little reading a doctor can practice medicine, but it is not astonishing how badly he may do it.

—William Osler

Over the last year, coronavirus disease (COVID-19) has been identified in more than 85.3 million individuals, leaving a wake of more than 1.8 million deaths (1). As hospitals around the world struggled to cope with an unprecedented flood of critically ill patients, a concurrent torrent of information washed over the international medical community. This ocean of information expands on Osler's observation: How badly can medicine be practiced with uncritical reading? This raises the question: How can clinician educators teach trainees best practices for critical reading, not just in the classroom but amid the rapidly flowing currents of a pandemic?

The frenzied release of COVID-19 reports via unconventional platforms, such as preprint servers, news outlets, and social media, has resulted in a deluge of information, misinformation, and disinformation. This prompted the World Health Organization to reintroduce the term "infodemic," which is defined as "an overabundance of information—some accurate and some not—that makes it hard for people to find trustworthy sources and reliable guidance when they need it" (2). Indeed, as of December 2020, the National Library of Medicine has listed more than 85,000 COVID-19 citations (Figure 1) (3). In comparison, PubMed searches of the 2009 H1N1 influenza pandemic, the 2014 Ebola epidemic, and the 2015 Zika virus epidemic resulted in approximately 12,000, 3,000, and 2,000 publications, respectively, during their first years. Likewise, the preprint servers medRxiv.org and bioRxiv.org have listed more than 9,300 and 2,600 COVID-19 citations, respectively (4). Although these latter platforms are intended for communal dialogue as opposed to practice-changing proclamations, their lack of scrupulous peer review can lead to inaccurate reports plagued by missing data and inconsistencies. Unfortunately, these reports can be expeditiously propagated; for example, the original hydroxychloroquine trial, which used questionable methodologies, was noted to be referenced 520 times following its initial listing on medRxiv.org (5). Left unchecked, this type of flawed information can quickly circulate, as it was observed that from January 2020 through

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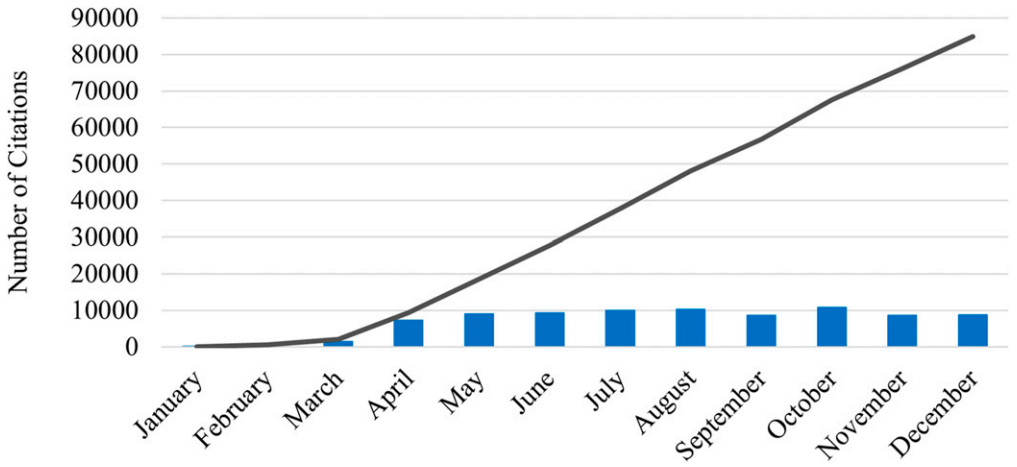

Figure 1. The monthly and cumulative number of coronavirus disease (COVID-19) citations from January 2020 through the end of December 2020 per the National Library of Medicine's LitCOVID database.

March 2020 there were more than 360 million videos uploaded to YouTube and more than half a billion posts on Twitter referencing COVID-19 (2).

This rapid distribution of information and implementation of therapies lacking scientific scrutiny has resulted in an unsustainable level of diligence and perspicuity, which sends a dangerous message to trainees: uncertainty is to be feared, and when faced with equipoise, it is good and even admirable to err on the side of "don't just stand there, do something," even when that "something" may be an expensive and potentially harmful intervention with insufficient evidence. Case in point were the adoption of potentially injurious interleukin-6 inhibitors and anticoagulation therapies to treatment protocols based on early provocative studies. With trainees closely observing clinician educators, it is paramount to maintain a high bar for translating new therapies to the bedside.

Despite the chaos, there are counter-strategies in motion that should be continuously developed. Medical societies and government organizations have worked tirelessly to consolidate the plethora of information to provide up-to-date guidelines based on the best available data (6). In addition, in response to expedited editorial review processes leading to more than 60 retractions including from high-caliber journals (7), there has been a reactive push by scientific journals to preserve strict, rigorous guidelines for publications (8). This, along with frequent study results being made available via press releases before peer review, has reinforced the notion that it is the ability of physicians to independently critically appraise scientific literature that is of utmost importance for the delivery of optimal care to patients (9). Despite pandemic stress and burnout, clinician educators must continue to be on guard for questionable information and, importantly, impart this vigilance to trainees. Now is the time to prize critical thinking and skepticism.

Critical—and, saliently, skeptical—thinking revolves around the persistent examination and questioning of knowledge assertions. Developing this skillset requires the lifelong reiteration and application of rationality, self-awareness, honesty, open-mindedness, discipline, and judgment. In 1995 Carl Sagan wrote, "In the course of

their training, scientists are equipped with a baloney detection kit. The kit is brought out as a matter of course whenever new ideas are offered for consideration" (10). Sagan asserts this "kit" contains the "tools" for skeptical thinking, and he goes on to argue how and how not to evaluate assertions of knowledge. For example, key logic fallacies he describes include the notions of "*ad hominem*," "*non sequitur*," "*post hoc, ergo propter hoc*," and "straw man." Important additions include independent confirmation, avoidance of a topic "authority," "Occam's Razor," confirmation bias, and short-term follow-up.

Not only is it necessary for clinician educators to impart these skills to trainees, the American College of Graduate Medical Education mandates that internal medicine residents and pulmonary and critical care fellows must be able to critically assess and implement scientific evidence (11). Specifics, however, are left to the clinician educators. One method for developing a curriculum is to revisit and use the five steps of evidence-based practice (EBP) as outlined by the International Society for Evidenced-Based Health Care (Table 1) (12). These steps were formalized in 2005 in response to the exponential growth of research over the last century to facilitate translating the best available evidence to the bedside. EBP concepts, specifically principles of biostatistics and epidemiology, are additionally necessary for established physicians and should be stressed in continuing medical education and recertification examinations. However, with the flood of information in the COVID-19 era, further education in information literacy and source credibility has now become crucial.

Succinct resources for identifying credible sources are readily available. For instance, one popular test wittily referred to as the "CRAAP Test" guides users to examine a source via its currency, relevance, authority, accuracy, and purpose (13). This questionnaire was developed in 2004 concurrent to the surge of Google after the authors were searching for a way to simplify information literacy training. However, a more comprehensive examination of information literacy is provided by a division of the American Library

Table 1. The five steps of EBP as described by the International Society for Evidence-Based Health Care (12)

Step 1	Ask	*Translation of uncertainty to an answerable question.* Ask a specific foreground question using PICO format.
Step 2	Search	*Systematic retrieval of best evidence available.* Comprehensively search scientific databases to obtain relevant evidence.
Step 3	Appraise	*Critical appraisal of evidence for validity, clinical relevance, and applicability.* Evaluate individual studies for design, validity, bias, suitability, and reliability while assessing their statistics.
Step 4	Apply	*Application of results in practice.* Translate evidence to the bedside integrating clinical expertise and patient values.
Step 5	Evaluate	*Evaluation of performance.* Reflect on the EBP process and the outcomes of applying the evidence. Communicate and disseminate these outcomes to other healthcare providers.

Definition of abbreviations: EBP = evidence-based practice; PICO = population, intervention, comparison, outcome.

Association, the Association of College and Research Libraries, who defines information literacy as "the set of integrated abilities encompassing the reflective discovery of information, the understanding of how information is produced and valued, and the use of information in creating new knowledge and participating ethically in communities of learning" (14). In 2015 the Association of College and Research Libraries developed a six-step framework for constructing an information literacy curriculum, underscoring *1*) authority is constructed and contextual, *2*) information creation as a process, *3*) information has value, *4*) research as inquiry, *5*) scholarship as conversation, and *6*) searching as strategic exploration (14). Although this framework is an exhaustive overview of information literacy requiring collaboration with academic librarians, it is viewed as a foundational process to specifically enhance EBP and critical thinking (15).

With the continuing advancement of communication technology, there will undoubtedly be future infodemics that surpass the current situation with COVID-19. Melding the components of EBP with information literacy to highlight critical thinking skills will help clinician educators filter and apply published medical information in a rational and responsible manner. Ideally, focused training of medical trainees in these skills will become universally incorporated in curricula, because the ability to decipher actionable medical "signals" from "noise" is crucial for abiding by our oath to *primum non nocere*.

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