

# Influencing the Culture of Scholarly and Professional Communities to Advance Clinical Research and Accelerate Knowledge Translation

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Professional and scientific associations that represent health care disciplines have a tremendous opportunity to help shape how evidence-based practice becomes integrated into the fabric of the professions that they support. Associations are membership organizations that are typically *not-for-profit* entities. Although their functions vary, common ways in which associations can bring value to a discipline include (a) advocating; (b) setting and enforcing ethical standards; (c) credentialing individuals; (d) accrediting academic training programs; (e) providing continuing education opportunities; (f) communicating news and other information through websites, magazines, blogs, and other social media; (g) publishing scientific journals; and (h) providing other forms of professional and scientific support to their membership. For associations whose members work in the health care sector, decisions made now about how best to plan and prioritize resources for the changing landscape in health care will likely play a critical role in determining how well these disciplines fare over the next decade. Actions taken by associations can affect the rate at which evidence becomes adopted into practice and, likely, the extent to which these practice changes result in improved patient outcomes. The nature of the efforts that are being marshaled by professional and scientific associations to “bridge the research-to-practice gap” are numerous, but perhaps the most promising among these are efforts that make use of big data, especially when coupled with text and data mining (TDM), semantic computing, and artificial intelligence. In this article, the need for and potential application of these technologies to advance evidence-based practice and health care quality will be described—as well as some of the more persistent and prevalent associated challenges in the adoption and implementation of evidence-based clinical practices.

The *data-driven health care*, *value-based purchasing*, and *pay-for-performance* trends in health care, as well as similar trends in other sectors such as K–12 education,

have given rise to many challenges that require strategically focused plans of action. Actions taken or not taken by professional and scientific associations over

the next few years may have far-reaching effects on the state and health of the disciplines that they support—and, taken together, the future quality of health care. Although there are undoubtedly many paths that could help health care disciplines and others to transition successfully into becoming more data driven and evidence based, inaction is not likely to be one of those paths. Arguably, a “we’ll do what we’ve always done in the ways we’ve always done it” response is not a wise approach in positioning a discipline to survive, and potentially thrive, in the context of radically new economic models of health care and education right at our doorsteps. In health care, the daunting complexity of the transition to value-based purchasing coupled with the abounding political uncertainty surrounding the Affordable Care Act (ACA), as well as numerous other policy and regulatory uncertainties, has made it very difficult to plan and act. However, the rapid development and adoption of web and computing technologies have made the range of possibilities for action broader than ever before—and the potential for success greater than ever before.

#### **Drivers of Change for Associations Focused on Health Care**

Over approximately the past 75 years, three areas have been evolving that have had formative effects on the priorities of the American Speech-Language-Hearing Association. The first is the evidence-based practice and implementation science movements, which encompass a host of efforts aimed at improving the quality of the scientific evidence, the rate of knowledge translation, and the effectiveness of clinical practice. Under the

umbrella of evidence-based practice/medicine, many standards and guidelines have been established to improve the design, conduct, and reporting of clinical trials and to reduce bias at every stage of the scientific process, including in the development of clinical practice guidelines. With the emergence of dissemination and implementation science, a new generation of research is being conducted to bridge the research-to-practice gap.

The second area of rapid change is health care—with specific attention given to the central role that outcomes measurement is playing in shifting to a value-based purchasing economy. According to Porter and colleagues (2012), “if nations place outcome measurement at the top of their reform agendas, they can begin to unlock forces of innovation and improvement that may yet help us realize the dream of financially sustainable, high-quality health care.” Their argument, from a business perspective, is that health care in the United States has never benefited from the forces of market competition because data has not been sufficiently available to allow comparisons of providers, facilities, or systems. To shift successfully to a value-based purchasing health care economy, outcome measurement needs to be mandated and the data made publically available. This vision has prompted many efforts to develop outcome measures and other quality indicators. It has also prompted recognition of the need to develop clinical data registries and a host of associated supporting efforts—such as determining which patient characteristics are most important to capture—so that data can be adjusted to

enable valid comparisons across providers, facilities, and systems, despite the heterogeneity of their patient populations and facility types.

The third evolution is big data and data science, an area that is redefining scientific publishing, boosting the scientific contribution of clinical data registries and electronic health records, and fueling the data-sharing revolution. A detailed account of the sources of these trends in evidence-based practice, health care, and big data is beyond the scope of this article. However, a discussion of some of the key thought leaders and drivers of change is included, as their contribution helps tell the story of how one scientific and professional association, the American Speech-Language-Hearing Association, is readying itself for the future. From across a broad mix of disciplines—such as epidemiology, business, computer science, medicine, social science, statistics, and more—many individuals and ideas have contributed to the aforementioned drivers of change. However, in our quest to improve the human condition through informed decision making based on trustworthy evidence, perhaps the largest game-changer will be the data itself as a contributing form of intelligence.

#### **Historical Roots of Evidence-Based Practice and Data-Driven Outcomes Improvement**

In the Introduction to his seminal monograph, *Effectiveness and Efficiency: Random Reflections on Health Service* (1972), Archibald Cochrane confessed that he long held the belief that “all effective treatments must be free” (p. 3). In fact, he stated that he originally wrote that slogan to be displayed on a banner at

a rally that he attended when the idea of a National Health Service (NHS) in Great Britain was being debated. During his years as a physician and a prisoner of war (POW), he observed that a large number of POWs with serious, life-threatening conditions survived incarceration without having received medical care. This observation and his experiences in epidemiology led him to the conviction that we need to be able to measure, without bias, the effects of any particular medical action on altering the natural course of health conditions. He termed this type of knowledge “effectiveness,” and his work led to the preeminence of the randomized controlled trial for establishing the efficacy of a clinical intervention. He also saw the necessity of being able to account for the costs of management, personnel and materials, and length of stay, among other things, to conduct realistic cost/benefit analyses of care. He termed this dimension “efficiency.” His experiences with the inequities of health care associated with poverty led him to herald another “E”—“equality”—which he declared as the third “yardstick” by which the success of the NHS should be measured. These terms have served as a compass ever since, guiding the evolution of health care policy, health care systems, analytic frameworks, and measure development in many countries—and they continue to guide discussions about how to improve health care quality in the United States. As one prominent example of this legacy, the terms *effective*, *efficient*, and *equitable* are now three of the six dimensions that the Institute of Medicine (2011a) recommends as principles to guide quality improvement efforts in health care and that the Agency for

Healthcare Research and Quality (AHRQ, n.d.) endorses as the analytic framework for quality assessment in health care. (The other three domains are *safe, patient-centered, and timely.*)

As these six quality domains became a cornerstone for assessing the return on investment for health care expenditures in the United States, organizations such as The Commonwealth Fund began to monitor health care quality across economically comparable nations. The Commonwealth Fund supports independent research that compares health care quality and expenditures across high-income countries. In the most recent report, *Mirror, Mirror 2017: International Comparison Reflects Flaws and Opportunities for Better U.S. Health Care*, 72 indicators designed to measure performance across five domains—Care Process, Access, Administrative Efficiency, Equity, and Health Care Outcomes—were compared across 11 high-income nations. As has been consistently the case, the United States ranked lowest with respect to overall quality and ranked poorest in three of the five domains—namely, Access, Equity, and Health Care Outcomes. Furthermore, the report stated that “the United States has the highest rate of mortality amenable to health care and has experienced the smallest reduction in that measure during the past decade” (p. 3). Of the 11 high-income nations included in the study, the United States is the only country lacking universal health insurance coverage. Including both private and public expenditures on health care, the United States spends nearly 17% of its gross domestic product (GDP) on health care. The country with the next highest percent of GDP spent on health care was

Switzerland (11.4%), and Australia spent the least (8.8%) of the 11 countries included in the comparison. According to another 2017 report from The Commonwealth Fund, *Aiming Higher: Results from a Scorecard on State Health System Performance*, “nearly all state health systems improved on a broad array of health indicators between 2013 and 2015. During this period, which coincides with the implementation of the ACA’s major coverage expansions, uninsured rates dropped and more people were able to access needed care, particularly those in states that expanded their Medicaid programs” (p. 3). Thus, despite the current political uncertainties regarding the fate of the ACA, as of October 2017 its implementation has been associated with significant improvements in the quality of and access to health care in the United States. That these authoritative data are not currently having a more influential effect on the policy makers who aim to dismantle the ACA—let alone on the millions of voters who stand to gain (or lose) so much pending the outcome of this debate—is a puzzling, yet somewhat predictable, phenomenon. It has become a common observation across many sectors that, even in situations where there is a strong body of compelling scientific evidence, behavior and attitudes do not necessarily change accordingly—and if they do, it is quite likely that the rate of such change will be slow and will spread only incrementally throughout a population.

In 1962, Everett Rogers published the first edition of his first book, *Diffusion of Innovations*, and coined this term to describe similar phenomena wherein new technologies, products, scientific findings, or other innovations are gradually

adopted by a population. As a doctoral student studying rural agricultural society at Iowa State University in the 1950s, Rogers became interested in modeling the usage patterns and rate at which Iowan farmers were adopting a new weed spray. The *diffusion of innovations theory* is broad enough to model how new ideas, products, scientific findings, and other innovations gain momentum and spread through a population or social system—or fail to catch on at all. In the theory, Rogers describes five different categories of adopters—innovators, early adopters, early majority, late majority, and laggards—and hypothesizes that the strategies most likely to promote adoption will vary based on the adopter category. In the fifth edition of his book in 2003, he put forth the innovation-decision process model and proposed five factors that shape the rate and likelihood of adoption—relative advantage, compatibility, complexity, trialability, and observability. His social science theory has been applied in many other fields—including communications, criminal justice, marketing, public health, and social work—and it has been particularly influential in dissemination and implementation science.

In 1984, Prochaska and DiClemente proposed the *transtheoretical model of change*, which expands on Everett's model of adoption to account for why people cease behaviors (or not). The slow rate at which Americans were ceasing to smoke cigarettes by the 1980s was unanticipated given the large body of convincing medical research linking smoking behavior to cancer and the omnipresence of antismoking campaigns. Prochaska and

DiClemente were motivated to understand what led to the success of some people and yet the failure of others in smoking cessation. Their research led them to develop a six-stage model of change through which individuals, or social groups, might progress: precontemplation, contemplation, preparation, action, maintenance, and termination. The notion of readiness for change is inherent in this model in that the actions associated with changing one's behavior are unlikely to occur if the person has not yet contemplated and prepared for the change.

Other theories of change that model the effects of the social environment and interpersonal influences also contribute to our understanding of how provider behaviors and attitudes might be influenced to promote the adoption of evidence-based practices. For example, consider two prominent theories highlighting the role that peer influence plays on individual decision making and behavioral change—the *social norms theory* developed by Perkins and Berkowitz (1986), which was developed to understand and reduce alcohol consumption and alcohol-related injury on college campuses, and the *social network theory* developed by Wasserman and Faust (1994). Social network approaches to changing behavior are showing promise as an effective way to help clinical providers consume clinical research and adopt evidence-based practices. Models of change may be helpful to advance our understanding of why the mere publication of scientific knowledge does not automatically or quickly result in behavioral and attitudinal change, regardless of whether the tar-

geted change entails adopting, stopping, or preventing behavior. These models may also be helpful in identifying successful strategies for bridging the research-to-practice gap.

### **The Emerging Science of Dissemination and Implementation**

Identifying the factors that influence the diffusion of innovations in science and medicine to practice and policy is a growing focus of research often referred to as *dissemination and implementation science*. This research seeks to narrow the gap between the discovery of new knowledge and its application by identifying the factors that influence the pattern and rate of change—and, ultimately, the maintenance of that change in people or systems. Estimates of the length of time that it takes for research to become translated into evidence-based policies, programs, and practices hovers between 15 and 20 years. For example, Morris, Wooding, and Grant (2011) reviewed the literature that attempts to quantify the time lag in the health research translation process. The title of their article sums up their findings: “The Answer Is 17 Years, What Is the Question: Understanding Time Lags in Translational Research.” They modeled the stages from innovation at the basic science stage, to testing with human/clinical trials, to guidelines development, to adoption in clinical practice—a process that took an average of 17 years based on the literature that they reviewed. Their findings are similar to the lag time reported in other dissemination and implementation research (see, e.g., Wolff, 2008). For both humane and economic reasons, Morris and colleagues (2011) argue the importance of speeding

up this process, and there is now an emerging consensus that evidence-based practices need to be more rapidly integrated into clinical care. However, translating science into clinical application is proving to be a very challenging process; the reality that failure is perhaps more common than success has led to comparing the bench-to-bedside translation process to crossing the “valley of death” (Meslin, Blasimme, & Cambon-Thomsen, 2013, p. 1).

From the inception of a research question to its dissemination and implementation stages, understanding the strategies and factors that can promote or hinder the uptake of new knowledge has become a central focus in health research. For example, in 1995, Andrew Oxman and colleagues published an article in which, once again, the title conveys the findings—*No Magic Bullets: A Systematic Review of 102 Trials of Interventions to Improve Professional Practice*. They searched the literature for studies that examined the effectiveness of dissemination and implementation strategies on changing behavior among health care providers. To be included in their analysis, the study had to report the outcomes of the implementation “intervention” using objective assessments of provider performance in the health care setting. The intervention types included educational materials, conferences, outreach visits, presentations by local opinion leaders, audit and feedback, reminders, marketing materials, local consensus processes, and more. They observed that “interventions to improve professional performance are complex” (p. 1427) and that complex interactions likely occur among “the characteris-

tics of the targeted professionals, the interventions studied, the targeted behavior, and the study design” (p. 1427). Although no one approach stood out as a clear front-runner (i.e., there was “no magic bullet”), they concluded that using a combination of dissemination approaches—perhaps the most important of which include social learning opportunities (e.g., journal groups)—“could lead to substantial improvements in clinical care derived from the best available evidence” (p. 1427). To achieve the goal that Cochrane (1972) originally inspired of better health through informed decisions based on trusted evidence, we will need to understand why, as Colditz (2012) put it, “discovery alone does not lead to use of knowledge; evidence of impact does not lead to uptake of new strategies; organizations often do not support the culture of evidence-based practice; and maintenance of change is often overlooked, leading to regression of system-level changes back to prior state” (p. 7).

Over the past three decades, quality metrics concerning the design, conduct, and reporting of clinical trials, evidence syntheses, and clinical practice guidelines have been developed. The unwavering aim of these metrics has been (a) to decrease the risk of bias and (b) to better ensure that research is reported and, ideally, conducted to maximize its usefulness for replication efforts and evidence syntheses. For the most part, the scientific community is welcoming the emergence of standardized reporting guidelines be-

cause stakeholders are recognizing that many of the key details needed for developing systematic reviews and conducting replication studies are not routinely reported in the clinical research literature (see, e.g., Hoffman, Chrissy, & Glaziou, 2013). As can be seen on the EQUATOR Network<sup>1</sup> website (<http://www.equator-network.org/>), more than 400 reporting guidelines have been developed for many types of clinical research, including randomized controlled trials (e.g., *Consolidated Standards of Reporting Trials* (CONSORT) – <http://www.consort-statement.org/>) as well as for the development of evidence-based systematic reviews (e.g., *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA) – <http://www.prisma-statement.org/>); and evidence-based clinical practice guidelines (e.g., *Appraisal of Guidelines for Research and Evaluation* (AGREE) – <http://www.agreetrust.org/>). With these developments, a level of consistency and rigor has been introduced that furthers the objectivity and value of the scientific process—an outcome that benefits researchers, students, journal publishers, editors, reviewers, health care providers, and, most important, patients. To fulfill the promise of evidence-based practice, however, there continues to be a dire need to increase the relevance of clinical research, the quality of scientific reporting, the readiness of providers, and the capacity of health care systems to support the implementation of evidence-based practices.

<sup>1</sup> The UK EQUATOR Centre is hosted by the Centre for Statistics in Medicine, Nuffield Depart-

ment of Orthopaedics, Rheumatology and Musculoskeletal Sciences (NDORMS), University of Oxford.

A key component of translating research to practice has been the development of evidence-based clinical practice guidelines. There are numerous definitions and uses of the term *guidelines*, including consensus guidelines, clinical guidance, quality statements and standards, clinical pathways, and evidence-based clinical practice guidelines. For most of the 20th century, practice guidelines were developed by professional societies, including the American Speech-Language-Hearing Association, based on the expert opinions of a selected subset of members. As payers became involved, they began to look to guidelines as a basis for making coverage decisions. Once payers themselves got into the guidelines business, those that they developed had unrealistically high evidence standards that generally could not be met. Many feared that payer-developed guidelines would be used mainly to absolve payers of the responsibility to cover all interventions except those that were most thoroughly researched and validated. The disconnect between guidelines developed by professional societies versus those developed by payers made it clear that a set of standards for guidelines development and quality appraisal was needed so that the same methods and quality standards could be applied regardless of the sponsoring entity. According to the Institute of Medicine (1990, p. 1), in 1989, Congress amended the Public Health Service Act to create the Agency for Healthcare Research and Quality (AHRQ; originally called the Agency for Health Care Policy and Research), largely to address this disconnect. Under the terms of Public Law 101-

239, AHRQ “has broad responsibilities for supporting research, data development, and other activities that will enhance the quality, appropriateness, and effectiveness of health care services. The creation of a practice guidelines function within [AHRQ] can be seen as part of a significant cultural shift, a move away from unexamined reliance on professional judgment toward more structured support and accountability for such judgment. Reflecting the first element of this shift, guidelines are intended to assist practitioners and patients in making health care decisions; reflecting the second aspect, they are to serve as a foundation for instruments to evaluate practitioner and health system performance” (p. 2-3).

In 2003, the era of consensus-based guidelines began a steady decline as the AGREE instrument for evaluating the process of practice guideline development and the quality of reporting was born. The Institute of Medicine (2011a) defined *clinical practice guidelines* as “statements that include recommendations, intended to optimize patient care, that are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options” (p. 1). A variety of stakeholders have used different methods to develop guidelines across different organizations and countries, but the Scottish Intercollegiate Guidelines Network (SIGN), the National Institute of Clinical Excellence (NICE), and Guidelines International (GIN) are the primary entities setting standards and providing tools for developing evidence-based clinical practice guidelines. As mentioned above, AGREE



is the most widely accepted set of standards by which the quality of clinical practice guidelines is evaluated. In addition, developers of clinical practice guidelines often use the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach to develop recommendations based primarily on findings from evidence-based systematic reviews (<http://www.gradeworking-group.org/>). The purpose of GRADE is to evaluate the quality of evidence and the strength of the proposed recommendations in a clinical practice guideline. GRADE uses five criteria to evaluate the quality of evidence: risk of bias, consistency of evidence, directness of evidence, precision in results, and publication bias. Based on these criteria, the overall quality of evidence is ranked and categorized into four levels. According to Langhoff-Roos and Shah (2016), the key concept behind the strength of recommendation in the GRADE approach is “the extent to which one can be confident that the desirable consequences of an intervention outweigh its undesirable consequences” (p. 844). All of the efforts that have been devoted to establishing quality standards for clinical research methodology, for reporting clinical research, for developing evidence-based systematic reviews, and for creating evidence-based clinical practice guidelines are moving us closer to bridging the research-to-practice gap. Unfortunately, the relevance of much of the biomedical and behavioral sciences research with respect to its applicability to clinical practice continues to be a very challenging shortcoming (Col-ditz, 2012).

### **The Promise of Clinical Data Registries as Learning Health Care Systems**

Clinical data registries hold much promise to fill in some of the gaps left unaddressed in the extant body of clinical research that has been initiated by individual scientists or teams of investigators. That *investigator-initiated* research may leave knowledge gaps is not surprising. Researchers necessarily focus deeply on specific topics and, understandably, may give less attention to how their research may be implemented in clinical practice or used to influence policy. Even for interventions whose effectiveness has been established with randomized controlled trials, typically little will be known about how well the intervention will work when applied to a wider range of patients and different settings than those included in controlled studies. Clinical data registries may help to fill in gaps in the body of investigator-initiated research. Moreover, because clinical data registries and electronic health records accumulate large samples of heterogeneous patient populations, there are questions that are arguably best addressed through big data and data science. Information about patient characteristics, the interventions applied, the outcomes of care, and the resources utilized can be amassed in clinical registries and analyzed to address the multifaceted question of “What works best for whom under which circumstances?” (see, e.g., Paul, 1967). This concept is described by the Institute of Medicine’s *Learning Health System Series* (2011b). The report states that “health and health care are going digital. As multiple intersecting platforms

evolve to form a novel operational foundation for health and health care—the nation’s digital health utility—the stage is set for fundamental and unprecedented transformation. Most changes will occur virtually out of sight, and the pace and profile of the transformation will be determined by the stewardship that fosters alignment of technology, science, and culture in support of a continuously learning health system. In the context of growing concerns about the quality and costs of care, the nation’s health and economic security are interdependently linked to the success of that stewardship. Progress in computational science, information technology, and biomedical and health research methods have made it possible to foresee the emergence of a learning health system that enables seamless and efficient health delivery of best care practices and the real-time generation and application of new knowledge. Increases in the cost and complexity of care compel such a system” (p. 1).

Central to the goals of cost containment and budgeting health care expenditures is the ability to predict that, based on the incidence of a given condition, a given number of individuals will need a given regiment of treatments at an estimated annual cost. At a minimum, four data domains are needed to inform predictive models of health care expenditures and to serve as a learning health care system, including information about patients (case-mix data), the services and interventions provided, the outcomes of care, and an accounting of the resources utilized to achieve these outcomes. Payment systems based on predictive modeling need first to be able to predict, based

on historical data, the rehabilitation potential of individual patients and then, based on evidence about which approach to intervention is likely to be most effective for a given type of patient in a given circumstance, predict the resources that will be required to achieve pre-specified rehabilitation goals. According to Massof (2010), the primary goal for such modeling is to predict the probability of obtaining a specified outcome given a mix of patient-specific factors and the choice of interventions. As patient factors mediate the effects of services on outcomes, case-mix-adjusted data are necessary to compare the effectiveness of different interventions and to model the costs and benefits of providing services for specific patient groupings.

With clinical data registries and data science added to the arsenal of clinical research methods, we can move beyond asking, “What works?” to addressing, “What works best for whom under which circumstances?” As put forth by Rogers and Mullen (2012), it is unlikely that we will be able to address this multifaceted question solely through investigator-initiated research. They assert that large-scale data collection instruments that amass information across each of the four data domains mentioned above are necessary so that adequately powered analyses can be conducted to identify the effects that case-mix and service delivery factors have on patient outcomes. The vision of a learning health care system is that analyses of large clinical data repositories will provide information about what works best for whom under which circumstances. Based on these analyses, decisions will be made about how services and outcomes might be improved.

After providers and systems make targeted adjustments, the newly collected data will provide information about the relative success and failure of the adjustments. Within the context of a learning health care system, data collection, analysis, change, and learning are cyclical, iterative stages. Learning health care systems are anticipated to accelerate the rate at which evidence-based practices and innovations in health care become adopted; thereby, reducing the research-to-practice gap.

#### **Data-Driven Publication Strategies for Straightening the Path to Implementation**

As noted previously, the gap between discovery of new knowledge and its implementation can be quite large, and the potential barriers to implementation can be so varied that there is no magic bullet for how to infuse evidence-supported changes into practice across the board. Although the optimal path to any given implementation may be unclear, there are a number of ways that professional and scientific associations can leverage their innate strengths to increase the precision and efficiency of implementation strategies. This is particularly true now because of the shift to a much more data-based and data-driven journal publishing enterprise that has unfolded over the past two to three decades.

Whereas the initial three centuries of journal publishing involved some structured data in the sense of the articles themselves having a defined, sectioned format and both the articles and the journals having bibliographic elements sufficient for tracking and organization of the collection of outputs over time, it was not until the online publishing era that true

structuring began to be put in place. Covering that evolution could itself fill many pages—and has (see, e.g., Ware & Mabe, 2015)—but a key milestone in that evolution was the relatively recent shift to the article, rather than the journal, being the “unit.”

In an article-based economy, the entire publishing workflow changes. Rather than hold articles for publication until, say, the next quarterly issue of a clinical practice journal, publishers (including the American Speech-Language-Hearing Association) have increasingly adopted continuous publishing models so that important research can be released as soon as it is ready to be read and used. In practical terms, this shaves off a period of time, often up to several months, from the overall amount of time that it takes to get new knowledge into implementation. With a timeline of 17 years associated with implementation, every such reduction counts.

Because of the focus on article-based publication, publishers have sought competitive advantage in time-to-market, and that has led to more radical reductions in the amount of time from the report of findings to the availability of that information in the environment where application of it can be made. Standardization at the XML markup level is now more typically relied on from submission all the way through to the production and publication of research. And it is increasingly driving a shift in the authoring process, as well. In aggregate, the standardization of the data behind the full range of the publication steps has certainly shaved off another several months to a year or more from the time it takes for new knowledge to get into discovery and use.

Likewise, concomitant with this now accelerated flow of new knowledge into the discovery environment, the same data standards underpinning its processing and production are also driving the means of discovery itself. In the era of the issue-based publication model, massive “stacks” of information developed and were archived in libraries and, eventually, stored in online repositories and aggregations, both accessible through a search approach where success was as variable as the searcher’s facility with query construction. In the semantic publishing era, very granular tagging is applied to articles so that a publisher’s platform can display articles in automatically curated collections by topic and can dynamically link related articles, thereby extending a user’s discovery. This, then, shaves additional time from the discovery phase of acquiring and applying new knowledge, although it would be hard to quantify the level of reduction in any meaningful way, given the breadth of disciplines and pace of development of research lines. In aggregate, savings here may more realistically be considered a factor mitigating against the sheer difficulty of coping with the greatly increased flow of new knowledge into the system, as made possible by the previously covered advances.

More important, the opportunities afforded by semantic tagging allow the publisher to offer a well-organized, highly accessible library of information versus a merely browsable online collection of articles that had been produced in print. In the article-based economy, with semantic data better characterizing the articles and being used to drive additional pathways into the stacks and away

from arrived-at articles to other articles that otherwise might not have been found, the deeper opportunity now exists for such publishers to better assess the actual patterns of knowledge acquisition or attempted knowledge acquisition—and to marry up those patterns with future curation and promotion activities. The opportunity is thus greater than ever for the society publisher to be a valued connector in the process of bridging research to practice, by virtue of that central, high-value information resource.

In addition to semantic data and the opportunities presented by it, the online article-based economy and its prevailing standards related to the objects themselves, such as the digital object identifier (DOI), have driven significant advances in other forms of data, such as attention-level metrics. A user can now rely on altmetrics, for example, to track how research has been used so far and by whom. For a publisher, imagine the value of that type of multifaceted data layered onto semantic usage data. Just over 10 years ago at the American Speech-Language-Hearing Association, for comparison purposes, virtually none of that data existed. Issues were produced and shelved at libraries or physically placed in mailboxes, and citation data years down the line were the only approximate gauge of how published research was being used.

This is truly the revolutionary point at which the gap between output (research) and use (practice) can begin to be more effectively observed and appraised. On the near-term horizon (and, in some cases, already in place) are advances such as text and data mining layers in publishing platforms, so that automated analyses

of the nature of patterns of research (including populations addressed, techniques used, and types of data derived) can be performed vastly more quickly and precisely. In addition, systems providing predictive analytics on citation likelihood are now being put into place. At the user level, the now more commonly in place HTML5 web standards are allowing for greater annotation of content and incorporation of it into shared learning activities.

All of these advances are emblematic of the tide of big data flooding all publishers. For the society publisher, deriving intelligence from that flow and leveraging it alongside programmatic efforts aimed at bridging the research-to-practice gap amounts to a fundamentally different business than what scholarly publishing formerly offered an association. The publishing enterprise within associations must be retooled accordingly, with a greater emphasis placed on strategizing with editors, working more directly with authors, and focusing on different domains—away from day-to-day production and toward a fuller embrace of science writing, content curation, and well-developed curation and promotion skills, especially those focused on support of learning-based usage contexts. If the past two decades have been any guide, the next two should lead to measurable improvements in reducing the gap from research to practice.

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