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Historical Roots of Dissemination and Implementation Science

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INTRODUCTION

A worldwide science of dissemination and implementation (D&I) has emerged, driven by new media, the interests of philanthropies and the needs of government agencies, and the persistent and growing applied problems that have been addressed but not solved by the dominant research paradigms in disciplines such as psychology, sociology, and political science. Dissemination science is being shaped by researchers in the professional and applied fields of study, including public health, health services, communication, marketing, resource development, forestry and fisheries, education, criminal justice, and social work. A number of peer-reviewed journals[1–10] have since 2004 devoted special issues/sections to the topic of dissemination or implementation of evidence-based practices.

Research about D&I is a response to a general acknowledgment that successful, effective practices, programs, and policies resulting from clinical and community trials, demonstration projects, and community-based research as conducted by academicians very often do not affect the services that clinical staff, community service providers, and other practitioners fashion and provide to residents, clients, patients, and populations at risk. In any one societal sector (populated, for example, by planners for health care delivery, or city-level transportation and parkway planners), the state of the science (what researchers collectively know) and the state of the art (what practitioners collectively do) coexist more or less autonomously, each realm of activity having little effect on the other. In the United States, this situation has been referred to as a "quality chasm" by the US Institute of Medicine.[11]

Dissemination science is the study of how evidence-based practices, programs, and policies can best be communicated to an interorganizational societal sector of potential adopters and implementers to produce uptake and effective use, such as among clinics on behalf of patients or among elementary schools on behalf of children. This definition means that dissemination embeds the objectives of both *external validity*, the replication of positive effects across dissimilar settings and conditions, and *scale-up*, the replication of positive effects across settings and conditions.[12] A *potential adopter* is someone who is targeted by a change agency to make a decision about whether to try an *innovation*, an idea, practice, program, policy, or technology that is perceived to be new. In public health or health care delivery, the innovation may be an evidence-based intervention that shows the potential to improve the well-being of a segment of a population.

Implementation science is the study of what happens prior to, and after, adoption occurs, especially in organizational settings. Many studies of implementation focus on field-based tests of external validity to understand the extent to which an evidence-based program or practice will still be effective when subjected to realistic practice conditions. A smaller proportion of implementation research concerns post-adoption behavior among practitioners under actual practice conditions, when implementation and sustainability traditionally have gone unobserved. An *implementer* is someone who will actually change his or her behavior to use an innovation in practice. In organizations, the people who make the decision to adopt an innovation are often not the users of innovations. The extent and quality of implementation and client or constituent responses to it have become dependent variables of study just as important, and sometimes more important, than initial adoption. Implementation researchers have not much studied sustainability,

which may be even more important than implementation, though this is beginning to change.[13] So dissemination science and implementation science merge the study and objectives of diffusion with those of organizational change. For example, public health researchers or practitioners can conduct combined D&I studies that target many county departments of public health with a new disease prevention program (a dissemination study objective) and then focus on understanding what is done with the program in a purposively derived sample of all adopting departments (an implementation study objective). The questions by public health researchers and practitioners about D&I can lead to rather different but perhaps equally fascinating projects, including questions such as:

- For a given public health program, does the change agency target types of organizations that are the most logical adopters serving the most needy clients or populations, or does the change agency simply target convenient or familiar organizations that they could easily contact because of a preexisting database?
- Does the change agency develop messages about the new program based on systematic formative evaluation?
- To what extent does the change agency strategically consider *when* to introduce the new program or do they just disseminate information as it becomes available?
- What is the competition for attention from the proponents of other similar programs and how does this change over time?
- What proportion of organizations targeted with dissemination messages respond by contacting the change agency for more information?
- How many try the new program (which might qualify them as adopters) of all those targeted (a measure of *reach*)?
- Was the program truly new conceptually to decision-makers in the adopting organizations, or were they already experimenting with similar programs?
- Do some organizations invest resources in adoption (taking the time to learn about the program, pay licensing fees, attend trainings, order booklets and train-the-trainer materials, become certified as coaches, etc.) but then never implement the program?
- What proportion of adopting organizations actually offer the program but then discontinue it?
- How many organizations stay in a holding pattern of adopting/not implementing/not discontinuing?
- What proportion of implementers offer the program as its designers intended with the same content, same number of modules, same behavior stimuli, same support, and checks on enrollee or client performance?
- What types of adaptations to the program are made by implementers? Do they offer all the program's core components? Are they true to the program's theory of behavior change? Do they drop some components, customize others, and/or create their own to better suit their organization and their clients?
- Does the implementing organization change in ways unanticipated by the program designers? Does learning the one program serve as a trigger or precipitating event for organizational decision-makers to adopt other, consonant or complementary public health programs?
- Do implementers think they are offering the program as the designers intended but, in practice, do something quite different?
- What is the client or enrollee yield? How many individuals sign up? How many complete all modules or classes? How many people actually do the variety of behavior changes—wearing pedometers, meeting in groups, writing in diaries, coming to class, completing their workbook, monitoring their progress—as suggested (and tested in efficacy trials) by the program designers?
- Is the public health program sustained by the organization? Do clients or enrollees continue their participation, too? Is fidelity or adaptation a better predictor of sustainability?
- What are the individual outcomes (weight loss, muscle tone, etc.) and public health impacts (for example, proportion of obese people in intervention communities)?
- How can implementers identify opinion leaders who are looked to by others for advice and example for practice improvement?
- How can cutting-edge computational approaches help health researchers

understand public attention and emotion toward health issues?

Given this range of dissemination science and implementation science questions that can be studied, it can be argued that these foci represent a most important type of diffusion of innovations study. The key, we suggest, is the stimulation of or tapping into intrinsic motivation of the staff in public health, health care and other types of organizations and among their clients and program enrollees in communities. Certain innovations are met with enthusiasm, open arms, and eager learners who go on to champion new programs and advocate them to others. Innovations spread rapidly when people want them and can access them.

Where does the current emphasis on D&I science come from? How are new media altering the diffusion of new practices, programs, and beliefs? We turn to the diffusion of innovations paradigm to address these questions.

THE CLASSIC DIFFUSION PARADIGM

Diffusion is the process through which an innovation is communicated through certain channels over-time among the members of a social system.[14] For example, Barker[15] reports on three international development efforts in relation to diffusion concepts. In Haiti, a United States Agency for International Development (USAID) effort to conduct HIV prevention education in rural villages identified and recruited village voodoo practitioners, who are almost always considered credible and trusted sources of advice by Haiti villagers, to encourage villagers to participate in village meetings with USAID change agents. Meeting attendance exceeded campaign objectives by 124%. In Nepal, where vitamin A deficiency contributes to very high rates of infant and maternal mortality, the innovation of kitchen gardens was diffused among households through neighbor social modeling, resulting in heightened knowledge, positive attitudes, increased vegetable and fruit growing and consumption, and improvements in vitamin A nutrition. In Mali in 1999, a study of 500 Malian youth evaluated their information-seeking behavior and perceptions of source credibility concerning reproductive health. A lack of accurate knowledge among youth was attributed to their most trusted sources of information being friends and siblings; youth did not consider information sources such as health agents and teachers to be accessible enough or trustworthy. In all three cases, the innovations of HIV prevention education, kitchen gardens, and reproductive health information are unlikely to impact Haitian villagers, Nepali infants and mothers, and Malian youths if the diffusion process is not stimulated by accessing trusted, informal opinion leaders.

Diffusion studies have demonstrated a mathematically consistent sigmoid pattern (the S-shaped curve) of over-time adoption for innovations that are perceived to be consequential by potential adopters, when the decisions to adopt are voluntary as opposed to them being compulsory, and with attendant logically related propositions, qualifying this literature as a theory of social change.[16] Many studies have shown a predictable over-time pattern when an innovation spreads, the now familiar S-shaped cumulative adoption curve. The "S" shape is due to the engagement of informal opinion leaders (as in Barker's study reported earlier) in talking about and modeling the innovation for others to hear about and see in action (Figure 3.1). For any given consequential innovation, the rate of adoption tends to begin slow, accelerate because of the activation of positive word of mouth communication and social modeling by the 5% to 8% of social system members who are sources of advice (i.e., opinion leaders) for subsequent other adopters, and then slow as system potential is approached. Box 3.1 provides a summary of the evolving opinion leader research for D&I interventions.

Key components of diffusion theory are:

1. The *innovation*, and especially potential adopter perceptions of its *attributes* of cost, effectiveness, compatibility, simplicity, observability, and trialability (see Table 3.1)
2. The *adopter*, especially each adopter's degree of *innovativeness* (earliness relative to others in adopting the innovation)
3. The *social system*, such as a geographic community, a distributed network of collaborators, a professional association, or a province or state, especially in terms of the *structure* of the system, its informal *opinion leaders*, and potential adopter perception of *social pressure* to adopt
4. The *individual adoption-process*, a stage-ordered model of awareness, persuasion, decision, implementation, and continuation[34]

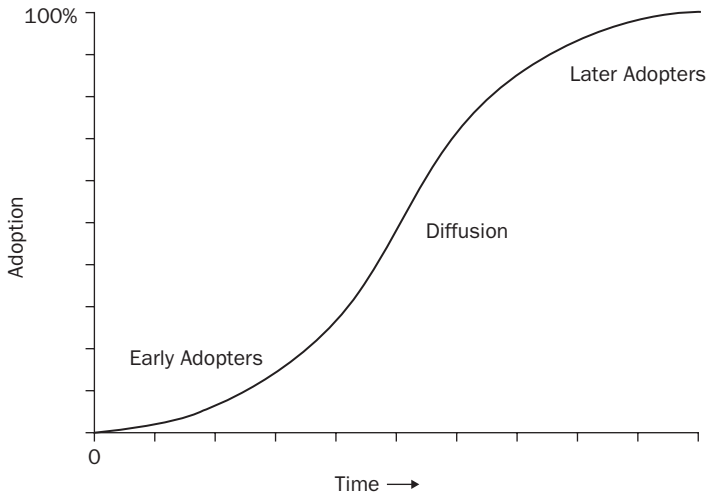

FIGURE 3.1 The generalized cumulative curve that describes the curvilinear process of the diffusion of innovation.

5. The *diffusion system*, especially an external *change agency* and its paid *change agents* who, if well trained, correctly seek out and intervene with the client system's opinion leaders and paraprofessional aides, and support the enthusiasm of unpaid emergent innovation champions

Diffusion occurs through a combination of (1) the need for individuals to reduce personal uncertainty when presented with information about an innovation and (2) the need for individuals to respond to their perceptions of what specific credible others are thinking and doing, and to generally felt social pressure to do as others have done. Uncertainty in response to an innovation typically leads to a search for information and, if the potential adopter believes the innovation to be interesting and with the potential for benefits, a search for evaluative judgments of trusted and respected others (informal opinion leaders). This advice-seeking behavior is a heuristic that allows the decision-maker to avoid comprehensive information-seeking, reflecting Herbert Simon's seminal insight about the importance of everyday constraints in "bounding" the rationality of our decision making.[35]

Needs or motivations differ among people according to their degree of innovativeness (earliness in adoption relative to others): The first 2.5% to adopt (*innovators*) tend to do so because of novelty and having little to lose; the next 13.5% to adopt (*early adopters*, including the subset of about 5% to 7% informal opinion leaders) do so because of an appraisal of the innovation's attributes; the subsequent 34% of early majority adopters and 34% of late majority adopters do so because others have done so. They come to believe that adoption is the right thing to do (an imitative effect rather than a carefully reasoned rational judgment). The last 16% to adopt do so grudgingly with reservations. Their recalcitrance is sometimes later proved to be well-justified, since new programs can have undesirable consequences.

One's orientation to an innovation and time of adoption are related to and can be predicted by each adopter's structural position in the network of relations that tie together a social system such as a school, community, or even a far flung professional network. When viewed sociometrically (especially who-seeks-advice-from-whom within a social network) in two-dimensional space, the pattern of diffusion begins on the periphery of a network as the first to try the innovation experiment with it; central members of the network—informal opinion leaders who are a special subset of early adopters—then adopt if they judge the innovation to have important advantages over current practices; the many others then follow, who pay attention to what these sociometrically central and highly connected network members do and advise.[36] This outside-inside-outward progression of adoption, when graphed as the cumulative number of adoptions over time, reflects an S-shaped diffusion curve (see Figure 3.1).

BOX 3.1

EMPIRICAL IDENTIFICATION OF OPINION LEADERS

Opinion leaders are "individuals who exert an unequal amount of influence on the decisions of others"[17] within a social system. They can play important roles in the diffusion of creative ideas, innovative products, and new practices. Although the conceptualization of opinion leaders is rather clear, the empirical identification of opinion leaders has proved nontrivial.[18] In the past, self-reported individual attributes, such as education degree, social-economic status, and trustworthiness, were employed to measure individuals' opinion leadership. However, such attribute-based measurement does not well capture the influence-susceptible relationship between opinion leaders and followers, which is central to Rogers and Cartano's conceptualization of opinion leaders.[19] Advances in network science can be combined with marketing approaches to help dissemination and implementation researchers identify and intervene with opinion leaders for health.[20]

Individual persons or groups in a social system are considered network nodes, which can be connected with one another via multiple types of links based on their similarities, social relations, interactions, or flows.[21] Such networks can be examined at the macro level to discover statistical regularities, at the meso level to reveal structural organizations, and at the micro level to uncover the positions occupied by individuals in a social system.[22] Micro-level analysis can allow researchers or practitioners to identify who is better connected in a social system and who is less so. Individuals in better connected positions have greater influence than those in poorly connected positions,[23] as the latter are dependent on the former for valued resources (e.g., knowledge, evaluation, and investment). Network science provides an array of centrality metrics to quantify the "better connected" positions, including degree centrality, closeness centrality, betweenness centrality, and eigenvector centrality.[24–26] More on network science is found in chapter 10.

These four metrics have been used separately or in combination to identify opinion leaders for various health issues (e.g., obesity, HIV/AIDS, and smoking) among the general public,[27,28] medical professionals,[29] and specific groups of patients.[30] Albalawi and Sixsmith[27] employed the degree centrality of Twitter users to identify which users have the potential to raise awareness of health issues and advocate for health in Saudi Arabia. They identified 100 accounts with the greatest potential to influence, including religious men/women, traditional media, commercial companies, sports-related accounts, politically related accounts, and health accounts. Holliday et al.[28] developed a peer support network among high school students in the United Kingdom and employed the degree, closeness, and betweenness centrally metrics to identify and engage opinion leaders.

In addition to these four centrality metrics, network scientists have developed more sophisticated algorithms to identify opinion leaders in social networks, such as the stability-sensitivity method,[31] the path counting method,[32] and VoteRank.[33] These metrics and algorithms can be applied in D&I science to help researchers and practitioners better understand, detect, and engage opinion leaders, which can facilitate the diffusion of ideas and practices among certain populations.

Forefathers of the Diffusion Model

The French judge cum sociologist Gabriel Tarde explained diffusion as a societal-level phenomenon of social change in his 1902 book, *The Laws of Imitation*, including the identification of an S-shaped curve in cumulative adoptions over time, the role of conversation in producing mimicry, and the importance of informal opinion leaders in jumpstarting the S-shaped curve. As a judge, Tarde had taken note of the way people coming before the bench used new slang and wore new clothing fashions as if on cue. In Germany at the same time, Georg Simmel, a political philosopher,

TABLE 3.1 DEFINITIONS AND APPLICATION OF INNOVATION ATTRIBUTES

Innovation Attributes	Definitions	Application to Public Health and Health Care Delivery
Cost	Perceived cost of adopting and implementing an innovation	How much time and effort are required to learn to use the innovation and routinze its use? How long does recouping of costs take?
Effectiveness	The extent to which the innovation works better than that which it will displace	Does a gain in performance outweigh the downsides of cost? Do different stakeholders agree on the superiority of the innovation?
Simplicity	How simple the innovation is to understand	How easy is an evidence-based program for adopters/implementers to understand and/or if it requires a steep learning and much training before actual implementation?
Compatibility	The fit of the innovation to established ways of accomplishing the same goal	How much/little would an evidence-based program disrupt the existing routine and/or workflow of the adopting/implementing organization?
Observability	The extent to which outcomes can be seen	How much and/or how quickly will the results of an evidence-based program become visible to an implementing organization, its clients, funders, and peer organizations?
Trialability	The extent to which the adopter must commit to full adoption	If an evidence-based program can be implemented as a pilot project without much investment and be abandoned without incurring much sunk cost?

was writing about how individual thought and action was structured by the set of interpersonal relations to which a person was subject. Tarde's perspective was the forerunner for the macro, social system perspective on diffusion as the means by which cultures and societies changed and progressed. Simmel's contribution, explicated in his book, *Conflict: The Web of Group Affiliations*, was the forerunner for understanding how social network position affects what individuals do in reaction to innovations, and when. Together, these perspectives provided an explanation for how system-level effects pressured the individual to adopt new things, and how individuals can affect change through their relationships in social networks.

Following Tarde and Simmel, European anthropologists seized on diffusion as a means to explain the continental drift of people, ideas, means of social organization, and primitive technologies. American anthropologists such as Alfred Kroeber in the 1920s also conducted historical studies but they confined their analyses—for the first time called *diffusion* study—to more discrete innovations in smaller social systems such as a community or a region of the country. Anthropologists studying diffusion focused not only on spread of innovations but on how cultures in turn shaped those innovations[37] by giving them new purposes and by adapting them to suit local needs—the beginnings of what we now call implementation science. The studies of these early diffusion researchers encouraged sociologists to take up diffusion work in contemporary 1920s and 1930s society, focusing on informal communication in friendship or social support networks as an explanation for the city-to-rural spread of innovations, the importance of jurisdictions as barriers to diffusion, and the importance of proximity to the spread of ideas.[38] And diffusion was not only understood as a one-way process: The American sociologist Pitirim Sorokin saw diffusion as inherently recursive. More developed countries extract raw materials from developing countries and send back finished goods; classical music composers, for example, absorb ideas from folk tunes into the creation of symphonies.[36] Public health and health care can be interpreted

recursively, too: Epidemiologic data about communities and practice-based research results are "diffused" to researchers, who develop new public health and health care interventions and seek to disseminate them back to those same practitioner systems and communities.[39]

A landmark event for diffusion science occurred in 1943 with a report on the diffusion of hybrid seed corn in two Iowa communities.[40] This seminal article set the paradigm for many hundreds of future diffusion studies by emphasizing individuals as the locus of decision, adoption as the key dependent variable, a centralized innovation change agency that employed change agents, and the importance of different communication channels for different purposes at different times in the individual innovation-decision process. The Ryan and Gross article propelled diffusion study to center stage among rural sociologists. It also made the application of diffusion concepts a key set of tools in the work of agricultural extension agents. Rural sociologists were closely wedded to the extension services for funding and for providing the distribution system by which diffusion study ideas could be tested. The academics were practice oriented. From 1954 to 1969, key faculty in the Iowa State University Department of Sociology gave an estimated 600 presentations about the diffusion process, many to extension service groups. In 1958 alone, there were 35 publications reporting diffusion data collected in the United States by rural sociologists. Six years later, rural sociology publications about diffusion in less developed countries reached a peak of 20.[41] Diffusion studies by rural sociologists began to wane in 1969, but by that time scholars in sociology, medical sociology, education, communication, and public health had begun diffusion research, such as Coleman, Katz and Menzel's classic study of physician's drug-prescribing behavior as a result of social network ties.[42]

Synthesizing the Diffusion Paradigm

The diffusion of innovations paradigm began to synthesize its approaches, central challenges, and lessons learned beginning in the 1960s. Internationally, an "invisible college" of rural sociologists had formed based in the American Midwest, drawn together both by intellectual questions and funding opportunities for research into a coauthorship, collaborative, and competitive network.[43] As these questions were answered by rural sociologists, diffusion research became fashionable to scholars in other disciplines and fields who conceptualized somewhat different problems, especially concerning policymakers as adopters and the conditions of innovation and spread in complex organizations. Yet diversification did not limit the centrality of diffusion scholarship as it importantly related to the growing paradigms of knowledge utilization and technology transfer studies and then to the evidence-based medicine movement.[44]

Everett M. Rogers, trained as a rural sociologist at Iowa State University, defended his dissertation in 1957 after growing up poor on an Iowa farm.[45,46] While the dissertation was ostensibly about the diffusion of 2-4-D weed spray among farmers, Rogers' real interest was in drawing generalizations that he believed were warranted on the basis of commonalities he had discovered by reading diffusion studies being published in different fields. The authors of the studies were not aware that other researchers were studying diffusion in fields different from theirs. Rogers expanded his chapter 2 literature review into the 1962 seminal book, *Diffusion of Innovations,* synthesizing what was known about diffusion in general terms. His modeling of diffusion as an over-time social process and, at the individual level, as a series of stages that a person passes through in relation to an innovation would soon come to be recognized across fields of study as the diffusion of innovations paradigm. Though Rogers[47] would remain for decades the single most recognizable name associated with the diffusion of innovations, many other scholars were studying diffusion. And many diffusion scholars took a slightly different approach than Rogers. Many of these scholars were former students and colleagues of his; their contributions continue to push the paradigm forward and outward. In particular, some working in the paradigm took a macro structural perspective on diffusion, especially those in population planning, demography, economics, and international relations. Anthropologists studying the spread of culture and linguists studying the spread of language also preferred a structural perspective on diffusion, which conceptualized waves of innovations washing over societies. To these structuralists, the study of diffusion was the study of social change writ large. For them, units of adoption are countries or cultures.

This macro orientation to diffusion was highly enticing to scholars because of its deductive and parsimonious potential based in a simple mathematical law of nature that describes a

logistic (S-shaped or exponential) growth curve. Marketing scientists, epidemiologists, demographers, and political scientists instantly appreciated the predictive potential and eloquence of the population perspective on diffusion. Mathematical modeling formed the basis of this work, most of which continues today in fields such as family planning apart from more qualitatively informed micro-level studies of diffusion.[48]

So a major part of Rogers' contribution was in persuasively showing how macro-level processes of system change could be linked to micro-level behavior. These ideas harkened back to Simmel and Tarde, that individuals were influenced by system norms, and system structure and rules were the cumulative results of individual actions. Diffusion was one of the very few social theories that persuasively linked macro with micro-level phenomena.

KNOWLEDGE UTILIZATION AND TECHNOLOGY TRANSFER

The agricultural extension model, with its basis in the training of social change concepts to full-time staff who were experts in areas such as cherry blight, zebra mussel eradication, and pine beetle control, was critical to the popularity of the diffusion of innovations paradigm. It was also important in the genesis of two closely related bodies of research. *Knowledge utilization* has been a robust paradigm for 40 years; its central problem was not how a new practice came to be voluntarily adopted by many people, but rather how knowledge in the form of prior results of a social program (the effectiveness of school busing, or of curbside recycling, or of business enterprise zones in cities) affected the subsequent decisions of elected representatives and policy staff in government. This is another route to social change, one that relies more on policy action by formal authorities followed by the compulsory adoptions of others than the traditional diffusion attention to informal influence. Were ineffective programs phased out by policymakers while effective programs were replicated and expanded? Did the social and education programs that managed to spread across the American states deserve to spread? The key intellectual contributor to this paradigm was the education scholar, Carol H. Weiss.[49] Weiss' studies of policy decision-making showed that rational expectations between evidence and program continuation/expansion were not supported by social science study. And beyond the expectation of a rational outcomes-to-funding relationship, Weiss and other knowledge utilization researchers of the policymaking process showed that any direct program evaluation-to-policy decision link was rare; rather, policymaking was inherently political.[50] Many more factors besides evidence of program effectiveness factored into decision-making.[51] When program evidence did affect subsequent decisions by policymakers, it did so through a circuitous cumulative learning by policymakers and staff as they became "enlightened" over time in terms of general programming lessons. In a gradual, accretionary way, indirect and partial knowledge diffusion did occur.

From the perspective of knowledge utilization, Blake and Ottoson[52] maintain that dissemination is the process of moving information from one source to another (as from program evaluators to policy makers), and the ultimate purpose of dissemination should be utilization by users. When utilization by users is achieved, information/knowledge has impact. This perspective has evolved with the field of knowledge utilization studies, through "waves" of research from the empirical studies in the 1940s by rural sociologists to studies of international development and family planning in the 1970s, to research in the 1990s about how research could improve human services in health and education.[53,54]

Researchers studying *technology transfer* identified a different problem. Beginning with Mansfield in the 1960s, scholars such as Leonard-Barton and von Hippel focused on the firm, especially complex organizations such as multinational corporations that partly by virtue of their size exhibited problems of coordination, knowledge sharing, and even knowing what was going on across its many divisions let alone having a managerial system for knowing which practices were more effective than others.[55] Whereas diffusion was about innovations that usually began with a single source and then spread broadly, technology transfer was one-to-one or "point-to-point." How can an innovative work-flow redesign or unit-based team approach to scheduling that produce huge productivity gains in Argentina be applied to improve the same company's productivity in Canada? What sorts of adaptation might be necessary?[56]

Contrary to the technology transfer label, Dunn, Holzener, and Zaltman[57(p. 120)] argued that, "Knowledge use is transactive. Although one may use the analogy of 'transfer,' knowledge is

never truly marketed, transferred or exchanged. Knowledge is really negotiated between the parties involved." Similarly, Estabrooks and colleagues[58(p. 28)] clarify that the Canadian Institutes of Health Research defines knowledge translation as the "exchange, synthesis and ethically sound application of knowledge—within a complex system of interactions among researchers and users." In other words, the notions of transaction, negotiation, interactions, and synthesis are key to the conceptualization of transfer (and dissemination/diffusion) of information/knowledge from producers to users. In health research and organizational technology transfer, one needs to understand what is being transferred, by whom, to which targets, through what process, and with what outcomes.[59] So effective transfer has knowledge utilization at its core.[51]

EVIDENCE-BASED MEDICINE AND EVIDENCE-BASED PUBLIC HEALTH

Literatures about diffusion of innovations, knowledge utilization, and technology transfer have found new application and expansion in the fields of medicine and public health. *Evidence-based medicine* is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence-based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research.[60]

Evidence-based medicine is an approach to medical practice that emphasizes the role of research literature (new information, latest knowledge), usually in the form of clinical practice or medical guidelines (increasingly based on comparative effectiveness research), over prior training and clinical experiences such that each becomes an input in decision-making about each particular patient's health. Although evidence-based medicine has been controversial among some medical professionals[61] and somewhat misunderstood as a movement to displace traditional practices in medicine, advocates[62] argue for augmentation rather than displacement. Clinical epidemiology, for example, has become infused with evidence-based knowledge generation, rapid critical appraisal of evidence, efficient storage and retrieval, and evidence synthesis.[63] When all four components are effectively practiced, the quality of patient care increases.

The desire for valid and generalizable evidence to inform decisions also has been applied to the domain of public health. Brownson and colleagues[64] proposed the following attributes as key to defining evidence-based public health: (1) Decisions are guided by best available peer-reviewed evidence and literature from a range of methodologies; (2) evidence-based public health approaches systematically make use of data and information systems; (3) its practice frameworks for program planning come from theories rooted in behavioral science; (4) the community of users are involved in processes of decision-making and assessment; (5) evidence-based public health approaches carry out sound evaluation of programs; and (6) lessons learned are shared with stakeholder groups and decision-makers. Simmons, Fajans, and Ghiron[65] additionally emphasize contextual factors as key in matching practice refinements to local conditions.

During the dissemination of evidence-based practices, we believe that it is useful to consider the interplay between the technical rationalities of knowledge producers or change agencies, and users' narrative rationalities, whether those users are patients and community members or health care providers and public health professionals. Technical rationalities are based on logics that are predictive, instructive, and technocratic, while narrative rationalities are stories of experiences that are interpretive, contextual, and dynamic.[66] Narratives can be illuminating to program planners as well as inform ongoing attempts to improve care and public health practice.[67,68] Collectively, these two perspectives represent the state of the science (what researchers collectively know) and the state of the art (what practitioners collectively do). New media and emerging technologies can facilitate the access to and use of both technical rationalities (guideline content) and narrative rationalities (for example, clinical practitioners' perspectives about how they have implemented such guidance given the realities of their practices).

NEW (AND NEWER) MEDIA

What are the effects of new information and communication technologies on dissemination activities by change agencies, the social diffusion processes that may result as potential adopters consider an innovation, and how implementation in organizations unfolds?

Collective knowledge of the diffusion of innovations paradigm has given way to a focus on

those paradigmatic concepts that can be operationalized in purposive tests of how to best disseminate and implement evidence-based health practices, programs, and policies.[69] This has long been an objective in trying to spread effective innovations for improved global health as well as for domestic health care and public health.[70,71] New media, in the ways in which they affect the dissemination of information by change agencies, the subsequent diffusion process among targeted adopters, and the resultant critical stage of implementation of evidence-based practices in organizations, are iteratively changing how we work and how targeted adopters respond to change initiatives. D&I researchers and practitioners are well-advised to be agile.

The traditional notion of an innovation as predesigned by centralized change agents is increasingly inaccurate. Increasingly, innovations are malleable and coproduced by researchers, practitioners, and those persons who adopt them, whether the researchers in question have this intention or not. Such a perspective on change has the advantage of enabling learning from those persons who are best positioned to make insightful and applicable real-time improvements to an innovation: users themselves.[72] This shift in emphasis to utilization by users would wed source perspectives on change with those of innovation users-as-creators. Utilization properly involves both the logics of innovation producers with the experiential expertise of users who are sensitized to issues of context and compatibility.

Technologies can facilitate information access and knowledge creation in the context of dissemination. In terms of information access, it is clear that information technologies and certain new media accelerate our ability to disseminate information worldwide.[73] Do they also accelerate diffusion (that is, resultant decision-making) among those health care and public health practitioners whom we sometimes try to reach and affect?[74] Technologies increase the dissemination of knowledge about innovations and expand reach in terms of health promotion,[75] disease prevention,[76] health compliance, telehealth,[77,78] and cybermedicine.[79] Technologies allow easy access to new information and latest knowledge via specialized knowledge management systems (such as medical literature databases) that health care providers can use to inform their medical practice, and general knowledge management systems (such as public web-based search engines) to help patients make better health-related choices in life.[80]

Furthermore, technologies may intensify the diffusion process among connected adopters whom change agents may target for change,[81] including tapping their weak ties and strong ties,[82] and designing strategic messages to drive views, comments, and shares on social media.[83] Traditionally and still today, diffusion is facilitated by mass media and interpersonal networks among people. In today's wired societies and more specifically in our networked market segments that are organized by common interests and professions, new media create new online social communities that are critical to the facilitation of information knowledge dissemination beyond geographically/temporally bound communities of the past. Technologies intensify the dissemination process by elevating social media platforms and their amateur broadcasters as well as new networks among people who do not know each other except through online communities[84] to an emerging position of intermediary, thus giving information/knowledge another push for dissemination throughout social systems.[85]

In terms of knowledge creation, technologies are enabling new and expanded professional networks among health care providers and public health professionals, leading to interorganizational sharing and cross-fertilization of information and knowledge about common challenges.[86] New media make coproduction of knowledge between producers and users easier to achieve because of the low cost and high speed for feedback and ongoing communication.[87] Technologies support automatic and cumulative data acquisition (including electronic medical records in health care organizations and online data mining) for computations and analyses that, in turn, can produce more knowledge. In this way, the use of technologies demonstrates Sorokin's view that diffusion is inherently recursive. We surmise that if potential adopters of innovations feel that they have been involved in the creation of or refinement of an innovation, their adoption and implementation is more likely. If new media lead to the experience of broader participation in knowledge creation, then those media will stimulate not only dissemination but diffusion, too. Box 3.2 provides a summary of applications of computational social science to D&I research in health.

SUMMARY

This chapter has tried to show the evolution of diffusion of innovations theory, and how concepts from that paradigm as well as knowledge

BOX 3.2

COMPUTATIONAL SOCIAL SCIENCE AND PUBLIC HEALTH RESEARCH

Computational social science (CSS) has penetrated health research due to widely available, massive ("BIG") datasets and increasingly sophisticated computational methods.[88] The computational paradigm has triggered the creativity of researchers from different disciplines (e.g., computer science, physics, communication and epidemiology) to examine health phenomena at an unprecedented scale.

The most visible application of CSS in public health is the forecasting of disease outbreaks with search query data. Ginsberg et al.[89] tracked the search volumes of 45 influenza-related queries at Google and found that the searching trends of these queries could alert the general public to flu pandemics earlier than could government statistics from the Centers for Disease Control and Prevention in the United States. Although recent studies found that Google search trends would overestimate the epidemic degree of influenza in the United States,[90,91] this study has prompted scholars to apply query data to monitor the trends of various diseases, such as dengue,[92] stroke,[93] and tuberculosis.[94] Researchers were also inspired to employ data from other social media platforms (e.g., Twitter) for influenza surveillance.[95] Such surveillance and forecasting of specific diseases is of great significance for public health professionals who can send timely alerts to the public and prepare adequate resources to address outbreaks.

Another notable application of CSS in health is the mining of voluminous textual information on the Internet to understand and monitor how the public thinks about and feels toward health issues. By combining manual content analysis and automatic text mining algorithms, researchers analyzed information collected from various online sources (e.g., Twitter, blogs, and news) to understand public confidence toward vaccination,[96] discover major themes underlying public discussion about measles[97] and Zika,[98] and examine public sentiment toward depression and anxiety disorder.[99]

A third application of CSS in public health is to investigate how offline and online social connections among individuals may lead to the diffusion of health behaviors. By creatively utilizing several large-scale longitudinal datasets, Nicholas Christakis, James Fowler, and their colleagues[100–103] conducted a series of studies to investigate how a specific health phenomenon (e.g., obesity, smoking, alcohol consumption, drug use, and depression) can spread across network ties. Researchers have designed experiments on social media platforms (e.g., Facebook and Twitter) to examine how individuals' online connections may lead to changes in health behavior in various domains, such as fitness,[104,105] sexual health,[106] and smoking.[107]

With the increasing availability of datasets from more platforms and the rapid development of computational algorithms, the CSS paradigm will contribute more theoretical insights and methodological options for dissemination and implementation research in health.

utilization and technology transfer research have contributed to the evidence-based medicine and evidence-based public health emphases in D&I. The authors suggest that D&I researchers and practitioners will continue to find relevance and applicability in these former research traditions as they seek ways to study and apply new information and communication technologies to the challenges of dissemination activity by innovation proponents, diffusion responses by adopters, and then subsequent implementation and sustained use.

SUGGESTED READINGS

Readings

Dearing JW, Smith DK, Larson RS, Estabrooks CA. Designing for diffusion of a biomedical intervention. *Am J Prev Med*. 2013;44(1S2):70–76.

The authors suggest how diffusion concepts can be applied during strategic planning for the roll-out of an evidence-based intervention for HIV/AIDS prevention. The article emphasizes the importance of formative evaluation to understand and then appeal

to the motivations of potential adopters and implementers in community health centers.

Estabrooks C, Derksen L, Winther C, et al. The intellectual structure and substance of the knowledge utilization field: a longitudinal author co-citation analysis, 1945 to 2004. *Implement Sci*. 2008;3(1):49.

This article is a bibliographic analysis of the knowledge utilization field between World War II and the present and how it has evolved in that time. The authors cite the emergence of evidence-based medicine during this time period, a major advance with significant influences on models of evidence-based practice in other fields, including public health.

Green LW, Ottoson JM, Garcia C, Hiatt RA. Diffusion theory and knowledge dissemination, utilization, and integration in public health. *Annu Rev Public Health*. 2009;30:151–174.

Green et al. provide a rigorous review of the public health implications of diffusion, dissemination, and implementation to improve public health practice and guide the design of future research. The article suggests a decentralized approach to D&I, as well as ways diffusion may be combined with other theories.

Rogers EM. *Diffusion of innovations*. 5th ed. New York: Free Press; 2003.

Rogers's classic text on how ideas and opinions diffuse over time through various communication channels and networks. Because many new ideas involve taking a risk, people seek out others who have already adopted it. As a result, the new idea is spread through social networks over a period of weeks, months, or years.

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