Diffusion Theory and Knowledge Dissemination, Utilization, and Integration in Public Health

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Abstract

Legislators and their scientific beneficiaries express growing concerns that the fruits of their investment in health research are not reaching the public, policy makers, and practitioners with evidence-based practices. Practitioners and the public lament the lack of relevance and fit of evidence that reaches them and barriers to their implementation of it. Much has been written about this gap in medicine, much less in public health. We review the concepts that have guided or misguided public health in their attempts to bridge science and practice through dissemination and implementation. Beginning with diffusion theory, which inspired much of public health's work on dissemination, we compare diffusion, dissemination, and implementation with related notions that have served other fields in bridging science and practice. Finally, we suggest ways to blend diffusion with other theory and evidence in guiding a more decentralized approach to dissemination and implementation in public health, including changes in the ways we produce the science itself.

INTRODUCTION AND PURPOSE

As concern mounts in many countries, among governmental and other sponsors of health services and programs, over the gap between research and practice, a burgeoning literature accumulates on dissemination (definition from Reference 99, p. 6; see also 97) and translation. In the United States, the National Institutes of Health (NIH) Roadmap Initiative (131, 132) has encompassed Translation 1 from basic science to applied developmental studies or clinical trials ("bench to bedside") and translation of evidence largely from controlled trials to practitioners, variously referred to as dissemination, knowledge brokering, promotion of evidence-based practice, implementation (definition from Reference 96, p. xxi), knowledge utilization, and Translation 2 (129). Most of the NIH investment so far in the Roadmap Initiative has focused on Translation 1, but a steady drumbeat of concern from legislators, health organizations, and the scientists and practitioners themselves has fueled a growing literature on Translation 2 and a revival of dissemination and implementation (34) research under the generic rubric of translational research (20). Other national research funding organizations in the U.S., such as the Agency for Healthcare Research and Quality (AHRQ) (1), the Centers for Disease Control and Prevention (CDC) (54), the Task Force on Community Preventive Service (113), and the Milbank Memorial Fund (109), and in other countries, such as the recently organized Canadian Institutes for Health Research (CIHR) (22) and its forerunners (CFHSR, MRC, NHRDP) (64, 74, 75), and the Medical Research Council of the United Kingdom (55), have also given special attention to this set of issues in the movement of science into more extensive application.

Dissemination: diffusion that is directed and managed, although Rogers chose to include both the planned and spontaneous spread of new ideas in the term diffusion

Translation: moves scientific knowledge from basic discovery to testing for technological efficacy (Translation 1) or from efficacy-tested interventions to testing for effectiveness and acceptability for adoption in practice (Translation 2)

National Institutes of Health (NIH): a division of the U.S. Department of Health and Human Services, supporting most of the biomedical and other health-related research

Implementation: translation and application of innovations, recommended practices, or policies. A process of interaction between the setting of goals and actions geared to achieving them

Knowledge utilization: the process of converting or adapting knowledge such as evidence-based guidelines into practice

SOURCES OF CONCEPTS, DATA, AND UNDERSTANDING

We review here a subset of literature that pertains particularly to the diffusion (definition from Reference 99, p. 5), dissemination, and implementation aspects of research translation in public health practice and community change and the theoretical foundations or roots of that literature in diffusion theory. In diffusion theory and research, we find a long history of theoretical and empirical attempts to understand the natural history of the spread of ideas and actions within social systems, which have variously included nations (112), crowds (70), the farmers of a region accepting a new hybrid seed (100), physicians adopting a new drug or evidence-based medical practice (28), public health officers adopting a new policy (10, 11), other health professionals intervening on heart disease risk factors (79), and organizations adopting new administrative practices (130). If diffusion tends to relate to uncontrolled natural spread, dissemination has concerned itself with the conscious efforts to spread new knowledge, ideas, policies, and practices to specific target audiences or to a public at large. Its theories and data sources in public health are those of mass communications, interpersonal communications, health education of the public and continuing education of professionals, social marketing, information technology, and related bodies of literature on obtaining information and influence from authoritative sources to the intended users of that information or practice (e.g., 17, 21, 30).

Implementation theory and research is the more recent literature from various sources, arising largely from the recognition that even when information, ideas, or policies do reach practitioners or other intended users, and even if they profess that they accept and intend to use them, the effective application tends to wane, deviate from the intended use, or take on new forms. The diffusion literature usually reserved a place for adoption and maintenance as the last two phases of the diffusion process, but these stages of diffusion research focused more on the characteristics of the innovation than on the context and circumstances of implementing it.

Spanning these three bodies of literature—diffusion, dissemination, and implementation—are subspecies of the literature with their own journals and disciplines that have attempted to explain, predict, and

guide efforts to influence the translation of research to practice. These include knowledge utilization, transfer, and translation. We review these with a conviction that knowledge utilization, in particular, may hold potential to help break the frustrating impasse that seems to have characterized the more traditional ways of conceptualizing and pursuing the dissemination and implementation of research to and in practice and policy. Knowledge integration (14, 15) offers a more recent ecological, systems-oriented approach to knowledge utilization. These variations bring more critical attention to the ways in which the research is produced in the first place, rather than assuming that whatever scientists produce will find its way into policy and practice with our ever-greater technologies of dissemination.

We take as the point of departure for this review Glasgow & Emmons's (39) excellent review of translating research into practice for the 2007 issue of *Annual Review of Public Health*. They derived 32 "barriers to dissemination of evidence-based interventions" (p. 415). Nine of them related to characteristics of the intervention being disseminated. These align roughly with the "attributes of innovations and their rate of adoption" extensively documented from decades of research in various applied fields (99) and used to classify and predict the ease or rate of adoption of specific practices recommended in public health (43, 52). Glasgow & Emmons added another 10 barriers related to the situation or context of the intended target audience, 7 barriers related to limitations of the research reporting on the intervention (such as sampling limitations, failure to evaluate costs, and external validity), and 6 more barriers pertained to the interaction of the other 26. Our review relates more to these three latter categories of barriers rather than to the first, although we find that the characteristics of the intervention being disseminated often miss the mark of what practitioners want and need precisely because the intervention was developed without due consideration to contexts in which it would be applied and to the methods of study and systematic review by which it was deemed worthy of dissemination.

Another departure from Glasgow & Emmons in our review is our examination of implementation as a distinct body of literature. They listed the following as their final barrier to dissemination: "[O]rganization is unable to implement intervention adequately" (39, p. 415). This statement implied that implementation was considered part of dissemination. We found a growing but scattered literature on implementation, knowledge utilization, and knowledge integration that is more or less independent of the diffusion and dissemination literature. We agree with Glasgow & Emmons that implementation is a critical final stage in meeting the main purposes of dissemination (91). Dissemination is not an end in itself, but a distinct process from the implementation processes of reinventing or adapting what has been disseminated and working through and around the policies, traditions, culture, and other constraints of the organizational context in which disseminated innovations or policies are to be implemented.

Most studies Glasgow & Emmons cited were from clinical settings but with implementation of clinical preventive services or patient self-management often the intervention being disseminated. We expand their inventory of barriers drawn heavily from the medical care literature, with consideration of additional barriers for public health interventions, such as the geographic spread and diversity of community settings, the role of mass media and social networks, the multiple additional levels at which community or regional interventions must be implemented, and the greater difficulty of randomizing subjects and otherwise conducting controlled trials in free-living populations compared with clinical settings.

We aim primarily to present a review of the theoretical and research streams that have informed the dominant public health approaches to what the NIH has labeled Translation 2, referring to the dissemination and implementation of evidence-based practices to policy makers, program planners, and practitioners,

Agency for Healthcare Research and Quality (AHRQ): charged with supporting and producing research on the transfer of medical and other health knowledge into practice and policy

Centers for Disease Control and Prevention (CDC): investigates trends and causes in health, illness, and injury, formulates strategies to prevent and control them, and supports others applying these strategies

Canadian Institute of Health Research (CIHR): a federal agency supporting much of the biomedical and population health research in Canada

CFHSR: Canadian Foundation for Health Services Research

Diffusion: the process by which an innovation is communicated through certain channels over time among the members of a social system

External validity: the degree to which findings from a study or set of studies can be generalizable to and relevant for populations, settings, and times other than those in which the original studies were conducted

Evidence-based public health (EBPH): practices and policies of the field that are based on data. Must combine a variety of evidence from alternative sources of research, surveillance, and evaluation

as well as to the lay public. We do that here primarily within the context of public health, which faces targets of change, contexts, and conditions of implementation of both the science and its dissemination, which are different from those of evidence-based medicine (19). In making this distinction for our review, we refer the reader to a complementary review by Brownson et al., also in this volume of the *Annual Review of Public Health* (18). Their review queries the literature for progress on how public health has sought to adapt and apply the principles of evidence-based medicine to public health over the past decade or so; how public health has incorporated other types of surveillance and evaluation data in a hierarchy of evidence; and the "challenges and opportunities (e.g., political issues, training needs) for disseminating EBPH" (18, p. 175). Our review looks back even further to the theories of diffusion, dissemination, and implementation that emerged from nineteenth-century stirrings of concern with the emergence of a mass society and the influence of mass media, evolved through mid-twentieth-century communications theory and research, and culminates in a twenty-first-century effort to reconcile the demands from policy makers and practitioners for relevance and fit of the evidence with the expectations of scientists and funders of programs that the evidence will be implemented with fidelity.

MIND THE GAP BETWEEN SCIENCE AND PRACTICE

Science has always drawn to it people whose love of knowledge and its pursuit were sufficient to justify their research works as inherently valued without having to demonstrate their practical utility. In one of the early-sixteenth-century scientific notebooks of Leonardo da Vinci, however, was his notation that "I have been impressed with the urgency of doing. Knowing is not enough, we must apply" (29, 108). Leonardo anticipated by six centuries—early in the Renaissance blossoming of science—a recurring need for more creative use of the extant knowledge and more utilization-focused knowledge generation.

Legislators and others have sounded various alarms over the apparent gap between evidence and its application in policy, professional practice, and the preventive measures the rest of the population take in their daily comportment. The research-funding agencies have responded to the pressures from congress and parliaments by proliferating government and foundation initiatives (1) and university research centers dedicated to closing the gap with better translation and dissemination (47). That a gap exists does not seem to be in question. The etiology and prognoses, however, remain contested, and most of the remedies tried—from continuing education to evidence-based practice guidelines—have been disappointing (2).

Why Does the Gap Persist?

Why, with the growing volume and apparent quality of evidence and with the growing technological and organizational efficiency of indexing, storing, retrieving, synthesizing, and disseminating evidence, would practitioners, policy makers, and the public seem to be having difficulty incorporating the evidence into their practices and using it more assiduously? The blame for gaps between science and practice points variously at tradition-bound practitioners, who insist on practicing their way and believe they know their patients or populations best, and at the smugness of scientists believing that if they publish it, practitioners and the public will use it. The underlying problem for all of them, if the lessons of dissemination and implementation theory are brought to bear fully, might be with the way the production and dissemination of evidence is organized institutionally with highly centralized (mostly federal and national) funding, storing, indexing, synthesizing, and disseminating of science, whereas the application of that science is highly decentralized. Even policy makers, as

consumers of science, are more distributed at state and local levels in public health matters than concentrated at the national level. The gap is then partly one of social distance between the supply and the demand sides of science in geography as well as in organizational and professional or personal self-identities. Even at the local level, the town-gown social distance prevails because scientists are more oriented to the international audiences of other scientists for which they publish than to the needs of practitioners, policy makers, or the local public.

Viewing the Gap as Leakage in a Pipeline

Much of the writing about knowledge translation or transfer, research dissemination, and the adoption and implementation of evidence-based guidelines assumes a pipeline in which evidence is produced by scientists, then vetted and disseminated to policy makers and practitioners. **Figure 1** renders the pipeline as a funnel, which aligns with the accompanying assumption that much more research must be done than will be usable in practice. This idea gives the research enterprise license to conduct a wider range of basic research than necessary for practical purposes. It justifies and is justified by the notions of basic research being valuable as an end in itself without immediate application, with the understanding that basic research ideas can have multiple lines of potential application, and with the inherently exploratory and heuristic qualities of discovery research.

This narrowing, filtering, and vetting of evidence works well for strictly biomedical interventions where the pathological mechanisms, target organs, and physiology are relatively homogeneous. For many primary care and most public health interventions, however, the object of interventions is far more diverse in psychological processes, cultural contexts, and socioeconomic conditions that may mediate or moderate the relationship between the intervention

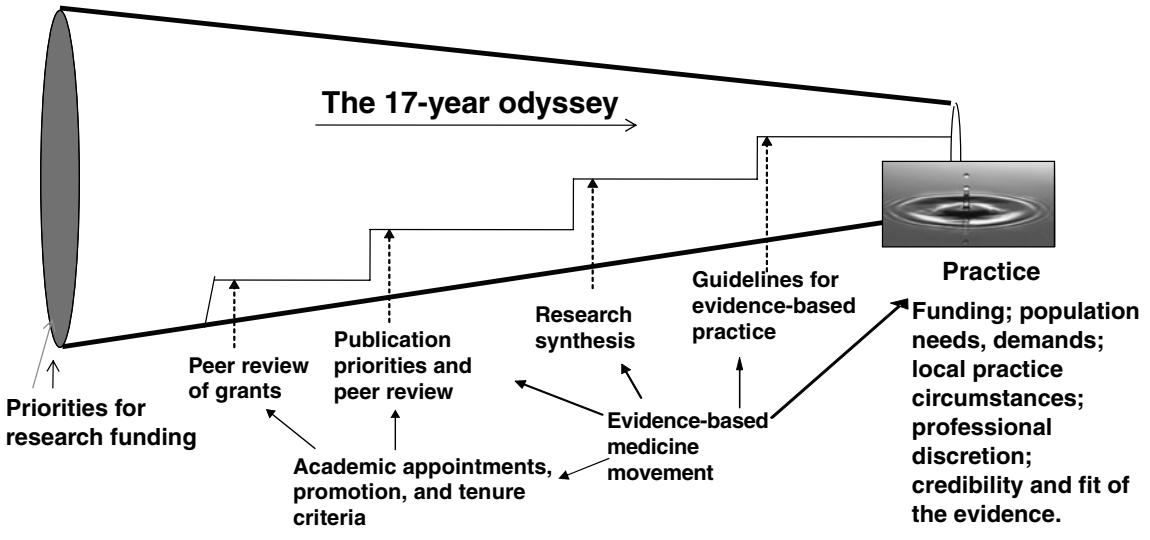

Figure 1

The conceptualization of the production and transfer of knowledge from research to practice and policy usually assumes a pipeline in which the vetting of the research through successive screens assures the quality of the research delivered to practitioners and policy makers, but it does little to assure the relevance and fit of that research to the needs, circumstances, and populations of those practice or policy applications. From Reference 48 with permission.

and the outcomes. For these interventions, context, adaptability, and external validity become as important as experimental control, fidelity of implementation, and internal validity (40, 41, 45, 49). Thus elimination from the dissemination pipeline of a large number of studies related to diverse populations and circumstances leaves a small pool of evidence-based best practices that are unrepresentative of the realities in which the end users live and work. These are not two distinct approaches to science, but instead a continuum of relative weight of evidence placed on internal validity to external validity. This variation is reflected in the adaptations of evidence-based medicine made by other professions such as social work (37), nursing (80), and psychology (95).

An alarming and frequently quoted statement about the total attrition in the funnel and the lapse between research and medical practice indicates that it takes 17 years to turn 14% of original research to the benefit of patient care (123). These estimates of 17 years and 14%, attributed to Balas & Boren (5), come from the summing of discursive measures of the leakage or loss of medical-clinical research from the pipeline at each stage from completed research through submission, publication, indexing, and systematic reviews that produce guidelines and textbook recommendations for best practices to the implementation of those practices in health care settings (48). Changing technologies and priorities of publishing, bibliographic data management, and systematic reviews and disseminating evidence-based guidelines would produce different estimates as time passes, and the estimates might be different for public health research than for clinical research.

SYSTEMATIC REVIEWS MAY DEEPEN THE CHASM BETWEEN RESEARCH AND PRACTICE

Most of the research qualifying as worthy of systematic reviews that lead to best practice guidelines disseminated to practitioners and policy makers is highly controlled research under unrepresentative circumstances. This practice often makes such research of dubious relevance to many public health practitioners who would be expected to adopt and implement the guidelines. Thus, much of the effort to disseminate such guidelines to practitioners more efficiently produces disappointing increases in adoption, implementation, and maintenance of the best practices.

Particularly disturbing from the standpoint of what practitioners might consider most helpful is the attrition of some 17% of original research that never gets submitted, usually because the investigator assumed negative results were unpublishable. In their attempts to adapt guidelines for patient or community interventions to their practice circumstances, negative results of interventions are of interest because they often tell the practitioner about the intervention's misfit with populations or conditions other than those in which the original research leading to guidelines was conducted. The pipeline approach fails the practitioner here because the literature on which guidelines are based constitutes an unrepresentative sample of the varied circumstances and populations in which the intervention might be usable or unusable. Such samples of studies typically favor selection of the highly controlled academic situations in which the studies eligible for systematic review were conducted, giving them an advantage over studies conducted in more typical, less controlled populations and settings (58).

The dissemination pipeline's next large leak is between submission and acceptance. The 46% of studies submitted but not published was attributed largely to sample size, power, and design issues (5). This attrition protects the internal validity of what gets published, but might, like each of the others, bias the external validity or generalizability of guidelines derived from the systematic reviews of published literature.

Between acceptance and publication, the average time lag is only a half year, similar to that between submission and acceptance. The lag time is even less between publication and indexing in bibliographic databases, but the attrition

of studies is significant at 35%. Balas attributed this loss mainly to inconsistent indexing. One may reasonably hope that with improving information storage and retrieval technologies, this gap would be narrowing.

The next gap of the funnel is a long one, especially for public health. For medicine, even with the many groups conducting systematic reviews, estimates of lag are from 6 to 13 years to get from indexing to inclusion in reviews that might lead to guidelines for best practices. With only half of the bibliographically indexed studies on databases surviving the screen for inclusion in systematic reviews, guidelines, and textbooks, the practitioners, policy makers, and others awaiting the data can hardly be blamed for the gap and the lag. Systematic reviews, especially in the tradition of evidence-based medicine and the Cochran Collaboration, weed out most studies that do not meet randomized control trial (RCT) standards. A large body of potentially useful information for practitioners is lost in final guidelines. A recent examination of meta-analyses led Shrier et al. (104) to four conclusions: that "including information from observational studies may improve the inference based on only randomized trials," that the estimate of effect is similar for meta-analyses on the basis of observational studies as for RCTs, that the "advantages of including both. . .could outweigh the disadvantages" and that "observational studies should not be excluded a priori" (104, p. 1203). Going beyond biomedical interventions to behavioral and self-care interventions, and to complex programs, which become increasingly common with community chronic disease control, more studies would not survive this leg of the journey because randomized methods are more likely to face ethical and logistical challenges (81, 101).

The final leg of the journey of evidence to practice is the one that receives most of the attention in discussing the research-practice gap, even though Balas & Boren (5) estimate for clinical knowledge that there is virtually no loss in this phase. It takes nine years, on average, for interventions recommended as evidence-based practices in systematic reviews, guidelines, or textbooks to be fully implemented. Why is it not diffused and adopted faster?

HISTORY OF DIFFUSION THEORY

For more than a century, diffusion theory has provided a wellspring of ideas, concepts, measures, and examples of application in the dissemination and implementation of innovations (31, 50, 51). It has served a variety of applied fields in which science seeks to solve human problems in the application of technologies and practices arising from science. Diffusion theory has also become a repository for the collection of concepts from various social sciences concerned with the transfer of knowledge, and of experiences from the application of technology, and spread of these in populations. The evolution of diffusion theory marks the emergence of various theoretical explanations for social behavior and various subdisciplines of practice in communications, marketing, and education.

A Rendition of Diffusion Theory's Evolution and its Traditions

The late Everett M. Rogers is the most frequently cited chronicler of the theoretical and empirical literature on diffusion for the applied fields of agriculture, health, education, and other social services, and for his own original discipline of rural sociology and his later specialization in communication science (105). In retracing the winding theoretical and empirical road to our current understanding and use of diffusion theory, we skip most of what has been noted so well by Rogers, through five editions of his classic compilation (99). We begin with the same origin of diffusion thinking, attributed by Rogers to Gabriel Tarde, and then elaborate here on just a few of the other key contributors whose work is most relevant to our current understanding of the problem and task at hand in public health, as well as a few others not documented by Rogers.

Gabriel Tarde's Early Theory of Imitation

In 1890, Gabriel Tarde, a French sociologist, attributed the basis of social life and advances of society to the desire for imitation inspired by people with original ideas (intellectuals, artists, creators) that spread through human interaction to the less-educated classes (proletarians, farmers). "This original act of imagination and its spread through imitation was the true cause, the sine qua non of progress" (110, p. 43).

Through the social mechanisms of suggestion-imitation impelled by the role-modeling example of the innovators, according to Tarde, the contagious virus of ideas arises with the exposure of members of the public, over time, to habits of society, urban life, or proximity. Tarde conceded the highest importance to conversations as the main channel of influence on others. "Conversation is, as a consequence, the most powerful agent of imitation, of sentiment's propaganda as well as ideas and forms of action" (111, p. 193). He wrote, however, before the emergence of widespread literacy and before the development of most of the mass media.

Tarde differentiated three phases in the social development of ideas: repetition, opposition, and adaptation. The repetition phase is the interaction between two people in which one of them, the inventor, exerts a bigger influence on the other person, the imitator. The opposition phase describes the tendency of diverse social interpretations to fluctuate in the imitator's mind. The adaptation phase is the new balance achieved by the individual after reconciling the interpretations.

These phases might help unpack some of the current debate between the demand for fidelity in the implementation of evidence-based practices and the need for practitioners to exercise some professional discretion in adapting such practices to their patients, populations, and circumstances (7, 12, 58). If Tarde's second phase produces conflict for the practitioner or other adopting individuals because of changing circumstances with social and technological trends, the practitioner's or other adopter's adaptation can be seen not so much as lack of fidelity to the evidence-based practices as logical and natural adjustments of the intervention to fit their evolving situation.

Le Bon's Collective Behavior Theory

Rogers did not acknowledge another late-nineteenth-century French social-psychological theorist in his rendition of the history of diffusion theory (Rogers gave more play to British anthropologists as the pioneers in diffusion theory). In *The Crowd: A Study of the Popular Mind*, Gustave Le Bon (70) developed an early theory of collective behavior. Le Bon's description of the imitative process, as it occurs in crowds, offers insight into the process that Tarde described more generally for interpersonal imitation and offers some explanation for a breakdown of individual judgment in Tarde's second phase. Le Bon argued for a less independent mind and more of a herd instinct of individuals being influenced in the collective behavior context. Under these circumstances, imitation essentially skips over Tarde's second phase of weighing countervailing ideas and trends. For LeBon, this phase takes on a more mindless aspect, an unflattering characterization that might persist today in the notion that practitioners should adopt evidence-based practices with fidelity rather than with adaptations that might involve professional discretion.

This collective behavior focus can be seen in the tradition of critics of the tyranny of the majority such as Alexis de Tocqueville, James Bryce, and Walter Lippmann, as well as Gabriel Tarde. The theoretical focus can be understood as an answer from the intellectual elites to the European liberal revolutions of 1850 and the beginning of the mass society in the last quarter of the nineteenth century.

Le Bon argued that immersed in the crowd the conscious and rational personality of the individual transforms to an automaton. There, the natural character of the individual would be replaced by "the predominance of the unconscious personality, the turning by means

of suggestion and contagion of feelings and ideas in an identical direction, the tendency to immediately transform the suggested ideas into acts" (70, p. 12).

Three Waves of Twentieth-Century Research Toward Knowledge Utilization Theory

In his reconstruction of the twentieth century's evolution of diffusion and related theories into more robust theories of knowledge utilization (to be described in a section below), Backer (4) refers to a first wave (1920–1960) in which the rural sociologists [notably, Rogers's mentors, Beal & Bohlen (8) and Ryan & Gross (100)] tracked the diffusion of new hybrid seed corn to farmers, and educational researchers traced the adoption of new teaching ideas and technologies among schools (84). These studies shaped the current theoretical framework of diffusion theory and the methodologies used in most knowledge utilization research through mid-century.

In a second wave, a post–World War II flurry of international activity in the transfer of developmental knowledge, resources, technology, personnel, and skills produced an information explosion, very notably in the health and human service fields (9, 43) and educational technology (85). In international health and technical assistance, this was most prominent in family-planning program development in developing countries (42). Backer marks the second wave from 1960 to 1980, during which most studies of knowledge utilization emphasized organizational adoption of new ideas as much as individual adoption (e.g., 10, 11). It was a time of massive U.S. federal initiatives (Kennedy's New Frontier, and Johnson's Great Society and War on Poverty) in which most legislation channeling federal funds directly to local community health and other antipoverty programs carried the requirement of "maximum feasible participation" of local residents in planning and evaluating the programs (44, 82). The emphasis on accountability during this era gave rise to a new cadre of researchers identified with program evaluation as a field of professional practice (107, 124). Their reorientation of the research questions from theory-based hypothesis-testing to practice-based or policy-based program assessment of impact produced an influential body of more policy-relevant research (125, 126) and the birth of implementation research to trace what becomes of new federal policies as they roll out to "street-level bureaucrats" (73, 91, 96).

In the 1980s, Reaganomics in the United States turned to an era of cost-containment research and policy in which the job of public health education and dissemination became the reduction in use of health services, promoting consumer restraint in demand on health services rather than promoting their use. Backer characterized his third wave, commencing in 1990, as an era of research on how knowledge utilization can improve human services in health, education, and social supports. Parallel developments were afoot in other countries and in the United Nations agencies. For health policy, we could pick up where Backer left off in 1991 to note a proliferation of systematic reviews and guidelines promoting both the greater use of underutilized services (e.g., some preventive health care services) and the discouragement—even defunding—of practices for which evidence was insufficient to warrant widespread use (23, 24, 113–115). We have noted earlier some limitations of such systematic reviews as part of the pipeline approach to dissemination. The developers of these review and guideline mechanisms struggled with these questions (e.g., 76), but the guidelines took on a life of their own as official justification for reimbursement, program funding, and quality assessment.

Turn-of-the-Century Government Initiatives Driving Dissemination and Translation

In the introductory paragraph, we set the contemporary stage for this review with the influential NIH Roadmap initiative and, in particular, its Clinical and Translational

National Cancer Institute (NCI): one of the 27 units of the National Institutes of Health, part of the U.S. Department of Health and Human Services

Reinvention/ adaptation: the degree to which an evidence-based intervention is changed or modified by a user during adoption and implementation to suit the needs of the setting or to improve the fit to local conditions

National Cancer Institute of Canada (NCIC): with joint federal and Canadian Cancer Society funding, functions as the major peer-reviewed granting agency for cancer research and dissemination in Canada

Science Awards (CTSAs) to medical schools, with requirements for transdisciplinary research. Its distinction between Translation 1 ("from bench to bedside," mostly getting basic science to product development) and Translation 2 (from bedside and beyond, mostly dissemination) reflected, as we have argued, a pipeline perspective that has served clinical medicine reasonably well. Although the CTSAs are meant to be transformative in moving research results into practice and in specifying that a critical component of this translation is toward the communities and populations (132, 133), the dissemination to public health applications requires more attention to external validity. The variability in settings, populations, cultures, and historical circumstances for public health makes the generalizability of overly controlled experimental research findings dubious to practitioners and policy makers. The CDC has given greater attention to this dimension of the translation issue, especially through the Prevention Research Centers (47).

But even before the NIH-wide Roadmap initiative, individual institutes and the CDC led some of the U.S. federal efforts in health dissemination research. The National Cancer Institute (NCI), for example, established a Research Dissemination and Diffusion Program in 1999 to build and sustain the field of dissemination and implementation science (**http://dccps.nci.nih.gov/d4d/**). This program has generated several funding opportunities for supplements in dissemination research. These supplements aim to give investigators, who have developed and tested a successful intervention, the chance to extend their reach to other settings and populations. The CDC, the AHRQ, the Substance Abuse and Mental Health Services Administration, and the National Institute of Mental Health were early initiators of support for dissemination research, as well (66). More recently, institutes across the NIH issued program announcements asking for applications in dissemination and implementation to stimulate more research in this area. We have concluded that more practice-based evidence is needed to be successful in disseminating and implementing interventions for primary care practice settings (39–41, 45–49, 52–53]. One example is the collaboration between the AHRQ and the NCI to support practice-based research networks.

Another example of efforts at the federal level to facilitate dissemination of evidence into practice has been through a partnership with the NCI, the AHRQ, the CDC, the American Cancer Society, and the Substance Abuse and Mental Health Services Administration called the Cancer Control P.L.A.N.E.T (plan, link, act, network with evidence-based tools) online at **http://cancercontrolplanet.cancer.gov**. This is a Web-based portal that provides guided access to peer-reviewed research, evidence-base interventions, resources at the local level, and comprehensive cancer control plans to facilitate dissemination and implementation of proven interventions rather than the sometimes-unwitting reinvention (definition from Reference 97, p. 117) of the same interventions.

Some of these efforts have extended internationally in collaboration with the National Cancer Institute of Canada (NCIC) and others in formulating shared perspectives on the issues of dissemination and translation research (14, 59, 60, 66). Work for the NCIC Joint Working Group on Translational Research and Knowledge Integration (15) presents a concept of knowledge integration. This concept emphasizes how the products of research need to be integrated across multiple levels and sectors of health systems in which they would be applied.

An example of such evidence from the CDC was presented by the Office on Smoking and Health in a 1999 document called *Best Practices for Comprehensive Tobacco Control* (26). It broke rank with the government's conventional use of the term best practices insofar as the evidence was not so predominantly limited to controlled trials and included evidence from the "natural experiments" of state experiences in California and Massachusetts. The comprehensive programs of these two states had tripled and quadrupled, respectively, the rates of tobacco

consumption decline in the other 48 states in the years following their launch. Their evidence for these declines came from surveillance systems rather than from RCTs, but no other CDC document was more widely used by other states than this one.

Tipping Points, Connectors, Mavens, and Salespeople

In his best-seller, *The Tipping Point*, Gladwell (38) offered an interpretation of the process by which a given idea, product, or behavior could become a part of the mainstream. He used the term tipping point (definition from Reference 38, p. 12) to explain how certain phenomena spread out to an entire group or population when a critical mass of people have been reached. Gladwell defines tipping point as "the moment of critical mass, the threshold, the boiling point" (38, p. 12).

As with some of the earliest diffusion theorists, Gladwell compared a bestselling product or popular practice with a virus that eventually provokes an epidemic. To spread the virus of opinion or practice beyond a minority of a population, the product or idea needs to be promoted by at least three types of people: connectors, mavens, and salesmen. All three of these might align roughly with diffusion theory's early adopters.

1. Connectors are people with good social skills and professional experience in a variety of different fields that make them unique in connecting many diverse people whose lives would not otherwise intersect.
2. Mavens are experts in specific fields or consumption niches (cars, computers, etc.) who like to share their knowledge and to help other people make choices.
3. Salesmen are people with outstanding personalities and impressive persuasive powers to influence what others buy or accept.

A product or idea that receives the attention of these three types of people will likely succeed, according to Gladwell. Gladwell's main contribution from the perspective of this review is his revival of concepts of interpersonal networks and influence in a media-saturated environment where people have become so savvy that messages conveyed by the media are increasingly ineffective in sparking trends and creating opinions. These interpersonal influence concepts were integral to some of the earliest theories of imitation and contagion of ideas from Tarde a century earlier and of mass media influence, such as Katz & Lazarsfeld's "two-step flow of communications" (definition from reference 65, p. 32) a half-century earlier. Both Tarde's imitation theory and Katz & Lazarsfeld's two-step flow of media influence theory emphasized the role of personal influence in the creation of people's opinions. Katz & Lazarsfeld analyzed how certain people exert a disproportionately greater influence on the voting intentions of their friends. Opinion leaders were found in every occupational group. However, these opinion leaders were influenced by the mass media. They filter and translate the ideas contained in the messages conveyed by the mass media as a first step "flow *from* radio and print to opinion leaders and *from them* to the less active sections of communication" (65, p. 32, emphasis in original).

The increasing universality of television as a medium during the past five decades attenuated that dynamic and made superfluous the role of these local opinion leaders. Instead, the public became more influenced by the "authority of the image" (102, p. 76). The new mentality equated image and truth and undercut the centrality of the traditional opinion intermediaries. But, as Gladwell pointed out, a new era has arrived. The explosion of the Internet and the saturated media environment have generated a new type of audience that, more critical than ever of mass media, has started to rely again on other people's opinions at the interpersonal level. Much of that interpersonal communication and opinion leadership has now become mediated by two-way electronic devices, text messaging, blogging, and other innovations in connectivity.

Tipping point: the moment of critical mass, the threshold, the boiling point

Two-step flow of communication: the flow from radio and print (and now other mass media) to opinion leaders and from them to the less active sections of communication

Social Network Analysis in Diffusion Processes

Social network analysis has become increasingly prominent in the literature in public health communications and diffusion theory (77), concurrent with the emergence of new statistical tools for network analysis and with people's return to a reliance on other people's opinions at the interpersonal (albeit now often electronic) level rather than on the mass media. Diffusion theory has always kept a place for interpersonal influence in explaining how new ideas and cultural practices expand within and between communities. Empirical research has demonstrated the importance of interpersonal contact and the social networks that provide such contacts in these processes of expansion of new ideas and practices (57, 116, 120) and even of health status without necessarily involving interpersonal communication about the health behaviors associated with the health conditions (27). The latter work would seem to invoke some of Tarde's (110) earliest notions of an imitation process accounting for some, if not much, diffusion.

Among the five stages of diffusion theory's adoption process—knowledge, persuasion, decision, trial, and adoption—the mass media have more impact in the first two or three stages, whereas interpersonal contact and social networks become more influential in driving the last two or three phases in which the idea or innovation is evaluated (99). The interpersonal aspects of diffusion theory were noted in the pioneering study of Ryan & Gross (100), which emphasized the importance of social factors in understanding farmers' adoption of new patterns of behavior. From his reviews of this and hundreds of studies that followed in the middle decades of the century, Rogers emphasized the importance of social networks for both the diffusion and the adoption of innovations. Nonetheless, there remains a paucity of empirical analysis on issues as fundamental as the time of adoption and the process by which the network extends its influence (117).

Another aspect that requires further exploration is how diffusion theory can integrate mass media, interpersonal communication, and social network analysis to be truly useful as a framework in planning and implementing programs in public health. The positive combination of mass media and interpersonal communication has been undervalued, and models integrating both forms of communication remain scarce (118).

The interaction between mass media and interpersonal communication is difficult to grasp in part because it is a moving target: New forms of mass and local communication emerge almost daily and the journalistic or interpersonal treatment of health news and opinions take highly varied forms in different media and venues within and across countries and communities (e.g., 61, 103). Furthermore, not everyone reacts in the same way to media sources or to interpersonal sources of information, models, and influences (e.g., 12). The same can be said about the way and the time it takes for some people to process new information and to adopt new behaviors. Some people do it when only a few of their friends have adopted, whereas others wait until a majority of their reference groups have done so; still others need to perceive a social norm reflected in mass media and community change (106).

Other factors indicated by Valente & Fosados (118), from their study of efforts to promote STD/HIV preventive health behaviors, are the necessity to choose the right channel (organization, media outlets, etc.) and to tailor messages to be as entertaining and personalized as possible. The effectiveness of these messages would be reinforced with an appropriate mix of impersonal and personal communication tactics to construct more appealing and memorable messages.

Diffusion theory views opinion leaders not as the innovators, but as the early adopters of innovations and trendsetters. In Western society, the main opinion leaders are journalists, actors, artists, politicians, and entrepreneurs, among others. These figures take the temperature of public opinion, our "social skin" (83). Opinion

leaders play multiple roles in health-promotion programs. They legitimate and validate external changes, they act as a link between communities and agencies and between innovators and the majority, they serve as role models for the rest of the community, they are communicators of health messages, and they may help institutionalize programs after a funding agency has withdrawn from a project within a specific community (119).

Although investigators agree in theory that opinion leaders play an important role in social networking, it is not clear how these opinion leaders should be identified and incorporated into programs. In their categorization of almost 200 studies that have used opinion leaders to promote behavior change, Valente & Pumpuang (119) created a decalogue of the ten most frequent techniques used to identify opinion leaders: (*a*) celebrities, (*b*) self-selection, (*c*) self-identification, (*d*) staff selected, (*e*) positional approach, (*f*) judge's ratings, (*g*) expert identification, (*h*) snowball method, (*i*) sample sociometric, and (*j*) sociometric. Some of these methods have well developed instruments or methodologies; others are more or less informal. Individuals identified as opinion leaders using one method sometimes are not considered opinion leaders using other methods. Nonetheless, the inconsistencies suggest that each case would ideally use a triangulation of combined identification techniques to obtain more reliable results.

A growing consensus in public health that the use of social networking will serve to develop more effective health programs in years ahead is driven in part by the increasing recognition of the potential utility of systems thinking and ecological approaches (16, 46). The growing body of evidence on peer and other primary group influences on opinions, attitudes, and behavior, the disappearance of newspapers, and declining trust in mass communications also drive the increased search for ways to tap into interpersonal networks to enhance dissemination efforts. Finally, there has been growing interest in strengthening the role of health professionals in the interpersonal networks of health communication and inserting them into the scientists-to-practitioners-and-back network of communication as "knowledge brokers" (3, 98) or "cultural brokers" (32) or in faith-based health initiatives, in "boundary leaders" (56), and in school health and worksite health-promotion programs, "linking agents," or "linkage systems" (86, 87).

KNOWLEDGE UTILIZATION AND INTEGRATION: ALTERNATIVE UMBRELLA THEORIES

Up to this point, we have viewed the research-practice gap predominantly from a diffusion and dissemination lens. Here we turn to an alternative theoretical lens, knowledge utilization, to understand the gap. Knowledge utilization has been portrayed as a broad umbrella (4) covering numerous subsets or fields, such as transfer (6), application (89), implementation (96), and even diffusion, dissemination, and translation. From knowledge utilization's use of the umbrella analogy, diffusion and each of the others are viewed as one of many theoretical spokes needed to support the umbrella covering the research-practice gap. Most of these subfields have their own literature, contexts, applications, and even cultures. The differences among them have important implications for what, when, and how something is utilized and evaluated (90).

Setting aside who holds the umbrella—diffusion theorists or knowledge utilization theorists—or whether any theory or process should make such a claim, we explore the literature on knowledge utilization for its broad understanding of influences on research-practice links. The field of knowledge utilization includes research, programmatic interventions, and policy decisions aimed at increasing the use of knowledge to solve social problems (4). The knowledge utilization literature is spread over various disciplines and fields, including rehabilitation, education, sociology, psychology, marketing, and health (62). By the early 1990s, more than 10,000 knowledge

utilization citations were found (4). These citations and those that followed have been reviewed repeatedly (63, 128) and organized metaphorically as waves of research over time (4; see Three Waves of Twentieth-Century Research Toward Knowledge Utilization Theory, above) or as a hierarchical ladder from simple transmission to full-scale application (68), or as levels of knowledge integration from individuals to organizations and larger social units (15, 16). Insofar as the latter multilevel perspective of Best et al. (15), called "knowledge integration," emphasizes systems approaches (46, 71, 122), it might be seen as the newly emerging and consolidating perspective on knowledge utilization, at least in public health.

Theories of Knowledge and Use

The many meanings of the knowledge utilization process were described in early writings (126) and subsequently found their way into different conceptual frameworks of utilization, such as instrumentalist, technological, conflict-theoretic, or transactionist (62). Each offers a different view of how the process of utilization works. The instrumental view of utilization suggests that knowledge, once turned over from researcher to practitioner, would be put to direct and immediate action or decision making to solve social problems. This view aligns with the pipeline perspective of the biomedical sciences. Disappointing evidence of interventions affecting this type of utilization led to more complex understandings of use. For example, knowledge might be used to legitimize a point of view, to conceptually enlighten policy decisions, to warn about potential or existing problems, or to manipulate knowledge strategically for power or profit (62, 128).

No single theory or model has gained ascendancy in knowledge utilization (62), and there remains no single, valid measure of utilization (69). Despite the differences, investigators generally agree that the knowledge to be utilized in this literature, rather than other types of knowledge, such as practical, intellectual, small-talk, spiritual, or unwanted knowledge, is most often referred to as research (78).

The Multiple Influences on Use

Numerous influences on the use of knowledge have been identified and are grouped here according to the source, content, medium, user, and context (62, 69). The source of the knowledge facilitates use by its (*a*) credibility, (*b*) relationship building with potential users, (*c*) realistic expectations of use, and (*d*) building in a consideration of use into the early stages of research and development (35, 62, 121, 128) or even engaging the users in the research—even letting them control it (25, 33, 45). The content of the knowledge facilitates utilization by its perceived (*a*) accessibility; (*b*) adaptability; (*c*) advantage; (*d*) compatibility with values, concerns, expectations, or policy agenda; (*e*) challenge to the status quo; (*f*) quality, trustworthiness and soundness; and (*g*) emphasis on positive behavior with clear, low-cost, action implications (4, 13, 35, 63, 68, 69).

The medium through which knowledge is connected to the user facilitates utilization by its (*a*) multiple sources or forums for exchange, (*b*) intermediary linking mechanisms, (*c*) concern for equity, (*d*) personal interaction, (*e*) timeliness, and (*f*) communicating language. Such language translates ideas into messages that are tailored, simple, clear, brief, reinforcing, more concrete than abstract, and enriched with analogies that can be understood in the local language (4, 35, 62, 68, 69). Facilitators of utilization associated with the user include the (*a*) early and sustained involvement of the user in the research process; (*b*) readiness to change; (*c*) links among users; (*d*) level of acquisition effort; and (*e*) interests and ideology (4, 62, 68, 69).

According to Landry et al. (69), the best socio-organizational predictor of utilization is the user context. Characteristics of the contexts that facilitate use include (*a*) resources; (*b*) supportive social conditions; (*c*) a champion

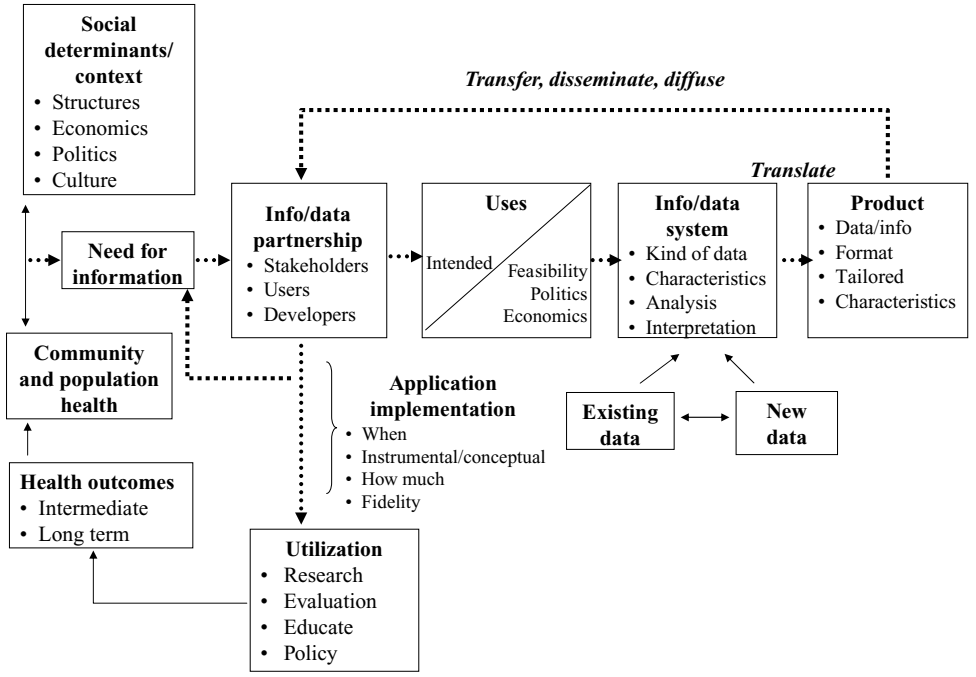

Figure 2

Utilization-focused surveillance framework.

for new knowledge; (*d*) slack for change; (*e*) no strong political or bureaucratic opposition; (*f*) incentives to changes; (*g*) leadership by example; and (*h*) support for long-term interactive relationship (4, 13, 35, 62, 68, 72, 91). Weiss (127) churns the interaction of these variables—interests, ideologies, information, and institutional form—with a reminder of their interaction in a political context.

Applying the Knowledge Utilization Umbrella in Public Health

Having reviewed the broad knowledge utilization literature, we look now at what it views as component theories—transfer, translation, implementation, diffusion, dissemination, and application. We put these to a test of their composite application to the policies and practice of surveillance, a core public health function that involves research. To facilitate use of surveillance data, we propose[1] a framework that considers the broad context of surveillance, including multiple understandings of use and users.

The utilization-focused surveillance framework in **Figure 2** begins with the social determinants and context influencing community and population health (92). Out of this interaction come questions, dilemmas, or crises that provoke some need for information. Either the need for information can be dominated by contextual subsystems, such as economics or politics, or it can stimulate an information/data

[1]This framework draws on two conferences organized by David Mc Queen and sponsored by the U.S. CDC's National Center for Chronic Disease Prevention and Health Promotion. The first conference was on "Analysis, Interpretation, and Use of Complex Social and Behavioral Surveillance Data: Looking Back in Order to Go Forward," June 14–16, 2000, in Savannah, Georgia; the second conference was on "Capacity Building, Comparability, and Data Use in Behavioral Risk Factor Surveillance: Focus on Global Surveillance Issues," September 11–13, 2000, in Atlanta, Georgia.

partnership among multiple stakeholders. The seeds of use are embedded in this partnership where use becomes a forethought, not an afterthought. Through a participatory and collective process, decisions can be made about data that would be useful, not just nice to know, and the contextual feasibility of collecting useful data.

For the intended uses, an information/data system is developed. It considers both existing and new data and the characteristics of those data that will make them both relevant to and of adequate quality for intended users. Translation links the data system to products tailored to various stakeholders, and a communication loop brings those products back to the information/data partnership via diffusion, transfer, dissemination, or other capacity-building processes or strategies. The partnership, having been involved in the design of the surveillance system, is now poised to apply and implement surveillance products to their own contexts, thereby improving health outcomes and community and population health (The dashed lines of **Figure 2** contain the critical pathways proposed in a utilization-focused surveillance system).

Elements of knowledge utilization research are found in the model to help maximize use: (*a*) The source of surveillance data should be credible and involve potential users early in the research process; (*b*) the content of surveillance data should be accessible, adaptable, and sound; (*c*) the medium of transmission should be tailored and multiple in sources; (*d*) the user should be supported in knowledge acquisition and the implications of change implied by the data; and (*e*) the context of use can provide incentives and leadership in utilization.

In summary, this framework offers several propositions about the knowledge utilization process. First, no matter which theory or subtheory is being applied, the facilitation of use needs to start with the end users. Use needs to be about shaping the product, not just disseminating or selling it. Second, no one theory explains the whole research-practice gap. Rather than proposing one big umbrella, we propose that all these theories are themselves umbrellas that cover the many handoffs and circumstances of knowledge utilization. Third, most of the variables that determine use are beyond the control of any one stakeholder on either the researcher or the user side (72), which increases the need for a participatory approach to the challenges of utilization.

Implications for Further Research and Development

The prevailing disappointment with the flow of scientific information and guidelines into policy, professional practice, and public response has much to do with the misguided expectation drawn from a misreading of diffusion theory and dissemination research that the truths discovered by science, whatever their fit with daily life or practice, should automatically influence behavior. This review of diffusion theory and dissemination and implementation research tells us that people—whether policy makers, program planners, practitioners, or the public—will filter the information and advice they receive to consider, try, adopt, and maintain selectively that information that fits with their perceived needs, priorities, and circumstances. We conclude from this review that applied health sciences research would have a much enhanced probability of influencing policy, professional practice, and public responses if it turned the question around from how can we make practice more science based to how can we make science more practice-based? Consistent with our colleagues, Kottke et al. (67), we conclude that this would happen if applied health research (not just research on diffusion, dissemination, or implementation) were directed by five broad principles:

1. The needs of patients and populations should dictate the health research agenda;
2. The research agenda should address contextual and implementation issues including the development of implementation and accountability systems;
3. The research agenda should dictate the research methodologies rather than

methodologies dictating the research agenda. With principles 1 and 2, this will drive a more balanced consideration of internal and external validity;

4. Researchers and practitioners and other users should collaborate to define the research agenda, allocate resources, and implement the findings;
5. The level of funding for dissemination and implementation research should be proportionate to the magnitude of the task.

In the traditions of the pipeline of science to practice, governmental and other program funding agencies and insurance companies have insisted that practitioners and program planners adhere to protocols or guidelines defined by efficacy studies in highly controlled research. When the results are not what the studies implied they should have been, the funders assume that the program planners or practitioners did not adhere to the protocol "with fidelity." Similarly, when the public is given guidance in public health programs or mass media campaigns, the assumption is that we did not reach them or they did not comply with the recommended regimen. In both instances of diffusion failure, we assume the failure was in the dissemination and implementation of science into practice, without sufficient consideration of how well the evidence fit the practice circumstances, context, culture, and perceived needs (93, 94).

This model of evidence-based practice has served medicine and other clinical professions well in clearing away some ill-conceived clinical practices and in gaining wider adoption and more assiduous implementation of procedures, vaccines, and pharmaceuticals that have greater efficacy and effectiveness. But when transplanted without consideration of some fundamental differences in the nature of the interventions and the objects on which we are intervening in public health, the methodological and ethical limitations of applying the same experimental controls to produce EBPH practices present some challenging trade-offs between internal and external validity of designs (81) and the reporting, interpretation, generalization, and exportation of the evidence to other settings, populations, and circumstances (40, 49). In biomedical interventions, the subject is usually a discrete entity, and the human object is pathology in a biological organism with relative homogeneity across the species. With public health, the "intervention" usually becomes increasingly a program made up of multiple interventions, and the object is a diverse population or a community with heterogeneity across geographies, cultures, social structures, and histories. These differences could make both the production of the science of public health and the dissemination and implementation of scientific evidence more varied than the tasks in evidence-based medicine.

Another approach to these differences suggested by Hawe et al. (58) is to theorize interventions differently in the experimental testing of them, allowing their form to vary with settings, but testing their function rather than their form using cluster (group) randomized trials. They argue that overcontrolled interventions have resulted from faulty fidelity to the form of the interventions, whereas what the research needs to do is to specify the function served by the intervention, allowing its form to vary with the diversity of contexts and populations.

A third approach to enhancing our translational tasks of putting research to better use is to depend less on building the dissemination and implementation of evidence from efficacy trials within every subject area, but rather depend more on generalizing strategies across topical areas, such as the effects from the successes of tobacco control on the emerging issues in physical activity and obesity control (e.g., 36, 53).

These differences call for more of the evidence to be produced in practice-based settings, in collaboration with community members and other representatives of the intended end users of the products of the research, and with flexibility of form but with fidelity to the function of interventions. Surveillance and program evaluation, as mainstays of public health evidence, epitomize the more distinct traditions

of science upon which public health has been developed, and probably deserve more attention as the issues of dissemination, implementation, applicability, and generalization are appreciated and debated. In that debate, the dissemination task can be framed less as a pipeline push strategy and more as a social marketing or participatory pull strategy of determining what people need and want to know or do and should package the scientific knowledge to address those needs and wants (88). Finally, the evidence from scientific studies, whether by investigator-initiated research with cluster randomized trials or by practice-based evaluation, will never be a perfect match with the time × population × circumstances combination faced by a practitioner, program planner, or policy maker. Therefore, there will always be a need for best processes to complement best evidence with theory, professional judgment, and the indigenous wisdom of those who live with the health problem locally.

SUMMARY POINTS

1. Dissemination strategy in medicine and public health has been influenced by diffusion theory and by an assumption that closing the gap between science and practice or policy or public use is largely a process of vetting fragments of the research more rigorously, summing their strength of evidence, and pushing them more efficiently as best practice interventions through a pipeline to intended users.
2. Diffusion theory has deep roots in imitation and social influence theories, which emphasized first a somewhat mindless tendency to adopt ideas and practices that were fashionable and later emphasized mass media to disseminate evidence-based health innovations that could be taken on faith to be best practices.
3. Dissemination is not an end in itself; its intended benefits depend on integration and implementation by the end users, who will also determine the relevance and usability of whatever is disseminated. Therefore, they need to be considered early in the process of generating the research they might use.
4. Most of the research that qualifies for inclusion in systematic reviews and that receives the greatest weight in recommending evidence-based practices in guidelines to be disseminated is research that has been conducted in highly controlled circumstances, which maximizes its internal validity but limits its external validity and perceived relevance and fit in practice. To implement more evidence-based practice, we need more practice-based evidence.
5. The rebirth of social network, systems thinking, and interpersonal influence thinking in diffusion, dissemination, and implementation research, and the reformulation of these bodies of literature in umbrella concepts of knowledge utilization and knowledge integration, has given greater attention to the receptor end of the research pipeline.

FUTURE ISSUES

1. Diffusion and dissemination research need to give greater attention to external validity in the production and systematic reviews of evidence for adoption by policy makers, practitioners, or the public.

2. Research beyond efficacy trials needs to be more practice based, outside highly controlled academic circumstances, to be more relevant, believable, and actionable to practitioners who would implement its conclusions.
3. More participatory approaches to research, with the active engagement of practitioners or policy makers or community-based residents or patients, can help shape the research questions and methods for sampling, design, analysis, and interpretation that will assure greater relevance, credibility, and implementation.
4. Evaluation of actual public health programs in real-time, typical situations, with typical personnel conducting the interventions (and participating in the evaluations), will regain respectability in reviews of evidence and promotion of evidence-based practices.
5. Enhanced surveillance systems, to track comparable data over time and between jurisdictions, will be needed to make public health program evaluation more feasible and useful beyond the particular program being evaluated.
6. More surveillance, accreditation, and quality assurance or accountability down to the local level will enhance the potential for such evaluation of community programs, thereby producing more practice-based evidence.
7. Systems analytic approaches to simulation of complex change phenomena and knowledge integration across multiple ecological levels of communities will serve public health's needs increasingly as these methods are developed.

DISCLOSURE STATEMENT

The authors are not aware of any biases that might be perceived as affecting the objectivity of this review.

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117. Brought social network analysis methods to an enrichment of diffusion theory and renewed interest in social influence processes in the communication of innovations.

128. Reflects on the work leading up to the author's 1979 book, *Using Social Research in Public Policymaking*, and what we have learned since, and summarizes the field of knowledge utilization.

131. Sets the stage for the "Roadmap" initiative of the then-new director of NIH, setting out the case for greater emphasis on translational and transdisciplinary research to bring the fruits of science to public health and medical benefits.

RELATED RESOURCES

1. Making Health Communication Programs Work: **http://www.nci.nih.gov/pinkbook/**
2. Cancer Control PLANET: **http://cancercontrolplanet.cancer.gov**
3. Designing for Dissemination: **http://dccps.nci.nih.gov/d4d/about.html**
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