TRANSLATING SCIENTIFIC DISCOVERIES INTO PUBLIC HEALTH ACTION: HOW CAN SCHOOLS OF PUBLIC HEALTH MOVE US FORWARD?

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> "To him who devotes his life to science, nothing can give more happiness than increasing the number of discoveries, but his cup of joy is full when the results of his studies immediately find practical applications."
>
> —Louis Pasteur

There is a large gap between the volume of public health knowledge generated through research and the application of that research in community settings.[1–3] Too often, public health scholars do not translate or disseminate this research for use in community settings where it is likely to have positive impacts.[4]

Both the empirical literature and patterns of federal spending on health research reveal much about the limited dissemination of discovery to practice. Two studies in the literature show the extent of dissemination and institutionalization of effective interventions. In a content analysis of 1,210 articles from 12 prominent public health journals, 89% of published studies were classified as basic research and development.[5] The authors classified another 5% of studies as innovation development, less than 1% as diffusion, and 5% as institutionalization. Similarly, Sallis and colleagues conducted a content analysis of four journals and found 2% to 20% of articles fell in a phase defined as "translate research to practice."[6] In 2003, the United States spent more than $27 billion on health-related research.[7] Between 9% and 25% of this amount was expended on prevention research,[8,9] i.e., the direct and immediate application of effective intervention strategies to benefit the public's health.[10] Farquhar has estimated that 10% or less of prevention research is focused on dissemination.[8]

In clinical disciplines such as medicine and nursing, a similar gap exists between discovery and application. Despite advances in evidence-based medicine,[11,12] systematic application of clinical research findings to improve patient care remains limited.[13–15] In a review of the quality of care among patients in the United States, only 60% of those with chronic conditions received recommended care.[16] Studies of dissemination of evidence-based guidelines (aka, consensus statements) suggest that awareness varies widely across medical subspecialty, with awareness ranging from as low as 20% among cardiac surgeons to 90% to 95% among obstetricians.[17] The dissemination gap for clinical research also has a time component. A review suggested that it took an average of 17 years for 14% of original (i.e., discovery) research to be integrated into physician practice.[18] In general, dissemination of clinical guidelines using passive methods (e.g., publication of consensus statements in professional journals, mass mailings) has been ineffective, resulting in only small changes in the uptake of a new practice,[19] and single-source prevention messages are generally ineffective.[20]

The literature suggests that effective dissemination of an evidence-based program often calls for time-efficient approaches, ongoing training, and a high organizational value on research-informed practice.[21] Further, the dissemination of a research discovery among organizations, practitioner groups, or the general public is likely to occur in stages.[22] The decision to adopt, accept, and utilize an innovation is not an instantaneous act, but more often a process.

In this article, we describe a four-stage approach for translation and dissemination (T&D) of research discoveries into public health action. We discuss key actions that will improve our ability to progress through these stages. We focus on measures that can be stimulated or enhanced by academic higher education, particularly among schools of public health.

A FRAMEWORK FOR TRANSLATING RESEARCH INTO PUBLIC HEALTH ACTION

We propose a staged approach for understanding and systematically studying the process of research translation (Figure). Multiple studies support this staging, based on case studies and empirical literature describing dissemination of health-related innovations (new

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Figure. Pathway for translation and dissemination in public health

research discoveries)[23,24] and many other issues including agricultural practices and social movements.[22,25]

Phase 1: Discovery

The goal of the first phase is to investigate determinants of health, disease, and behavior; evaluate the effectiveness of health services and interventions; and develop and test scientific methods and theoretical perspectives. Epidemiologic and clinical research has identified and quantified many health risks. Etiologic studies in epidemiology seek to measure the magnitude of an association in terms of an effect estimate. Many other disciplines contribute to the discovery phase, including behavioral sciences, biostatistics, health services research, and environmental health. Often, in this phase, the development and testing of behavioral science theory provide a foundation for later phases.[26] Also included in Phase 1 is the testing of an intervention or organizational innovation in carefully defined, "ideal world" settings (sometimes called efficacy research). Most academic research in public health falls within this stage.

Phase 2: Translation

In Phase 2, the goal is to synthesize research findings and convert them into a form applicable to a target population or audience in the context of the conditions in which its members live and interact. When conducting work in Phase 2, the emphasis often shifts from a focus on efficacy to effectiveness, i.e., "How useful and generalizable is an intervention under 'real world' conditions?" The context for the intervention, policy, or organizational innovation is of vital importance. Understanding context often creates tension between fidelity and reinvention.[27] Fidelity refers to the extent to which a replicated or applied discovery has been modified from its original design; altering a program or its components may reduce its effectiveness upon replication.[28] Conversely, reinvention argues that changes in programs are needed when replications occur in new settings, with the goal of preserving the essential features while taking local circumstances into account.[29] Cultural adaptation is frequently a crucial aspect of the translation phase when adapting a discovery for use in or by population subgroups other than those from which it originated.[30]

Adoption of new programs in the translation phase is in part a function of advantage—relative and differential. Relative advantage is the degree to which planners consider the innovation better than the practice it supercedes. For preventive interventions, this relative advantage is sometimes difficult to quantify because there may be a long delay between adoption and when a reward (e.g., positive health outcome, cost savings) is realized.[20] Differential advantage is the extent to which a potentially effective innovation will interact within an array of possible interventions to improve outcomes. Attention to issues of differential advantage increases the likelihood that an innovation creates synergy in the portfolio of interventions operating in a population, community, or organization.

Existing syntheses of public health knowledge can be valuable resources in developing a generalizable, externally valid intervention. For community settings, the Guide to Community Preventive Services (the "Community Guide") is an excellent example of an evidence-based tool (www.thecommunityguide.org).[31] The Community Guide seeks to answer three questions: (*1*) "What has worked for others and how well?" (*2*) "How can I select from among interventions of proven effectiveness?" and (*3*) "What might this intervention cost and what am I likely to achieve through my investment?"[32]

Phase 3: Dissemination

Phase 3 seeks to communicate and/or deliver translated research findings to populations in ways that are meaningful and relevant. In this phase, we realize the beginnings of enduring change. An organization's priorities and resources should be assessed to determine the long-term viability of an innovation. Passive forms of dissemination that are untargeted and undifferentiated are usually insufficient to achieve widespread program and/or policy adoption.[19,20] Effective methods of active dissemination are essential. Active dissemination should take into account the credibility of the information source, quality of the scientific evidence, time efficiency, and the need for reminders.[33]

The longer-term objective of Phase 3 is the institutionalization and maintenance of the discovery in a particular setting, in which the innovation is integrated into the routine practices of a social system.[34] More

studies have focused on adoption and implementation of change rather than on maintenance.[23] Factors associated with maintenance of innovations include cost, modifiability, quality of the strategic and operational fit with the organization, and organizational support for the program.[21,23,35,36]

Phase 4: Change

Finally, Phase 4 strives to improve health through long-term behavior change, program adoption, organizational change, policy adoption, and/or environmental change. The ultimate goal of the application of a research innovation is creation of change—i.e., improving particular health indicators and quality of life. A variety of important changes might occur in Phase 4. For example, as the result of work in the earlier phases, a health insurer might decide to implement coverage of an effective preventive service (e.g., immunizations, smoking cessation in pregnancy). In this phase, we need metrics that not only assess traditional endpoints (e.g., vaccination and smoking rates), but those that assess more intermediate endpoints such as organizational capacity or changes in public policy. Because adopting organizations are complex, contextual, and multiply determined, measures of change should recognize and incorporate these characteristics.[37]

Movement between phases

Although the terminology may vary, the four phases described above are included in most explanations of the T&D process. What is less well understood is how to promote movement from one phase to the next. The successful translation and application of public health discoveries and adoption into practice and policy depends on not just a commitment to do so, but also proven processes, strategies, and tactics. This is where a new era of T&D research may make its greatest contributions. Here we offer initial ideas about some of the key issues to be addressed in understanding and facilitating movement between phases.

To move new public health discoveries into a translation phase, we must determine who is likely to use the discovery and how they are likely to use it. To get this information, we might ask, "Who would benefit from the discovery?" Potential beneficiaries include not only end users or recipients, but also the organizations that serve them or would deliver the translated discovery. Specifically, how are these potential beneficiaries—both individuals and organizations—likely to use the discovery? What are the unique needs, interests, or goals of different beneficiaries? Answers to these questions will inform decisions about how the discovery must be adapted to maximize the likelihood that potential adopters will use it. It is also important to clearly identify the essential elements, or active ingredients, of the discovery without which its effectiveness or value is diminished. Care should be taken to maintain the integrity of these elements in any adaptation. Finally, what lessons can be learned from the success or failure of past attempts to translate similar public health discoveries? Progress in moving discoveries into translation will be accelerated and more successful if each translator doesn't have to start from scratch.

Progressing from translation to dissemination involves developing and carrying out strategies to promote the translated discovery to potential adopters. This requires understanding key attributes of both the discovery and potential adopters. For example, what are the relative advantages of the translated discovery over current or alternative solutions? These may include objective advantages like cost savings and efficacy, but also more subjectively judged attributes like organizational fit and malleability. It is also important to recognize that different adopters will likely vary in the value they place on the same advantage or attribute. Thus when strategies are developed for introducing and promoting the translated discovery to potential adopters, a one-size-fits-all approach will likely have limitations. But moving from translation to dissemination involves more than just salesmanship. There are also practical and logistical challenges to be addressed. For example, adopters may need instruction or assistance to learn how to use the translated discovery. What specific mechanisms and resources will be needed for delivering this training and providing ongoing technical assistance to support successful adoption and institutionalization? Broader trends in public health might also facilitate movement of discoveries from translation into dissemination. For example, if understanding and appreciation of evidence-based public health practices was more widespread,[38] the demand for translated discoveries might also grow. Collecting exemplar case studies of different paths taken to successful dissemination and adoption would also be a valuable resource.

What promotes movement from dissemination to change? It seems likely that the impact of dissemination and the probability of institutionalization are affected by the way a translated discovery is implemented, and the ways, if any, the discovery and its implementation have been adapted over time to accommodate changing circumstances. Developing metrics for evaluating these outcomes is a pressing need for public health. For example, what are appropriate indicators of quality control and fidelity for implementation?

How, if at all, has the discovery changed the adopting organization? What outcomes can be reasonably expected, among whom, after what period of dissemination, and how should they be measured? Perhaps most importantly, a system is needed through which such information can be shared with potential adopters and those working in all other phases of the T&D process. This feedback loop is critical for making improvements in the overall process, and to increasing institutionalization.

WHAT CAN SCHOOLS OF PUBLIC HEALTH DO?

We have identified seven strategies that schools of public health could apply to increase the application of scientific discoveries to public health action. We encourage our colleagues at other institutions to add to this list, and share their ideas and experiences so that all schools can benefit and so that collectively, we can advance the field.

Increase organizational commitment to T&D efforts

For example, in a study from Canada, organizational characteristics were more likely to predict the influence that systematic reviews had on public health decisions than any other characteristic.[21] Academic institutions, in particular schools of public health, can play important roles in promoting agenda for more and better T&D. First, universities must play a leadership role in this area. Schools can elevate the emphasis on T&D to the level of other fundamental public health principles like prevention, social justice, community-based action, and having a population perspective. In other words, to do public health is to embrace a commitment and responsibility to applying what we learn to improve others' lives.

Design for dissemination

Effective dissemination is likely to be a combination of sound planning and serendipity. Too often, we think about target audiences for T&D after the discovery process. Researchers should identify partners prior to conducting discovery research, so that those who might adopt the discoveries will see results in a collaborative relationship. This suggests a greater emphasis on building strategic partnerships early in the T&D process. It seems that at least three basic steps are warranted: (*1*) determining how and by whom a public health program or intervention is likely to be used in a non-research setting; (*2*) assessing the needs, resources, and infrastructure of potential adopters; and (*3*) assuring that the program or intervention is developed in ways that match adopters' needs, resources, and infrastructure.[39]

Build partnerships and capacity

The importance of trans-disciplinary partnerships has long been recognized in public health.[40,41] Often the goal of these partnerships is to enhance the work of the public health partners. For T&D to thrive, we must expand to new kinds of partners, and recognize that in many cases, the goal of the partnership is to enhance others' works, not only our own. We need to extend partnerships to include more intermediaries—organizations that already have established relationships with those who stand to benefit the most from public health discoveries. We should balance the amount of time we spend building direct relationships with the ultimate beneficiaries with time spent building relationships with the intermediaries. In addition, the capacity of an organization is likely to have a direct bearing on its ability to disseminate effective programs.[25] If capacity is low (e.g., poorly trained staff, lack of facilities), even the most effective intervention approach will face long odds.

Provide faculty development and incentives

Based on clinical studies of evidence-based practice, we know that without specific incentives, desired changes in practice are unlikely to occur.[42,43] Similarly, schools of public health need incentives for greater T&D of discoveries to practice. We need to reward T&D efforts in faculty performance evaluations and in tenure and promotion decisions. Some universities have established "practice tracks" that in part seek to address this need to reward efforts that follow discovery. For example, tenure at the University of North Carolina School of Public Health is partially based on the criterion that ". . . the practice must be shown to have affected not only a given policy, community, agency or program, but it must also be shown that the practice has in some way contributed to advancing the state-of-the-art of public health practice itself." Incentives, in the forms of types of grants funded and types of articles published, should also come from major funders (e.g., the National Institutes of Health) and from peer review systems for research proposals and publication in scientific journals.[36]

Develop new ways of communicating and presenting information

We must target information to specific audiences. Scientists talk to other scientists in most scientific publications and presentations. For T&D to occur, we must share discoveries through channels most likely to reach potential adopters and end users. These adopters, users, and channels will likely vary based on the discovery. Especially for policy change, scientific data must translate into compelling stories that are relevant to

policy makers and the people who vote for them. In addition, the media are influential and an important driver in T&D. Schools of public health should develop stronger skills in working with the media to share scientific discoveries and applications.

Offer curricula and training

We need to better integrate T&D concepts and competencies into required coursework. These concepts apply both to formal curricula for degree-seeking students and to training programs for practitioners seeking continuing education. In program planning coursework, we should consider a lesser emphasis on skills for developing new programs and increase the emphasis on identifying existing evidence-based programs and adapting them for use in a given population or organization. In behavioral science and health education, we might expand competencies in community diagnosis to include organizational diagnosis. In particular, these changes will provide students with both the perspective and skills to gather information about potential adopters. In this way, students would be better equipped to support movement from Phases 1 to 2.

We need curricula that portray public health broadly, integrated to include all five core disciplines, to effectively train our students for T&D. Increased strategic and operational management skills would enhance students' ability to determine the relative and differential advantages of alternative interventions. For example, learning to approach a T&D challenge as a product or service market entry question, students would learn to identify the chain of producers, distributors, and buyers necessary to bring the product or service to market. Public health students with a greater understanding and appreciation of systems outside governmental public health could look more broadly for venues that might successfully adopt public health discoveries. Expanded settings that could benefit might include systems of medical care, health industry companies (e.g., insurance, health and medical supplies, pharmaceuticals), and political and other governing bodies.

Conduct more research on T&D

In relation to its importance in improving population health, there has been sparse systematic inquiry into effective methods and standards for T&D research. Numerous areas are in need of study. Here are a few examples of pressing research topics:

- We know from longstanding experience in public health surveillance that "What gets measured, gets done." Yet for T&D, we often lack the proper indicators and metrics to measure success. We also need a systematic assessment of how much of day-to-day public health practice is evidence-based.[38] In particular, we need better measures of external validity, including generalizability. In a review of outcome studies in four settings (worksites, health care, schools, community settings),[44] internal validity criteria were reported much more often than metrics of external validity.
- Useful tools (e.g., the Community Guide),[31] Cancer Control PLANET,[45] and RE-AIM,[46] are now available to provide syntheses of large bodies of intervention research and/or systematic planning approaches, yet these tools are underutilized. We should better understand how to make use of existing resources supporting evidence-based public health.
- Although economic data can be powerful drivers in decisions to adopt a translated discovery, cost and cost-effectiveness data are seldom collected as part of public health program evaluations.[44] Work is needed to make economic evaluation a routine part of intervention testing and translation.
- T&D work will benefit from a sound theoretical basis. Frameworks like the one we are proposing are a start, but we need to better understand which questions are important to ask because the body of research will increase more quickly if we identify specific gaps and priorities.
- Current T&D activity across disciplines spans many levels of analysis, from biological research aimed at clinical innovations to behavior and psychological dimensions for interventions, to broad social and cultural interactions with environment. Further T&D research must consider the implications of multi-level approaches.[47]

CONCLUSION

Decades of support by governmental and private sources has produced a remarkable foundation of knowledge in all disciplines related to public health. During this time, scientists, leaders, and the public have all endorsed the idea that progress toward better health can only be achieved with the most accurate information. Although the progress attained is well known and reported regularly in popular media, evidence summarized here suggests that the discovery of knowledge implies no natural mechanism for deploying it. Years may pass before practitioners adopt new knowledge into clinical or community applications.

We propose that this process itself, of harvesting knowledge for the public's benefit, requires understanding and action. Researchers must recognize the

practical applications of their findings, and learn to identify collaborations and build partnerships that can address the many complexities of moving a project from Phase 1 to Phase 4. Further, in a time of increasing pressure on scientific resources, researchers must continue to meet the implied obligation to the public that the billions of dollars invested in basic science will continue to yield specific and tangible benefits to their health. In public health, we have discovered much, not yet applied, that holds the promise of important change in health.

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