Practice-Based Evidence in Public Health: Improving Reach, Relevance, and Results

Alice Ammerman,[1,2] Tosha Woods Smith,[1,2] and Larissa Calancie[1,2]

[1]Center for Health Promotion and Disease Prevention, [2]Department of Nutrition, Gillings School of Global Public Health, University of North Carolina, Chapel Hill, North Carolina 27599-7426; email: alice_ammerman@unc.edu, tosha.smith@gmail.com, lcalancie@unc.edu

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Abstract

The most threatening public health challenges today are chronic and complex and require joint effort from academic researchers in partnership with clinical and public health practitioners to identify and implement sustainable solutions that work in the real world. Practice-based research offers researchers and practitioners an underutilized way forward, an opportunity to work together to design and test feasible, evidence-based programs to address our greatest challenges. In this article, we outline the need for practice-based evidence, tools, and strategies that investigators can use to generate practice-based evidence, describe approaches to translating practice-based evidence into practice, and offer recommendations for making practice-based research the norm in public health.

INTRODUCTION

Public health research seeks to understand the causes of public health problems, to develop solutions, and to apply those solutions to public health problems. Epidemiology has become ever more sophisticated in identifying risk factors associated with disease and numerous well-tested theoretical models are now available to guide intervention efforts. We have a proliferation of tested programs and policies designed to address problems at multiple levels of the socioecologic model, from downstream individual behavior interventions to upstream policy and environmental change. Emerging technology now allows us to expand our intervention reach and significantly enhance data collection. However, with few exceptions, we are not seeing the reduction in disease burden that might be predicted from the many advances in our field. Experts estimate that there is a time lag of some 17 years for 14% of research evidence, including much that never gets published, to be translated into practice (35). Public health researchers and practitioners need better approaches to the research enterprise that result in greater impact, producing more than an academic product such as a peer-reviewed publication that has minimal reach into the practice community.

As budgets tighten and competition for resources increases, funding agencies have increasingly required public heath interventions to be evidence-based and thus presumably likely to be effective when implemented (15, 64). In most cases, the evidence used to select these interventions is the program's impact on a primary outcome measure, and internal validity is prioritized over external validity (28). Meanwhile, public health practitioners are faced with implementing interventions that were designed by researchers with limited knowledge or understanding of the environment in which interventions will be used (48). Often, in order to achieve the level of impact expected to qualify as evidence based, interventions are designed to be highly resource dependent, rely on implementation staff with training and supervision beyond what is generally available in practice, require intensive participant commitment, are not easily sustained in the agencies intended to house the program, and thus fail to be adopted and are seldom maintained over time. As a result, the original reason for choosing evidence-based interventions—to assure that they will have an impact when implemented—is often thwarted because these interventions are designed to achieve evidence of impact alone rather than to promote implementation at the practice level. Very few programs are "designed for dissemination" (9, 45) such that they are scalable from the beginning, which is essential for true public health impact. To address this problem, researchers and practitioners are forming partnerships to generate practice-based evidence. Practice-based evidence acknowledges that efficacy or effectiveness is only one of many pieces of information required to make the case that an intervention will ultimately impact public health (7). Practice-based evidence first requires a deep understanding of the challenges faced by both those who deliver and those who receive the intervention (35, 36). This method generally requires formative work in the community and the use of partnership models such as community-based participatory research (87), where both the public health intervention and the research strategy are informed by the combined wisdom and experience of health care consumers, practitioners, and researchers (87, 89).

Unfortunately, the current academic research enterprise (promotion and tenure requirements, peer review of grants and manuscripts, editorial preferences of journals, Impact Factor scores) does not adequately reward the generation of practice-based evidence. The time and resources required to develop true academic-practitioner partnerships do not always fit well within grant deadlines or other academic pressures such as the ticking-up-or-out tenure clock for assistant professors (37). Grants are scored and manuscripts critiqued on the basis of their potential for impact in a highly controlled research setting rather than of their feasibility and scalability (36). Thus, researchers are rewarded for resource-intensive, short-term, high-impact interventions rather than for long-term community engagement from which more sustainable, more cost-effective,

and ultimately more successful interventions can emerge (37). After a long tradition of developing public health interventions in academia and then implementing and testing them in artificial, semiacademic settings via randomized trials, there is a growing call for systematic approaches to gathering practice-based evidence. As Larry Green has been quoted so often, "If we want more evidence-based practice, we need more practice-based evidence" (35, p. i23).

A national response to the need for more practice-based evidence resulted from a Congressional Act authorizing the Centers for Disease Control and Prevention to create the Prevention Research Centers (PRC) program, which currently funds 37 community-based academic research centers conducting applied prevention research ranging from individual-level to policy and environmental changes (38). The PRCs work closely with state and local health departments as well as other community partners to develop and test programs and policies that directly impact community-based public health needs (2, 39). In recent years and following recommendations of an Institute of Medicine (IOM) report, the focus of PRCs has moved toward a greater focus on using practice-based evidence to achieve broader public health impact through dissemination and implementation research. The implementation of national thematic research networks involving researchers from several PRCs addressing an important public health topic (e.g., physical activity policy, nutrition and obesity, health aging) has facilitated investigation into important research-practice gaps (38).

PRACTICE-BASED EVIDENCE AND PROGRAM EVALUATION

Before the terminology "practice-based evidence" was widely used, program evaluation strategies began introducing this approach without naming it, by emphasizing more systematic and participatory assessment of needs in program planning and implementation monitoring (1). In 1969, Knutson (47) suggested that evaluation's primary purpose was to "provide objective estimates of achievement and to provide guidance for the conduct of program activities" (p. 46). Weiss (91) described how research methods could be applied to evaluation of social programs to "measure the effect of a program against the goals it set out to accomplish as a means of contributing to subsequent decision making about the program and improving future programming" (p. 4). She offers practical guidance for forming evaluation questions and conducting evaluation research in what can be "turbulent" settings. Suchman (79) compares evaluative and other kinds of research in his book *Principles and Practice in Public Service and Social Action Programs*, noting that "unlike the basic researcher, the applied [evaluative] researcher must be constantly aware of the potential utility of his [or her] findings." He continues, "[T]o a far greater extent than the basic researcher, the evaluator loses control over the research situation" (p. 21). Shortell emphasizes the use of scientific methods in evaluating research to answer questions concerning, for example, how and why a program did or did not work and what can be done to improve it, rather than attempting to isolate the causes of events or outcomes, as is the focus in most basic or "nonevaluative" research (75). Suchman emphasizes the importance of the right study design to answer the question rather than deeming one design superior to another (79). These early evaluation researchers laid the foundation for using a range of methods, beyond controlled trials, to understand the contexts of and influences on effective intervention implementation, i.e., generating practice-based evidence.

THE GROWING CALL FOR PRACTICE-BASED EVIDENCE

Several policy and practice groups have issued reports, consensus statements, and guidance documents outlining the urgent need for practice-based evidence and steps to achieve it. The landmark 2001 IOM report *Crossing the Quality Chasm* called for evidence-based clinical practice but argued that "evidence" must not be equated with results generated only by randomized

controlled trials (RCTs). The committee wrote, "Although the concept of evidence-based practice has come to be regarded by some as implying rigid (even mindless) adherence to the evidence drawn from randomized controlled trials, we mean it here to encompass the use of the best available clinical evidence from systematic research of many designs and integration of that evidence with clinical expertise" (17, p. 47). In an additional report issued in 2002 titled *Who Will Keep the Public Healthy?*, the IOM argued that the nation's schools of public health have a particular responsibility to establish new relationships with community organizations, other health science schools, and health agencies to foster transdisciplinary research and that schools of public health should emphasize the "importance and centrality of the ecological approach" for public health research and practice (26, p. 10). The Association of Schools of Public Health (ASPH) agrees that the generation of practice-based evidence is a unique responsibility of the nation's academic public health institutions. In 2006, the ASPH issued the guidance document *Demonstrating Excellence in Practice-Based Research for Public Health*, which called for an "ecological paradigm of research" that understands and embraces the complexity and interdependence of the various factors that influence human behavior and health (68, p. 5).

In 2003, the National Institutes of Health (NIH) underwent an institution-wide planning process termed the "NIH Roadmap." One of the three priorities identified during that Roadmap process was the need for more implementation research, both through interdisciplinary teams and through public-private partnerships. Describing the conclusion of the Roadmap process, the director of the NIH at the time, Elias Zerhouni, wrote, "In the past, all research for a clinical trial could be conducted in one academic center; that is unlikely to be true in the future. In these initiatives, NIH will promote creation of better integrated networks of academic centers that work jointly on clinical trials and include community-based physicians who care for large groups of well-characterized patients" (93, p. 64). To generate more practice-based evidence via academic-community partnerships, the NIH established the Clinical Translational Science Award (CTSA) program in 2006, which listed as one of its three charter tenets the engagement of community partners. This community-based research focus is integral to the generation of results that are practical and useful for the intended target communities. As of summer 2013, nearly 60 research institutions in 30 different states have housed active CTSA centers (62). In many of these institutions, the requirement for a stronger community focus on translational research has forged partnerships between public health and clinical care and produced a greater demand for practice-based evidence at the interface between the disciplines (92). Additionally, in 2009 the NIH issued a program announcement (#10–038) focused explicitly on dissemination and implementation research. This request for application (RFA) encourages the formation of interdisciplinary teams and practitioner-academic partnerships to conduct research in diverse community and practice environments to generate practice-based evidence about what works in program implementation and dissemination (63).

As the high cost of health care in the United States remains a pressing issue, lawmakers are also seeing the value of practice-based evidence for identifying solutions that work in routine clinical care. This has resulted in two new research mechanisms: comparative effectiveness research (CER) and the Patient-Centered Outcomes Research Institute (PCORI). PCORI was established in 2010 by Congress as part of the Patient Protection and Affordable Care Act as an independent, nonprofit research organization. Its mission and vision focus on research that is guided by those who are positioned either to receive or to deliver evidence-based interventions to promote health (**http://www.pcori.org/**). To enhance the practical and applied utility of research, PCORI emphasizes CER. CER directly compares two evidence-based interventions rather than comparing an intervention to a usual care or control group. Glasgow and colleagues (29) argue that CER leads to more rapid translation of evidence-based findings by moving the science closer to practical application.

PATIENT-CENTERED OUTCOMES RESEARCH INSTITUTE

The mission of the Patient-Centered Outcomes Research Institute (PCORI) is to help people make informed health care decisions and improve health care delivery and outcomes by producing and promoting high-integrity, evidence-based information that comes from research guided by patients, caregivers, and the broader health care community. Its vision is for patients and the public to have the information they need to make decisions that reflect their desired health outcomes.

RESEARCH DESIGNS AND METHODOLOGIES FOR GENERATING PRACTICE-BASED EVIDENCE

Far better an approximate answer to the right question, which is often vague, than an exact answer to the wrong question, which can always be made precise.

–John Tukey (83)

RCTs are especially useful for estimating causal relationships when disease processes are simple, biological, and acute. Efficacy RCTs call for tight control of study protocols to achieve conditions that are as near as possible to ideal. In efficacy RCTs, the influence of context is minimized with extensive inclusion and exclusion criteria and strict program enforcement meant to elucidate clear distinctions between treatment and control groups. Many investigators have argued (37, 46, 86) that such RCTs may be less useful for investigating chronic diseases, which have myriad biological, social, behavioral, and environmental risk factors and long, messy disease processes. Unfortunately, chronic diseases, such as obesity, diabetes, and heart disease, represent a greater threat to public health today than did the more acute, infectious diseases of the past. The contextual complexity of chronic disease calls for innovative approaches to research design that can capture more depth than simply whether an intervention works or does not work.

RCTs, with some slight modifications, can be feasibly conducted in practice and community settings to produce relevant results for health system and policy decision makers. The two aspects of efficacy RCTs that advocates of practice-based research criticize most are strict inclusion and exclusion criteria and the fact that many interventions are delivered by expert research personnel rather than by the existing clinical or community care center staff members, who may have limited time and training. Both of these factors compromise the external validity of such studies. However, practical clinical trials, or (similarly) pragmatic clinical trials (PCTs), cluster randomized trials, and CER studies are good examples of how the traditional efficacy RCT can be modified to suit practice and community settings to generate more relevant clinical and public health evidence. PCTs are designed to recruit a diverse, representative study population: Often these populations include participants who are taking medication or participating in alternative treatment options, who are not compliant, who have comorbidities, or who otherwise introduce confounding factors and pose a challenge to tidy data collection and analysis. Because randomization is a strategy that, on average, distributes potential confounding factors evenly among treatment and control groups, essentially helping to distribute all these sources of individual variation, randomization and the use of control groups may still be an effective strategy for PCTs. Additionally, investigators and community partners are encouraged to collect comprehensive patient, process, and outcome data in PCTs to help explain individual variation in treatment effect (31, 84).

Group or cluster RCTs may be more useful for generating practice-based evidence than are traditional RCTs. In cluster RCTs, groups of individuals such as schools (65, 73), medical practices (20, 74), or entire communities (41) are randomized to treatment or control conditions. Group or

cluster assignment allows each medical practice, school, or community to continue operating as a whole unit, without dividing individuals into distinct treatment and control groups. Thus, cluster RCT studies may not need to devote as many resources to preventing contamination between treatment and control participants (11, 72) compared with traditional RCTs. Although groups of individuals are randomized in cluster RCTs, individual-level data collection and analysis are still possible if appropriate analytical techniques are used to account for data correlation (11, 60, 61). Many investigators have conducted cluster RCT studies in community-based settings (14, 41). Indeed, cluster RCTs may be politically more feasible because, rather than randomizing individuals within a single community, no one in the treatment community is excluded from program participation.

In some situations, it is not feasible, ethical, or politically expedient to randomize some participants to program participation and others to control groups. In these situations, well-controlled observational studies can be used to assess program impact with scientific integrity. Indeed, some investigators have even argued that well-controlled observational designs may be preferable to assess mediating and moderating factors, which are assumed to be present in complex, chronic disease processes (86). Other study designs, such as time series analyses, fractional factorial designs, natural experiments, and preference designs, when carefully constructed, offer scientifically rigorous alternatives to efficacy RCTs and can generate practice-based evidence in study conditions that more closely resemble the real world (46). Likewise, economic simulations (69) and other applications of systems science (54) can more fully embrace the messy contexts in which disease occurs instead of trying to minimize them. Recent advances in statistical methodology have facilitated control for confounding via modeling instead of by exclusion (4).

THEORIES, FRAMEWORKS, AND TOOLS FOR THE GENERATION OF PRACTICE-BASED EVIDENCE

Many theories, frameworks, and tools are useful for generating practice-based evidence, even if the practice settings, populations, or conditions vary. These theories and frameworks are useful precisely because they can account for heterogeneity in the research context and thus increase the external generalizability of study findings. Community-based participatory research (CBPR) is a useful approach for developing practice-based evidence because it can help bridge the gap between science and practice through community engagement and attention to existing relationships, needs, and assets in a community (87, 89). The principles of participatory research, broadly, offer guidance for conducting studies in various settings such as in primary care practices, in churches, and in other community-based organizations with wider reach than academic research settings (87). Participatory research can apply to grassroots community efforts, and can also be a process for engaging other important stakeholders, such as providers, practitioners, and policy makers (87).

The RE-AIM framework can also be used for both planning and evaluation and moves the researcher's thinking beyond efficacy or effectiveness to consider a variety of other contextual factors critical to achieving impact. Practice-based evidence generated by the RE-AIM framework includes the degree to which the intended audience is reached by an intervention; whether it can be successfully adopted by the delivering organization and staff without external assistance from a research infrastructure; the feasibility and consistency of implementation while still adapting to the practice environment; and evidence that the intervention can be maintained over time by both the individuals and the delivery setting (32). RE-AIM forces the research to consider practice-based evidence in both achieving and measuring an intervention's impact. In 2010, program officers at the Robert Wood Johnson Foundation (RWJF) and the Centers for Disease Control and Prevention

(CDC) published a review article detailing the use of evaluability assessments, an important tool to help researchers and practitioners develop a "pragmatic, practice-based research agenda" (53, p. 213). Evaluability assessments allow for rapid, real-time feedback on program performance and determination of whether a larger-scale evaluation study may be warranted. For those designing effectiveness trials, the PRECIS tool offers useful principles, and the 2009 amendment to the CONSORT statement provides guidance for reporting results from pragmatic trials (81, 94). The Intervention Wheel, developed by public health practitioners in Wisconsin, has been used in interventions spanning a wide range of public health topics (43, 44). The School Health Action Planning and Evaluation System is a framework designed specifically for use in school settings and uses school-specific data to give feedback about physical activity and obesity trends among students (10). The CDC developed and tested an evaluation tool called Swift Worksite Assessment and Translation, or SWAT, which helps small- and medium-sized work sites to identify rapidly those health-promotion programs that encourage healthy weight among employees and assist with evaluation (19). In addition to these examples, Tabak and colleagues identified 61 different models for dissemination and implementation research (80). Additional tools and theories that may be useful in practice-based research include planning models such as PRECEDE-PROCEDE (18), the measurement of proximal outcomes (21, 78), and the use of interdisciplinary research teams (57). The use of planning models such as PRECEDE-PROCEDE ensures that applicability and generalizability of findings are not afterthoughts, but instead a part of the study design process. Measurement of program effects on proximal outcomes, such as knowledge and attitudes, is needed to conduct practice-based research, especially in behavior-change programs when investigators cannot assess longer-term health impacts (50).

SYSTEMS SCIENCE

Systems science holds great promise for generating and understanding evidence that accounts for the complexity of the public health context (54) and therefore is applicable to practice-based research (34). As described by Richmond (71), "While the web of interdependencies tightens, our capacity for thinking in terms of dynamic interdependencies has not kept pace. As the gap between the nature of our problems and the ability to understand them grows, we face increasing perils on a multitude of fronts" (p. 113). Systems thinking is important for developing effective strategies to close this gap. Glass & McAtee (33) describe the range of factors to be considered that impact the health of an individual and the public, going beyond the socioecologic model, which considers individual- to policy-level variables (21). Their model integrates the natural and behavioral sciences, including the "underwater" elements, which are composed of genomics, molecular, cellular, and multiorgan level systems. Systems science approaches and frameworks that accommodate data from genetics to national policy can aid public health practitioners and researchers in accounting for complexity without becoming overwhelmed by it (33). Systems are dynamic, nonlinear, complex, and multilevel (i.e., include variables from multiple levels of the socioecological model), may contain feedback loops and delays, and often include multiple stakeholders (76). The behavior of systems is often difficult to predict because variables interact with each other and change over time. Modeling organizes variables in a system and shows how they relate to one another. Remembering that "all models are wrong; the practical question is how wrong do they have to be to not be useful" (6, p. 424), researchers and practitioners can use models to address challenging public health issues while acknowledging that models are helpful simplifications of problems that can seem overwhelmingly complex (54, 77).

Three major systems science approaches have been employed for public health research: system dynamics modeling, agent-based modeling, and network analysis. System dynamics modeling

demonstrates complex relationships (42), including nonlinear and dynamic functions; agent-based modeling requires data about predicted behavior of agents then models simulated effects of their behavior over time (3); and network analysis allows investigators to quantify network characteristics (e.g., density, connectivity) (5). For a complete review of these approaches, see Luke (55), "Systems Science Methods in Public Health: Dynamics, Networks, and Agents." Researchers have used system dynamics modeling, for example, to identify "leverage points" or "places one can intervene within a system to effect change" (p. 284) where an intervention is likely to have a positive effect on an outcome of interest while minimizing negative or unintended consequences (54, 59). Agent-based modeling and network analysis are also systems methods that have useful applications in public health (55). Data from practice can be used to create systems models to help explain which factors are associated with program/policy success or failure. This approach can provide structure to process evaluation or yield simulated outcomes if good-quality data are available for factors and relationships between them. For example, researchers at Virginia Tech and UNC's Prevention Research Center are currently using comparative case studies and simulation modeling to understand the key factors that regulate success and failure of adoption, implementation, and maintenance of chronic disease prevention and treatment programs, with a focus on interventions targeting obesity. Interventions included in the study are Baltimore Healthy Carryout (49), NC Shape [a state-wide effort to implement NAPSACC in child care centers (90)], and the North Carolina's Prevention Partners healthy food environments in cafeterias initiative (13). Insofar as the tool was developed with extensive stakeholder input and careful attention to the context in which the various interventions are functioning, it should be applicable to comparable real-world conditions where practitioners are charged with adopting, implementing, and maintaining similar programs.

Participatory systems science methods, such as group model building, are an appealing approach to building practice-based evidence (27). This approach can be used as a part of participatory research to facilitate new thinking about complex public health issues. Group model building is a technique by which a group of stakeholders work with a facilitator to build a system dynamics model, including defining model boundaries by focusing on a problem, identifying important variables, and then describing the nature of relationships between variables (85). For example, Gillen and colleagues (27) describe a process for engaging stakeholders to build a qualitative system dynamics model that includes health behavior theory and input from stakeholders to distill and display reciprocal relationships, which can be positively or negatively reinforcing, such as those between parents of children with asthma and primary care providers working to improve asthma control in children. Constructing models as a group helps participants recognize the dynamic, interrelated, and multilevel nature of many public health issues. It also enhances participants' ability to forecast and communicate intended and unintended consequences of potential interventions. The models can be returned to community members or shared with practitioners and researchers to help inform intervention and policy development or for translation or adaptation of existing interventions and policies. Participatory systems science methods can be used in the formative phases of public health practice (e.g., as part of a needs assessment), during implementation, or during evaluation (27).

Although various model validation techniques are available, simulated systems models are limited by assumptions about the nature of relationships between variables, as well as other typical threats to validity such as measurement error. Still, systems models offer new opportunities for analysis in practice-based public health research. System dynamics models can accommodate variables for which there are no data available, yet they are theorized to affect the system or outcomes of interest (40). Also, system dynamics models have broader model boundaries than do some modeling techniques currently used in public health analysis, and they include equations

that account for interdependencies between variables and feedback over time. Other fields, such as economics, physics, biology, and ecology, have embraced modeling techniques that accommodate complex systems; public health practitioners and researchers can benefit from best practices for systems thinking and methods developed in other fields (40).

TRANSLATION: DISSEMINATING THE RESULTS OF PRACTICE-BASED RESEARCH

To foster partnerships and to ensure the best use of limited resources, efficient and scalable mechanisms for exchanging knowledge between researchers and practitioners are needed. Interventions that have been effective either in research or in practice settings can be adapted or translated to be more broadly applicable (36). Adaptation is broadly defined as a change to an intervention that maintains core meaning but modifies it to accommodate different audiences or settings. Once an intervention is adapted, it can be translated to reach a broader audience. In public health, translation can describe the movement of the discovery of a new vaccine in a lab to widespread vaccination campaigns, as well as expansion of new or existing public health interventions to reach new populations or settings (88). For example, Hip-Hop to Health Jr. is a behavioral intervention aimed at increasing physical activity and healthy eating in minority preschool children (23). Its efficacy was first demonstrated in an RCT during which the intervention was delivered by trained research staff (24). Next, the intervention was adapted such that classroom teachers were trained to deliver the intervention, making it less resource intensive and more likely to be maintained in schools over time. A study of intervention effectiveness, or whether it continued to have a significant impact on childhood body mass index (BMI) trajectories even when implemented under more real-world conditions, showed that the magnitude of change was smaller when classroom teachers delivered the intervention, but the direction of effect remained the same (25). In this example, modifying the requirements for who could deliver the intervention was an adaption of the original model, but the core elements, or those components that embody the theory or internal logic likely to be responsible for the intervention's success (56), remained the same. Once an intervention or innovation is shown to be effective, it can be translated to be more broadly applicable. Practice-based interventions or innovations can speed up the translation from innovation to broad applicability because they are designed to have high external validity, particularly when participatory approaches are employed (30).

Translating findings from research studies to practice requires an in-depth understanding of the practice setting. Castro and colleagues (12) provide examples for how public health interventions can be translated to address the tension between fidelity and fit, particularly in minority populations. Fidelity refers to whether an intervention is implemented as designed, tested, or intended, whereas fit describes how well the intervention aligns with the needs, resources, capacity, and interests of intended beneficiaries. Practice-based research may uncover interventions that are a good fit for specific settings and populations. Defining good fit as well as distilling which core intervention elements are responsible for the intervention's beneficial effect, yet are likely to work in different contexts, are both challenges and rewards of practice-based research.

Practice-based research networks (PBRNs) have demonstrated the value of research-practice collaborations in generating evidence that is highly relevant to practitioners' needs. PBRNs have a long history of serving as clinical laboratories where practices sign on to test new treatment approaches or strategies as they are translated from the discovery phase to implementation (36). Mold & Peterson (58) argue that PBRNs are now evolving from clinical laboratories to learning communities working at the interface between quality improvement and research and serving as

WHAT ARE PUBLIC HEALTH PBRNs?

Public Health PBRNs expand the scientific knowledge needed for evidence-based decision making in public health through the following mechanisms:

- comparative studies of the organization, financing, and delivery of public health services in different public health practice settings;
- multisite observational studies to reduce unnecessary, inefficient, or harmful variations in practice;
- intervention studies and community trials to test effectiveness of new programs and quality-improvement initiatives for existing ones; and
- evaluations to monitor effects of changes in laws, policies, regulations, staffing, funding, and organizational structures.

A PBRN brings together public health agencies and academic research partners to identify pressing research questions of interest, design rigorous and relevant studies, execute research effectively, and translate findings rapidly into practice (see **http://www.publichealthsystems.org/pbrn.aspx**).

"engines for improvement of primary care delivery systems" (p. S12). Participatory models allow providers to be engaged in identifying research needs, implementation strategies, and research design as an approach to applying research findings to everyday care. This practice-based knowledge is critical to successful translation of research to practice.

More recently, public health PBRNS have emerged. The Public Health Practice-Based Research Networks (PBRN) Program is a national program of the RWJF that supports the development of research networks for studying the comparative effectiveness, efficiency, and equity of public health strategies in real-world practice settings (**http://www.publichealthsystems.org/phssr.aspx**). The Public Health PBRN Program currently supports 12 research networks composed of local and state governmental public health agencies, community partners, and collaborating academic research institutions. The program also offers affiliate membership to organizations interested in developing and/or implementing a Public Health PBRN.

A logical next step for PBRNs is to establish community networks willing to create learning collaboratives and research capacity across the public health and primary care spheres. Numerous recent reports, including some from the IOM, have emphasized the critical importance of bridging the research and practice gap between these two disciplines (16, 82). Eliciting collaboration between clinical and public health stakeholders to identify joint research needs and generate practice-based evidence could help bridge the current divide between them. In their article, "Linking Practice-Based Research Networks and Clinical and Translational Science Awards: New Opportunities for Community Engagement by Academic Health Centers," Fagnan and colleagues (22) describe survey results from CTSA and PBRN leaders that suggest the potential for such collaborations.

GENERATING PRACTICE-BASED EVIDENCE TO INFORM POLICY

Practice-based research has been successfully used to inform policy implementation and research. For example, the Arkansas General Assembly passed Act 1220 of 2003, which generated practice-based evidence for policy interventions. The Act was designed to reduce childhood obesity in Arkansas through modifying the school food environment and sending children's BMI information home to their parents. Since the policy went into effect in 2004, obesity rates have not increased in Arkansas, and few adverse events have been reported (70). Researchers studied this example and

offered guidance for similar efforts in other states, including lessons learned to avoid a small but vocal group of opponents to the policy (66).

The principles underlying practice-based research can also help inform future policy implementation and policy research. Decision makers seek evidence that an approach will work in the real world, where their constituents vote, where budgets are contested and resources are limited, and where many contextual factors influence an intervention's success or failure. Researchers can learn from policy makers who are "practitioners" of policy and decision making (8). For example, Pitts et al. (67) interviewed local-level policy makers in rural North Carolina to learn how realistic evidence-based, community-level obesity-prevention strategies were for their rural jurisdictions. Their findings showed that policy makers thought certain recommendations were more relevant, or "winnable," given the context in which they make decisions.

TOOLS TO ENHANCE IMPLEMENTATION OF PRACTICE-BASED EVIDENCE

The Center for Training and Research Translation (Center TRT), the National Cancer Centers Research-Tested Interventions (R-TIPS), and the CDC's Diffusion of Behavioral Interventions (DEBI), Task Force on Community Preventive Services, and Replicating Effective Programs Plus (REP+) are all examples of practice-based tools that can help guide policy. Center TRT staff work closely with the CDC to identify interventions and policies that have high potential for public health impact on preventing obesity (**http://centertrt.org/**). The Center TRT uses a model for reviewing interventions classified as emerging, practice-tested, or research-tested, depending on the type and extent of evaluation data available (51). After content experts review an intervention, Center TRT staff work with intervention developers to create a dissemination template that offers implementation guidance to public health practitioners and policy makers interested in replicating successful interventions. By highlighting core intervention elements, as well as facilitators and barriers to implementation, Center TRT dissemination templates give practitioners important information about how to implement interventions and policies, in addition to describing what was done to achieve documented results. The Center has also developed an evaluation framework designed with input from public health practitioners to help them meet increasing demands for intervention evaluation and accountability (52).

Research Tested Intervention Programs (R-TIPS) is a searchable database of research-tested cancer control interventions that provides public health practitioners access to intervention information and resources (see **http://rtips.cancer.gov/rtips/index.do**). Interventions are reviewed by topic experts for research integrity, intervention impact, and dissemination capability and then made available on the R-TIPS website. The site also contains training and guidance for selecting and adapting interventions for local contexts. Although the site features research-tested interventions, the focus on bridging research and practice makes R-TIPS useful for those interested in practice-based research.

Similar to the Center TRT and R-TIPS, DEBI and REP+ are web-based resources for practitioners looking to adapt and implement evidence-based interventions. These sites specifically feature HIV-prevention interventions. Among other resources, DEBI lists behavioral and "structural interventions," which "are designed to implement or change laws, policies, physical structures, social or organizational structures, or standard operating procedures to affect environmental or societal change" (from **http://www.effectiveinterventions.org/en/HighImpactPrevention/StructuralInterventions.aspx**). REP+ offers intervention packages that are user-friendly and coupled with technical assistance to facilitate proper implementation (**http://www.cdc.gov/hiv/prevention/research/rep/**).

Table 1 Practice-based evidence in public health: improving reach, relevance, and results[a]

Element of academic research	Barriers to practice-based evidence	Possible solutions
Training	RCTs are presented as the only strong research design	RCTs described as one of many research designs to be selected on the basis of the context and purpose of the research Emphasize critical/creative thinking required to use non-RCT designs while still controlling for bias
	Value of practice-based evidence is not emphasized	Include course content on implementation and dissemination and how this process requires strong practice-based evidence Include systems science in the curriculum
	Internal validity is emphasized over external validity	Give appropriate weight to each and discuss the role of external validity in translation, dissemination and implementation, and systems science
Grant writing	Inadequate attention is given to intervention context and how it might affect study findings	Use RE-AIM or a similar model that structures planning and evaluation around context
	Some are concerned that only an RCT will "fly" with reviewers	Consider pragmatic or practical clinical trials that include randomization but also practice-based evidence
	Justification for selection of the appropriate study design is limited	Use pilot studies to test study implementation and provide justification for larger proposals
RFAs and grant reviewing	Tolerance for non-RCTs is limited	Specify in the RFA that study designs should fit the research context and are not limited to RCTs Provide training to reviewers regarding acceptable study designs Reviewers should avoid peer pressure to "ding" any study design that is not an RCT
	Little emphasis is given to external validity or practice-based evidence	Develop/release RFAs that are designed specifically to facilitate research to generate practice-based evidence
	Focus is on individual-level outcomes versus intermediate variables and process measures	Specify in the RFA that individual-level outcomes are not the only acceptable outcome measures
Manuscript preparation/review	Most of the text is focused on internal validity	Journal editors should adopt external validity reporting criteria per Glasgow et al. (28)
	Space is limited in the manuscript to convey complexities of the practice environment	Use appendices and opportunities for web-based supplements for manuscripts
Promotion and tenure	Studies generating practice-based evidence are not considered as equally valuable for promotion	Set clear promotion and tenure guidelines that value practice-based evidence
	Securing grant funding and publishing papers regarding practice-based evidence is more difficult	See recommendations above for RFAs, grant reviewing, manuscripts

[a]Abbreviations: RCT, randomized controlled trial; RFA, request for application.

PRACTICE-BASED RESEARCH CHALLENGES AND OPPORTUNITIES

Practice-based research is often "messy." To increase external validity, and because population-wide interventions often do not lend themselves to random assignment and other controls, study designs and measurement strategies are not as tightly controlled as in traditional efficacy RCTs—they use broader inclusion and exclusion criteria and field-based staff instead of highly trained

researchers and are conducted in various settings. Sometimes prioritizing external validity can adversely affect internal validity, but not always. Until recently, the opposite has certainly been the case, where almost exclusive emphasis on internal validity has resulted in many efficacious interventions that have very little potential for implementation beyond the circumstances of the original research environment. Pragmatic clinical trials and systems modeling are among the emerging planning and analytic strategies that can help structure and integrate practice-based evidence with the more traditional research models emphasizing RCTs and internal validity. Researchers must recognize both the opportunities and the limitations of these models and draw appropriate conclusions.

Current incentives within the academic research environment still favor internal over external validity, and thus practice-based evidence is often seen as inferior or resulting from less rigorous methodology. Using a pipeline model, Green (35) illustrates how this line of thinking results in significant delays and limitations in translating research into practice. Grant proposals are reviewed more favorably if the potential for effect size is large and the study design is "tidy." Manuscripts resulting from research focusing on external validity and "designing for dissemination" may be of less interest to journal editors who are looking for big impact defined as effect size rather than reach, adoption, implementation, and maintenance. Efforts are under way to open this pipeline by influencing journal review practices (28, 36) and the emergence of funding opportunities that prioritize practice-based research.

RECOMMENDATIONS FOR THE FIELD

From how we train our students to how we review journal articles and grant proposals, there are several ways to move the field toward better integration of practice-based evidence, as described in **Table 1**. It will take time and effort to shift the paradigm of academic public health research, but the dividends of improved public health will be well worth it.

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