Implementation Science and Its Application to Population Health

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Abstract
Implementation science studies the use of strategies to adapt and use evidence-based interventions in targeted settings (e.g., schools, workplaces, health care facilities, public health departments) to sustain improvements to population health. This nascent field of research is in the early stages of developing theories of implementation and evaluating the properties of measures. Stakeholder engagement, effectiveness studies, research synthesis, and mathematical modeling are some of the methods used by implementation scientists to identify strategies to embed evidence-based interventions in clinical and public health programs. However, for implementation science to reach its full potential to improve population health the existing paradigm for how scientists create evidence, prioritize publications, and synthesize research needs to shift toward greater stakeholder input and improved reporting on external validity. This shift will improve the relevance of the research that is produced and provide information that will help guide decision makers in their selection of research-tested interventions.
INTRODUCTION: THE EVOLUTION OF IMPLEMENTATION SCIENCE

Implementation science for health evolved from practice-based evaluations that were conducted in the 1960s and 1970s to understand problems with implementing national initiatives (e.g., President Kennedy’s New Frontier and President Johnson’s Great Society and War on Poverty) (34). These programs required the adoption of new ideas by organizations, as much as individuals, to improve health and reduce the burden of poverty (34). The emphasis on organizational accountability and application of research questions to assess whether the policies were implemented as planned led to the emergence of implementation science (34).

During the 1980s and 1990s, evaluations of the Healthy People objectives further shaped the field of implementation science. Preliminary assessments of the initial Healthy People found poor progress with achieving many of the 226 objectives, primarily owing to the lack of measures. These assessments led to the selection of objectives for Health People 2000 that were more feasible to measure (3, 51). In addition, tools and implementation strategies are now distributed to states and local health departments to increase the potential for achieving Health People objectives.

Current applications of implementation science for health continue to develop tools and strategies to improve the success of implementation and to study how programs and interventions are used in practice-based settings. However, the focus of this field has shifted toward studying how to accelerate the translation of research-tested interventions into policy and practice, taking into account the complex, dynamic, adaptive systems in which these interventions can be implemented (6). This most recent evolution of implementation science was driven largely by an acceleration in funding from the National Institutes of Health (NIH) and various stakeholder interests to fill the gap between scientific discoveries and the application of these innovations to improve population health (34).

The Institute of Medicine’s (IOM) 1990 report that identified the gap between mental health research and practice as a national public health priority was among the first reviews that quantified the need for a return on the investment that federal dollars made toward research (45). At that time, almost 80% of the ~9.4-million drug-addicted and -dependent individuals in the United States went untreated, and the treatment administered did not keep up with the major scientific advances. In 1997, public funds accounted for 65% of the reported revenues in drug- and alcohol-treatment programs, creating a pressing interest to find better ways to implement innovations in effective treatment strategies.

For similar reasons, several years after the IOM report on the gap between mental health research and practice, the NIH highlighted the importance of moving basic research into human studies with the Roadmap Initiative (66). Billions of taxpayer dollars had been spent on scientific discoveries to improve health, but few were being used (53). Whereas the initial purpose of the Roadmap was to accelerate the translation of research benefits to patients (66), more recent iterations have expanded this view to include the translational steps from basic research to use by decision makers and residents (41). Although stakeholders have not been explicitly defined by the Roadmap Initiative, one can imagine the proximal and distal stakeholders at each translational step (Figure 1). The first translational step (T₁) seeks to move basic discovery into a candidate health application primarily through efficacy studies performed by clinical and behavioral scientists. In the second translational step (T₂), health services and public health scientists conduct effectiveness studies and systematic reviews to assess the value of the health application to a wider population and develop clinical or community guidelines for using research-tested interventions. In the third translational step (T₃), implementation scientists use methods similar to those used by scientists in the T₂ step to identify strategies...
that can move clinical guidelines or evidence-based interventions (EBIs) into clinical and public health practice. Implementation scientists also collaborate with stakeholders to conduct T4 research, which seeks to evaluate the real-world use of EBIs and implementation strategies by organizations and individuals.

Connecting with stakeholders (e.g., researchers from different disciplines, industry, public health, health care, and community-based groups) to inform the development of research at translational phases T1 and T2 is supported by the Clinical and Translational Science Awards (CTSA). Through a consortium of 60 medical institutions in 30 states and the District of Columbia, the CTSA supports clinical and translational investigators to develop skills to engage stakeholders in team science to accelerate the translation of research into clinical practice (11). Stakeholder engagement for T1 and T4 translational research is supported by the NIH Program Announcements on Dissemination and Implementation Research in Health. Because T1 translational research has a dual emphasis of dissemination and implementation, these two types of research are often discussed in the same context. However, the NIH distinguishes between dissemination, “the targeted distribution of information and intervention materials to a specific public health or clinical practice audience,” and implementation, “the use of strategies to introduce or change evidence-based health interventions within specific settings” (53). This article provides a review only of implementation science to improve population health as it is currently represented in translational steps T1 and T4 in the Roadmap. The review is intended to reflect the depth and breadth of the topic and is not a complete review of the literature.

**WHY IS IMPLEMENTATION SCIENCE NEEDED?**

Population health can be defined as “the health outcomes of a group of individuals, including
the distributions of such outcomes within the groups” (42). Health outcomes and the distribution of health outcomes are determined by interacting factors related to biology; health care systems; psychosocial, economic, and physical environments; and policies across the life span (42). A goal of implementation science for health is to identify the factors, processes, and methods that can successfully embed EBIs in policy and practice to achieve population health. Evidence based refers to interventions that have undergone sufficient scientific evaluation to be considered effective (56).

Over the past two decades, the United States has experienced a dramatic reduction in mortality for the leading causes of death: heart disease and cancer. These improvements in health are due largely to corresponding reductions in tobacco use; increases in use of screening tests for breast, cervical, and colorectal cancer (18); and improvements in therapeutics (49). Despite these improvements, the United States continues to be ranked at the bottom for life expectancy at birth out of 33 countries in the Organizations for Economic Co-operation and Development (OECD) (49). Reasons for this ranking are complex. However, key contributors to the relatively poor longevity in the United States compared with other OECD countries include continued high prevalence of tobacco use among adults without a college education (9), inactivity, and the increase in overweight and obesity among the US population (19). These health behaviors and comorbid conditions are major risk factors for heart disease and cancer.

Of equal concern to public health in the United States is the substantial inequities in the distributions of these risk factors for heart disease and cancer by social groups defined by education level, poverty level, race, ethnicity, and insurance status. Although health care services account for only about 10% of the population’s health (57), utilization of health care is a critical factor in the low longevity ranking for the United States compared with other OECD countries because many of the other countries provide universal insurance coverage at the national or regional levels, which facilitates access to life-saving screening tests and therapeutics. In addition, an uninsured status is disproportionately high among low-income, limited education, racial and ethnic minority groups who are already vulnerable to health inequities for heart disease, cancer, and associated risk factors and comorbid conditions. These social characteristics and the characteristics of the environments in which socially disadvantaged persons live, work, and play (e.g., built environment, food deserts, workplace policies) contribute to the persistent inequities in health in the United States (65).

Although it is not comprehensive, this list of health issues in the United States provides a clear picture of the work that remains to be done to improve the health of the nation. Evidence suggests that only about half of the available medical and public health innovations are used in practice (10, 24, 38), yet there are sufficient EBIs to reduce by more than 50% the burden of cancer and chronic and infectious diseases in the United States (12, 13). The following sections provide an overview of the factors that influence use of EBIs and the ways in which implementation science is being used or can be used to accelerate use of EBIs to improve population health and reduce social inequities in health.

FACTORS THAT INFLUENCE USE OF EVIDENCE-BASED INTERVENTIONS

Glasgow & Emmons (24) identified multiple, interacting reasons why adoption and use of EBIs does not routinely occur in practice, including the characteristics of the intervention (e.g., high cost, intensive time demands, not customizable), research design used to test the EBI (e.g., participants or setting not representative of target population or setting, failure to evaluate implementation), the situation of the intended target setting (e.g., schools, workplaces, health care facilities, public health departments), and interactions among these factors (24). These barriers can be particularly problematic when trying to use EBIs to
improve health for medically underserved populations and residents in underresourced areas because so few interventions are tested in these situations. A study conducted in rural West Virginia illustrates how these factors influence the use of EBIs in practice settings.

Example 1: Barriers to Use of Evidence-Based Interventions in Rural West Virginia

Residents in rural areas experience multiple barriers to high-quality health care that residents in urban and suburban areas do not encounter, such as longer distances to reach health services (2) and higher rates of unemployment, uninsured, and poverty (62). In addition, the health of rural racial minority groups is particularly disadvantaged with regard to heart disease, cancer, and diabetes (2). To understand the compatibility of EBIs in rural areas, the Mary Babb Randolph Cancer Center at West Virginia University released a request for proposals for community-based cancer education mini-grants. Eligible organizations belonged to the National Cancer Institute (NCI)-funded Appalachia Community Cancer Network. The call for proposals required that grantee organizations adapt and implement EBIs for cancer control, and the funders offered training to grantees to facilitate these processes (62). Using a multiple-case-study research design, investigators summarized information ascertained from surveys, interviews, and the final programmatic reports at the end of the funding period for the 13 grantee organizations (e.g., coalitions, health clinics, churches, nonprofit community organizations). Results of this study showed that grantees felt the requirement to use an EBI limited their options for interventions to improve cancer control. Many grantees commented that it was time consuming and difficult to adapt the EBIs because the interventions did not take into account older, less educated, or lower-income populations or the geographically isolated setting, or they required large work sites, churches, or staffing that were not available (62). All organizations adapted the EBIs. Some changes were minor, but other changes were substantial in that the core intervention components were condensed or eliminated.

This case study poignantly demonstrates how the characteristics of the intervention, research design, and context of the implementation setting affect use of the intervention, even when funding is provided to encourage use of an EBI. In 2004, Greenhalgh et al. (35) published a comprehensive meta-narrative review of nearly 500 articles that described factors associated with the spread and sustained use of EBIs in health service delivery and other organizations that are the primary target settings for EBIs (35). Among the key findings of this literature review was that organizations are part of a complex, multidimensional system with multiple interacting factors that influence use of EBIs at multiple levels (Figure 2) (35). Key features of complex systems include constant adaptation to nonlinear change, dynamic interactions between system components, and feedback loops (6, 47). The situations of these complex systems are influenced by individuals (e.g., perceptions of the innovation, adopter characteristics), social processes (e.g., communication, linkages, implementation), characteristics of groups (e.g., system antecedents, readiness to change), and the sociopolitical, economic environment (20).

The literature suggests that some factors are more influential than others to support the use of EBIs. For example, rewards for using EBIs, inadequate funding for EBIs, and support from state legislators are more influential on adoption of EBIs by public health decision makers than are factors associated with their personal characteristics (e.g., felt need to be an expert to make evidence-based decisions) (40). One study found that public health decision makers with a bachelor’s degree were 5.6 times (95% confidence interval 1.7, 17.9) more likely than those with a public health master’s degree to report that they lacked skill to develop evidence-based programs (40). In addition, an organization’s culture (e.g., the value that an organization places on using an EBI for decision
making) (14) is a strong predictor of whether a systematic review influences the use of EBIs (17). Perhaps most relevant to successful implementation is the strategic climate of an organization that motivates and enables employees to embed EBIs in existing practices through policies, procedures, and reward systems (1).

Much of what we know about factors that influence use of EBIs in organizations comes from the fields of sociology, psychology, communications, systems science, and organizational behavior (35). These fields have been using implementation science for decades, but its application to questions about public health is relatively new. A rich body of theory on implementation science for health has emerged over the past decade, with the development of more than 50 implementation theories (14, 15, 60). Several theories have similar constructs, and testing of the theories has been limited. No particular theories have been identified as most useful to predict or explain EBI implementation. For many implementation theories, the psychometric properties of construct measures have not been evaluated, the relationships among the constructs have not been assessed, and the predictive validity is unknown.

A systematic review conducted by Emmons et al. (20) of peer-reviewed literature highlights the need for additional research on measures for organizational constructs. The review investigated the definitions of constructs and
measures of five key characteristics of organizations that are antecedents for implementation science for health (i.e., leadership, vision, managerial relations, climate, absorptive capacity). They found that no measure of a specific construct was used in more than one study, many studies did not report the psychometric properties of the measures, some assessments were based on a single response per organization, and the level of the instrument did not always match the level of analysis (20).

**IMPROVING THE FIT OF EVIDENCE-BASED INTERVENTIONS IN REAL-WORLD SETTINGS**

Ideally, we want EBIs to be implemented in policy and practice settings in lieu of interventions that have not undergone sufficient testing (8). However, as we described earlier, characteristics of EBIs, the research design used to test the EBI, and the complexity of the systems in which EBIs are implemented can deter use of these research-tested interventions in practice. Green et al. (34) used the metaphor of a funnel to describe why EBIs generally do not fit well with real-life circumstances (Figure 3). At the start of the funnel is the universe of potential studies defined by funding priorities. These studies become narrowed by transitions through which researchers review grants, researchers determine publications in peer-reviewed journals, researchers synthesize the available evidence on interventions, and researchers (who also are often clinicians) develop guidelines to use EBIs in practice (34). At each transition in the funnel, the priorities and decisions have been rarely, if at all, informed by those who will ultimately use the research (34), and evidence with strong internal validity is overemphasized (32). The result of this discovery-to-practice process is that initial research often involves populations, procedures, and settings that bear little relation to the locus of actual implementation. Glasgow and Green have written extensively about the translation of research to routine practice (24, 26–28, 31–34). We summarize some of the key points in their discussions and expand on their ideas by depicting how greater stakeholder input and attention to external validity in translational steps T2–T4 would improve the relevance and increase the volume of research that passes through the funnel.

**Peer Review of Research Proposals**

Starting with the peer-review stage of research, funders can improve reporting on external validity of research by requiring that reviewers evaluate whether analysis plans include methods for data collection that will enable reporting on measures of external validity (e.g., description of withdrawals and dropouts; description of target population compared with population reached; frequency, duration, and intensity of intervention). Guidelines such as the extension of the CONSORT, RE-Aim, TREND, Jadad scale, and STROBE, which have been used recently to judge reporting on external validity of completed studies, can also be used to guide reviewers’ judgment on the analysis plans for reporting external validity in proposed studies (26, 32, 33, 64, 67).

Stakeholder review groups can also be added to the review cycle to inform the relevance of the scientific evidence from a user perspective. Several study designs have strong internal validity and use a broad sample of participants, incorporate aspects of general practice, or have flexible intervention strategies to improve the relevance of research (participatory research projects, pragmatic trials, or comparative effectiveness studies). Green recommends these forms of “action research” to produce practice-based evidence that is “closer to the actual circumstances of practice” (31, p. i23). Combining ratings across multiple stakeholder groups is already used in some areas. However, interdisciplinary reviews on the exact same criteria can result in low agreement in ratings across research, practice, and policy groups compared with agreement among members within these stakeholder groups (46). Adding a separate review for stakeholders to comment only on
Proposed process: increase stakeholder input and reporting on external validity

Current process: research informed

Peer review

Publication priorities

Research synthesis

Guidelines

Guidelines for use of evidence-based interventions

Stakeholder input on questions and gaps

Synthesis of observational studies complement meta-analysis

Greater merit given to studies that balance internal and external validity

Stakeholder review group

Funding priorities

Improved flow, greater relevance

Figure 3


relevance from their perspective would not undermine the ratings on scientific merit or relevance and would contribute toward funding of research with greater potential for application and scientific discovery. Because scientists from different fields have unique groups of immediate stakeholders (Figure 1), the composition of the stakeholders would change depending on the focus of the grant. Yet, the instructions could be standardized across all proposals.

Publication Priorities

At the next step in the funnel, journals can develop ways to reduce the leaks in research evidence and improve the relevance of the published manuscripts by requiring reviewers to consider how well authors report on external validity, in addition to the consideration currently given to reporting on a study’s internal validity. As noted above, reviewers can use several guidelines to judge an author’s report on the external validity of completed studies. This suggested change in review procedures for manuscripts is practical, given that numerous leading health journals have agreed that it would be important and feasible to report on external validity (26). Green & Glasgow (32) have recommended that journals take several other actions to improve reporting on external validity such as publishing editorials on external validity, featuring some exemplary studies or a special issue that highlights factors related to external validity, expanding online publication of protocols relevant to external validity, engaging other journals and organizations in these efforts, and indexing key words relevant to key dimensions of external validity.

Research Synthesis

Research synthesis can answer a broad range of questions for knowledge users and scientists using meta-analysis or qualitative methods (e.g., narrative synthesis, grounded theory, thematic analysis) to summarize the results. Meta-analyses of randomized controlled trials has dominated the research synthesis literature.
Research synthesis: the contextualization and integration of findings from individual studies within broader knowledge on the topic, using quantitative and/or qualitative methods.
control condition, persons, organizations, or communities often view random assignment to an intervention as unfair and may adopt aspects of the intervention even though its efficacy or effectiveness has not been tested (59). Alternative study designs that offer a placebo instead of no treatment or that wait-list the control group can minimize threats to internal validity of randomized trials. Another example is described in a review of the literature that identified primary studies on the validation of cardiovascular risk models and use of these models in guidelines to treat diabetes. The authors found 45 prediction models, several of which were incorporated in clinical guidelines for the management of type 2 diabetes, even though the risk scores had not been externally validated in a diabetes population (63).

**Practice and Policy**

Green’s image of the funnel moves directly from guidelines to practice and policy. Yet, use of EBIs by policy and practice stakeholders rarely occurs automatically after research synthesis and guideline development. For example, political will played a large role in slowing progress with tobacco control (59) and with expediting the discovery and implementation of antiviral therapy to treat HIV (21, 55). In addition, improved relevance of EBIs through participatory research can increase the use of EBIs by policy and practice stakeholders to expedite use of these innovations. However, even if the EBIs have been tested in the target population and setting, some characteristics of the intervention will likely need to be adapted for implementation to be feasible. Adaptation refers to “the degree to which an EBI 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” (54, p. 30). An important consideration for implementation scientists is the balance between adaptation and fidelity to the intervention’s core components, those thought to determine its effectiveness (8).

**PARTICIPATORY RESEARCH TO IMPROVE IMPLEMENTATION OF EVIDENCE-BASED INTERVENTIONS**

Green (31) emphasizes that scientists should engage in participatory research during the discovery research translational phase (T1) to produce EBIs that are more relevant and actionable to policy and practice stakeholders. Participatory research requires ongoing, bidirectional communication between researchers and stakeholders to develop relationships that will inform research questions as well as practice needs and inform the adaptation of interventions instead of development of new innovations that are later discarded because of poor fit (31, 48). The engagement of stakeholders in research can take on many forms, and partners can include institutions, organizations or individuals, or researchers from different disciplines. The specific terms used to describe theories of stakeholder engagement differ depending on whether one refers to social theory or organizational theory. However, consistent across theories is the basic tenet that partnership engagement can be thought of as a continuum of involvement (unlinked, exchange information, work side by side on a common goal, informal sharing of resources, formal sharing of resources based on a written contract or memorandum of understanding) (22, 23). Following are examples of T3 evidence being produced through implementation science along the stakeholder engagement continuum.

**Example 2: Using Statistical Modeling to Guide Policy and Practice Decisions**

At the lower end of the stakeholder engagement continuum, implementation scientists can use innovative statistical techniques such as Markov modeling and optimization to engage policy, public health, and clinical practice partners in applying EBIs in the real world. For example, Demarteau et al. (16) assessed the optimal mix of screening and vaccination against human papillomavirus (HPV) to protect against cervical
cancer. The evaluation used a Markov cohort model to estimate the outcomes of 52 different prevention strategies and an optimization model in which the results of each prevention strategy of the Markov model were entered as input data to evaluate the combination of different prevention options. The model was applied in the United Kingdom and Brazil. Findings from this implementation study suggested that for a zero increase in budget, the number of cases of cervical cancer would be substantially reduced in the United Kingdom (41%) and Brazil (54%) by implementing an optimal combination of HPV vaccination (80% coverage) and screening at prevaccination coverage (65% United Kingdom, 50% Brazil) while extending the screening interval to every 6 years in the United Kingdom and 5 years in Brazil (16).

Example 3: Using Pragmatic Trials to Create Applicable Evidence-Based Interventions

The pragmatic trial falls mid-range in the stakeholder-engaged continuum. This type of trial incorporates features such as allowing participating organizations to choose between options of care and determining the effects of an intervention under the usual conditions in which it will be applied. These features are in stark contrast to the features of traditional efficacy trials that study the effects of an intervention under ideal circumstances (61). These trials are not opposites. Rather they can be considered as end points on a pragmatic-explanatory continuum. PRECIS (pragmatic-explanatory continuum indicator summary) is a tool that has been developed to inform the design of intervention trials based on the research questions being addressed (real-world or explanatory) (61). The PRECIS tool consists of ten domains that guide researchers when deciding where their study should fall on the pragmatic-explanatory continuum. The PRECIS criteria have also been applied using a retrospective approach to describe completed trials. Using the PRECIS criteria, nine reviewers independently scored three completed studies that targeted obesity treatment in primary care settings. All three trials were rated in the moderate range on the PRECIS scale, but the ratings varied across PRECIS dimensions, being most pragmatic on the flexibility of the comparison condition and participant representativeness (25). This type of tool can help researchers improve the fit of their studies with real-world circumstances and provide a richer understanding of the potential for implementation success in usual care settings.

Example 4: Formal Partnerships between Researchers and Practice Experts

At the higher end of the stakeholder engagement continuum scientists create formal partnerships with the institutions and organizations that will ultimately implement the EBIs. The Quality Enhancement Research Initiative (QUERI) at the US Department of Veterans Affairs is an example of a highly integrated partnership between researchers and practitioners. Implementation studies that are conducted through QUERI are an exceptional source of practice-based evidence, and findings can often be generalized to other clinical settings. QUERI utilizes a six-step process to diagnose gaps in performance to identify and implement EBIs to reduce the disease burden for conditions common among veterans, such as heart disease, diabetes, HIV/hepatitis C, and mental health and substance use disorders. For example, one QUERI study explored the sustainability of a nurse-initiated HIV rapid testing intervention that was implemented via 2 90-minute in-service sessions designed to teach pre- and posttest counseling techniques as well as the administration, interpretation, and entering of results into patients’ medical records. Using time-series analysis, the authors found that, among registered nurses who participated in the in-service, this low-intensity implementation strategy resulted in a steady rate of HIV rapid testing for the year following the training. In addition, there was an unexpected increase in HIV blood testing among
other clinical staff, leading to a 70% site-wide increase in HIV testing (43).

Scientists can use multiple research methods to engage stakeholders at varying levels of integration along the stakeholder engagement continuum to produce evidence that informs how to use EBIs. The level of engagement is more a function of the researcher’s choice than of the research method. For example, time-series analysis is often conducted at the lowest levels of stakeholder engagement (i.e., unlinked or exchange information). However, the example provided here demonstrates use of this method in a highly integrated partnership setting.

MOVING FORWARD WITH IMPLEMENTATION SCIENCE TO IMPROVE POPULATION HEALTH

Implementation science has tremendous potential to improve population health by accelerating the use of EBIs in practice. We have outlined several ways in which implementation science is being applied to population health. Following are areas in this field of research that should be emphasized in the future to ensure that the products gained through implementation science are in balance with the benefits to population health.

Stakeholder Engagement

We discussed many opportunities to increase stakeholder engagement throughout the discovery to practice funnel. However, to shift the current paradigm for knowledge production toward a more user-engaged process, training programs, incentives, and reward systems for researchers must also change. Participatory engagement skills are not routinely required in public health, doctoral, fellowship, or faculty training programs for health researchers. University reward structures also slow implementation science because scholars lack incentives and rewards for collaboration across scientific disciplines and with policy and practice experts (23). Funding mechanisms also limit opportunities for community-engaged research when time frames for submission are short, review cycles are long, and funding periods limit evaluation of continued EBI use over time (31).

Systems Thinking

The introduction of systems thinking to implementation science has revolutionized old ideas that implementation is a simple linear process or that participatory research in itself will improve the use of EBIs in practice and policy settings (39). The extent to which an EBI will be used and the benefit sustained over time is dependent on multiple, multilevel, dynamic processes that respond to feedback loops through nonlinear adaption (39). The implication of this transition to systems thinking is that scientists need to consider how to move our methods of investigation beyond the reductionist approach toward a systems view to accelerate the development of EBIs and implementation strategies. Systems science methods such as agent-based modeling, systems dynamics, and network analysis are increasingly becoming more valuable to implementation science (47) and to implementation in practice.

A Pragmatic Approach to Research

A pragmatic approach to research selects the methods that are best suited to answer the research question instead of relying on a single research method. Randomized trials are the gold standard for discovery research that answers questions about what works, but this study design provides limited information about how to embed EBIs in complex systems that are constantly adapting to change. More prospective, practice-based cost-effectiveness and comparative-effectiveness studies are needed to clarify the resources needed to implement EBIs and identify which interventions or implementation strategies work best in particular settings. In addition, the development of stakeholder-friendly tools that use mathematical modeling to select interventions based on an individual’s risk for disease or to
choose implementation strategies based on characteristics of the intervention and target population will accelerate the use of EBIs in practice and policy settings. The Archimedes Model is one example of how advanced mathematical modeling is being used to advance implementation of EBIs in practice. The US Department of Health and Human Services is using the Archimedes Model to quickly and accurately research, analyze, and evaluate the cost-effectiveness and implementation strategies for specific health care interventions (4).

Reliability and Validity of Measures
Numerous measures of factors related to implementation of EBIs in target settings have emerged over the past decade, but evaluations of the psychometric properties associated with these measures are limited. Further research is needed to clarify the measures with the strongest properties for particular settings and those that require further development to improve reliability and validity. Also needed is clarification on whether individual measures capture unique constructs or overlapping concepts to refine the terms and definitions of constructs used in theoretical frameworks for implementation.

External Validity
In addition to knowing what works, policy and practice stakeholders want to know, For whom does it work? In what settings does it work? And in what dose frequency, intensity, and duration does it work? Meta-analysis of RCTs is routinely used to provide stakeholders with information on what works, but the remaining questions that stakeholders ask have not been adequately addressed by research. More research synthesis using meta-regression of RCTs, meta-analysis of observational studies, and meta-narrative reviews is needed to inform stakeholders about whether EBIs have been tested in populations and settings that are relevant to them and whether the characteristics of the interventions and implementation strategies are feasible for them to implement. Many of the EBIs recommended to stakeholders have been developed in studies with highly select participants and in settings with adequate resources and implemented by highly trained staff under ideal conditions. As a result, the greatest value of alternative research synthesis at this time is to identify the gaps in research that need to be filled by pragmatic trials, practice-based research networks, and ongoing participatory research. Even with an increase in action research (31), we will not get the perfect solution to external validity that applies to specific settings or populations. Therefore, the extended benefit of stakeholder engagement in research is the development of relationships that will inform strategies to guide ongoing adaptation and evaluations of interventions as the needs and circumstances of target settings change over time (31, 48).

SUMMARY POINTS
1. Measures for and theories of implementation of evidence-based interventions for health are in the early stages of development.
2. The existing paradigm for how scientists create evidence, prioritize publications, and synthesize research needs to shift toward greater stakeholder input and improved reporting on external validity to improve population health.
3. Implementation science can speed translation from discovery to application and public health benefits.
4. Stakeholder input and partnerships can increase the relevance of research to practice settings.
5. Practice-based evidence is needed to provide information on external validity and inform stakeholders’ decisions about the use of evidence-based interventions.

6. Implementation of evidence-based interventions occurs in target settings that are part of complex, dynamic systems that respond to feedback loops through nonlinear adaptation.

FUTURE ISSUES

1. How will tools such as PRECIS lead to more practice-based evidence?

2. How will an emphasis on external validity throughout the discovery-to-practice continuum better inform practice and policy stakeholders about how to use evidence-based interventions?

3. In what ways can mathematical modeling be used to accelerate the translation of research to practice?

4. How can we measure progress with implementation science at a population level?

5. How can we evaluate progress by including stakeholders’ perspectives throughout the discovery-to-practice continuum?

6. How can web portals that promote information on EBIs incorporate searchable information about the persons, settings, and doses of intervention for which the interventions are or are not effective?

7. How does systems science inform the development of implementation strategies for EBIs?

DISCLOSURE STATEMENT

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