Science of Research and Technology Branch
Strategic Plan
2014

Approximately half of all deaths are attributable to a circumscribed number of preventable behaviors such as tobacco use, poor diet, and physical inactivity. These behavioral risk factors also contribute substantially to disability, reduced quality of life, and increased healthcare costs. Behavior's contribution to disease and death is particularly salient for cancer. About a third of cancer deaths are the result of tobacco use alone, and another third are attributable to poor diet, physical inactivity, and obesity. Additional behavioral risk factors such as sun exposure and nonadherence to recommended cancer screenings further increase the risk of cancer morbidity and mortality.

There have been considerable advances in changing these cancer risk behaviors. A combination of new treatments for nicotine dependence and recent tobacco control policy initiatives has cut smoking rates in half over the past half century. A variety of diet and physical activity interventions have been shown to reduce weight, improve diet, and increase regular physical activity. Successful public health campaigns have reduced sun exposure and increased cancer screenings. These interventions, however, often produce relatively modest and short-term changes in health behaviors, often at considerable cost, and frequently fail to scale up or disseminate broadly.

To further advance our understanding of health behaviors and their mechanisms of change, our approach to behavioral research must change. Theories of behavior must become more integrated, multi-level, explanatory, and rigorously testable. Measures of behavior and its putative mechanisms must become more precise and longitudinally intensive. Emerging methods, analytics, and technologies must be leveraged to improve behavioral research. Cross-disciplinary research teams must be utilized and optimized to integrate expertise from a wide array of fields with the pressing questions in health behavior research.

The National Cancer Institute's Behavioral Research Program (BRP) within the Division of Cancer Control and Population Sciences initiates, supports, and evaluates a comprehensive program of research ranging from basic behavioral research to the development, testing, and dissemination of interventions in areas such as tobacco use, screening, dietary behavior, and sun protection with the goal to increase the breadth, depth, and quality of behavioral research in cancer prevention and control. Recognizing the need to make further advancements in the conduct of behavioral science, the BRP created the Science of Research and Technology Branch (SRTB) in 2012 to *lead and support the development and application of innovative research approaches, theories, methods, measures, analytic tools, and technologies to advance social and behavioral science in the context of cancer prevention and control.*

Since its inception, the SRTB has engaged in an iterative strategic planning process involving internal input as well as external input from an SRTB expert panel. The result of this effort has been an internal working document to guide the direction and initiatives of the branch, from which this publicly accessible SRTB Strategic Plan is based. In anticipation of the rapidly changing behavioral research landscape, this plan is not a static document, but instead reflects a dynamic iterative process that will produce frequent updates.

SRTB Scientific Priorities

The scientific priorities of the SRTB include, but are not limited to:

- Theory development, testing, integration, and application;
- Measure development and testing, particularly of antecedents to, changes in, and consequences of health behavior;
- Methodological innovation, particularly in analytic approaches;
- Data harmonization and research synthesis;
- Technology development and application in behavioral research; and
- Team science and cross-disciplinary approaches.

Although each scientific priority is treated separately in this strategic plan, there is considerable overlap and synergy among these priorities as they contribute to the common mission to facilitate innovative research in cancer prevention and control. Therefore, actions that address multiple scientific priorities of the branch are particularly important for the SRTB to pursue.

Effectively addressing these priorities requires critical examination of our current health behavior science methods, measures, theories, and scientific approaches, and encouraging new approaches that are potentially disruptive to the current behavioral science enterprise. The genomic and wireless digital technology forces that contribute to Topol's "creative destruction of medicine" also contribute to the creative destruction of behavior research. These forces will necessitate the questioning of accepted practice in the behavioral sciences and produce disruptive, paradigmatic changes in how behavioral research is conducted. As the branch within BRP charged with improving how behavioral science is conducted, the SRTB is well-positioned to facilitate these changes in health behavior research and encourage novel approaches that challenge the status quo.

Effectively addressing these priorities also requires breaking down disciplinary boundaries and seeking new approaches to advance health behavior research from engineering, computer science, basic behavioral science, social sciences, genetics, systems biology, neurology, and a range of other disciplines. One disruption of the status quo already taking place is the shift from independent researchers to cross-disciplinary teams of researchers formed to tackle increasingly complex research questions. Therefore, one priority within the SRTB is supporting and improving team science to facilitate the disruption of the status quo and the adoption of new approaches.

Priority Area 1. Improve the scientific rigor with which health behavior theories are tested and applied.

Action Plan 1: Promote integration among health behavior theories and encourage common ontologies and measures of these theoretical constructs. The ability to advance health behavior theory is limited by the current cacophony of disparate theories with similar constructs. Promote more empirical evidence to test the overlap and relative explanatory power of nominally different existing constructs and to assess the added explanatory value of additional constructs in existing theories, especially multi-level

theories and theories from outside the cancer prevention and control field. The NCI Grid-Enabled Measures (GEM) database, especially the theory workspace in GEM, provides a platform in which different theoretical constructs and their measures can be compared and contrasted to facilitate theory integration. GEM can be augmented by other web services that will allow the field to better map theories, constructs, and measures and their relationships to the behavior of interest and to the intervention components that influence these theoretical constructs. Apply newer approaches and technologies such as crowdsourcing, word-mining, semantic analysis, Delphi approaches, and modern measurement theory to evaluate the overlap/uniqueness of existing health behavior theories.

Action Plan 2: Encourage and support the use of new data sources and methods for theory testing. Theory testing must become more rigorous so that health behavior theories can be supported or refuted, and retained, modified, or replaced to increase explanatory power. Information about behavior and its influences is increasingly available from ubiquitous technologies such as mobile phones and social media. Whether from prospective or archival data collection methods, data are increasingly more temporally dense and "big" (high volume, variety, and velocity), requiring advanced analytic approaches. To advance more rigorous theory testing, especially via these new data sources and methods, cancer prevention and control researchers need greater access to these data sources and to advanced statistical and computational collaborators, as well as training in these approaches. Collaboratively with NCI's Cancer Intervention and Surveillance Modeling Network (CISNET), the SRTB will encourage the use of computational modeling for computer-assisted theory development and testing. Coordinating these efforts with NIH's Big Data to Knowledge (BD2K) initiative, along with complementary efforts specifically targeted to cancer prevention and control researchers, should facilitate the use of these data sources and analytics for theory testing.

Action Plan 3: Encourage and train cancer prevention and control researchers in the rigorous application of theory to health behavior intervention development and evaluation. Building from the successful NCI Advanced Training Institute on Health Behavior Theory, develop complementary online and in-person training to expand the breadth and reach of this resource. Provide training and guidance in theory-based intervention development and theory-testing within cancer prevention and control intervention studies, including component analyses, mediation analyses, and the construction of comparison conditions that are theoretically distinct. Promote the use in intervention research of explicit, a priori, testable conceptual models based on empirically supported health behavior theories.

Priority Area 2. Encourage the development and use of precise, accurate, efficient, technologically advanced, and harmonized measures of cancer prevention and control behaviors and their influences.

Action Plan 4: Improve and harmonize self-report measures of cancer prevention and control-relevant constructs and behaviors. Applying rigorous qualitative methods, modern psychometric theory (e.g., Item Response Theory), and technologically advanced administration (e.g., computer adaptive testing, ecological momentary assessment) to both existing and new measures of cancer prevention and control constructs should result in more precise, accurate, and efficiently administered

measures that can be harmonized for data sharing and integration. Continued support for the NCI GEM database provides a platform for comparing measures of a given construct and assisting researchers in selecting appropriate study measures and creating harmonized data.

Action Plan 5: Encourage the development and integration of passive sensor technologies in cancer prevention and control research. There has been exponential growth in passive sensor technologies that monitor behavior and its influences with minimal respondent burden. Expand these technologies and make them more applicable for cancer prevention and control research. Encourage field testing, including assessment of the relationship between these sensors and traditional measures, pairing the engineers developing these sensors with clinical researchers' content expertise and patient access. Promote sensor data harmonization and integration efforts. Encourage cancer prevention and control researchers to test and adopt these new technologies. Many sensors have been developed for commercial, non-research purposes, and gaining access to the data from these commercial sensors should be pursued.

Action Plan 6: Support the development of measures assessing higher-level constructs in multi-level systems. Compared to individual-level constructs, the measurement of higher-level constructs that influence behavior (e.g., family interaction, social supports, community, workplace or healthcare settings, policy) have received relatively little attention. Develop and test precise, accurate, efficient, technologically advanced, and harmonized measures of these higher-level constructs.

Priority Area 3. Support the development and application of new analytic approaches that align with emerging data sources in cancer prevention and control.

Action Plan 7: Improve the capabilities of electronic health records (EHRs) as a research data source for cancer control and prevention. While EHRs provide considerable, albeit noisy, data on various biomedical indices of health and illness, behavioral risk factors, and especially influences on these behavioral risk factors, are largely ignored in the standard EHR. Working with federal and non-federal agencies involved in EHR standards (e.g., Office of the National Coordinator), encourage adequate measurement of key behavioral indicators and influences of behavior. Encourage the harmonization and standardization of these measures in EHRs, as well as the systems and technologies to extract these data for research purposes.

Action Plan 8: Facilitate the use of "big data," especially non-traditional big data sets (e.g., from social media, search engines, mobile phones) for cancer prevention and control research. Extending the application of big data to theory advancement outlined in Action Plan 2 (to encourage and support the use of new data sources and methods for theory testing), big data provide cancer prevention and control researchers with novel, broad, and non-traditional methods to answer a wide range of behavioral research questions. Develop and refine procedures for identifying, accessing, and managing these big data sets, with appropriate security and privacy protections. Support the refinement of big data analytic approaches (e.g., data mining, pattern recognition) for cancer prevention and control research. Provide training in these big data management and analytic approaches to cancer prevention and control researchers.

Action Plan 9: Expand the translation and adoption of intensive longitudinal data analyses and within-subject designs in cancer prevention and control research. The rapid expansion of technologies that provide temporally dense, intensive longitudinal data (e.g., ecological momentary assessments on mobile phones, passive sensors) are anticipated to transform behavioral sciences from predominantly between-subject, cross-sectional designs to within-subject longitudinal designs. Refine emerging analytic approaches that make maximum use of within-subject variability and patterns and make them available to cancer prevention and control researchers via education and training. Single-case designs also benefit from the increasing availability of intensive longitudinal data and the acceptance, refinement, and dissemination of various single-case designs and analyses should be promoted.

Action Plan 10: Increase the capacity of cancer prevention and control researchers to use innovative designs and statistical approaches. While the traditional two-arm randomized controlled trial is a valuable design for answering certain behavioral questions, it is overused and sometimes inappropriately used for questions that are better answered via other designs. Encourage training in alternative designs, including but not limited to system science approaches, intervention optimization designs, and within-subject designs. Targets for such training include behavioral researchers as well as grant reviewers and journal editors, who can facilitate the adoption of these alternative approaches. Consider these alternative designs not only as a means to answer cancer prevention and control questions more rigorously, but also more efficiently, using less time and resources.

Action Plan 11: Facilitate the development and adoption of data-harmonization practices. For emerging data sources to be of maximal use, researchers should be able to share and merge their data with other databases. Coordinating with related efforts, such as those of the NIH Biomedical Informatics Council, facilitate the development, refinement, and dissemination of the infrastructure needed for data sharing and merging, especially among cancer prevention and control researchers. Encourage the use of common data elements and common measurement metrics. Pursue support for common data repositories, cloud computing models, and other resources used to facilitate data sharing. Improve the cost-benefit ratio associated with data sharing (e.g., by eliminating barriers to data sharing, incentivizing sharing). Refine integrative data analysis approaches and further disseminate them among the cancer prevention and control community.

Priority Area 4. Encourage technology development, evaluation, and application for cancer prevention and control research.

Action Plan 12: Foster the development of new technologies and the refinement and adoption of existing technologies with the potential to advance behavioral research. Technology can be used to assess behavior and its influences, and to deliver and evaluate just-in-time adaptive interventions. The behavioral sciences have begun and should continue to adopt these technologies to improve behavioral assessments and interventions. In addition to leveraging existing technologies for behavioral research, support is also needed for novel technological development to fulfill specific behavioral research needs not met by existing technologies. While technologies are increasingly being developed for consumer and clinical uses, more substantial use is needed in cancer prevention and control research, including to improve recruitment, retention, and

to further automate clinical trials. Foster collaborations between cancer prevention and control researchers and engineers/computer scientists to realize the potential of these new technologies. Additional collaborations between NIH and the National Science Foundation (NSF), especially in relation to NSF's Smart and Connected Health Program, and between academic and private entities, will facilitate the use of these technologies for behavioral research.

Action Plan 13: Improve the research infrastructure for testing and evaluating tech-based behavioral interventions. The evaluation of tech-based behavioral interventions could be facilitated with better research infrastructure. Test beds, rapid testing platforms, and registries of end users of specific technologies allow for rapid and iterative preliminary testing of new tech-based interventions. Open and modular software development allows the field to share development efforts and to more easily add or remove specific intervention components, especially for intervention optimization research. Guidance is needed to assess tech-based interventions in ways that reduce the need to re-evaluate similar interventions delivered on different platforms. Encourage more rapid testing methods to complete evaluations of new tech-based interventions before the technology becomes dated.

Priority Area 5. Advance our understanding of effective team science and cross-disciplinary approaches.

Action Plan 14: Facilitate effective team science collaborations, as well as training in team science, through the development of practical tools and resources and funding opportunities. Develop and disseminate evidence-based approaches for managing, conducting, funding, and evaluating effective and efficient cross-disciplinary, team-based research to speed innovation and breakthroughs in cancer prevention and control. Increase evidence-informed support for team-based research approaches at both academic institutions and funding agencies. Encourage training opportunities for team-based approaches in cancer prevention and control research.

Action Plan 15: Support the development and evolution of the "science of team science" field by supporting platforms for knowledge sharing and information exchange. A range of dissemination efforts are needed to accelerate the development and dissemination of principles, tools, methods, and resources in support of effective, team-based approaches to cancer prevention and control research, including conferences, special journal issues devoted to team science, and web-based technologies for knowledge sharing and information exchange on team science. These tools and resources should be applicable for training, education, and professional development in team-based research approaches for investigators at multiple career stages.

Action Plan 16: Use innovative multi-method approaches to study the processes and outcomes of cross-disciplinary team science initiatives. Apply novel methods, metrics, definitions, models, and approaches to the evaluation of cross-disciplinary team science initiatives. Develop the evidence base for team-based research, including effective practices and the potential added value this research could bring toward achieving key goals in cancer prevention and control.