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COMMENTARY/POSITION PAPER

Future directions for implementation science at the National Cancer Institute: Implementation Science Centers in Cancer Control

April Oh, Cynthia A. Vinson, David A. Chambers

Division of Cancer Control and Population Sciences, National Cancer Institute, Rockville, MD 20892-9760, USA

Correspondence to: A. Oh, ohay@mail.nih.gov

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Abstract

The National Cancer Institute (NCI) Cancer Moonshot initiative seeks to accelerate cancer research for the USA. One of the scientific priorities identified by the Moonshot's Blue Ribbon Panel (BRP) of scientific experts was the implementation of evidence-based approaches. In September 2019, the NCI launched the Implementation Science Centers in Cancer Control (ISC3 or "Centers") initiative to advance this Moonshot priority. The vision of the ISC3 is to promote the development of research centers to build capacity and research in high-priority areas of cancer control implementation science (e.g., scale-up and spread, sustainability and adaptation, and precision implementation), build implementation laboratories within community and clinical settings, improve the state of measurement and methods, and improve the adoption, implementation, and sustainment of evidence-based cancer control interventions. This paper highlights the research agenda, vision, and strategic direction for these Centers and encourages transdisciplinary scientists to learn more about opportunities to collaborate with these Centers.

Keywords

Implementation science, Cancer control, Implementation laboratories, Research centers

Implications

Practice: The National Cancer Institute's (NCI) Implementation Science Centers in Cancer Control (ISC^3) are building implementation laboratories within community and clinical settings to collaboratively study how to rapidly implement evidence-based programs in practice. Additionally, the larger Implementation Science Consortium in Cancer aims to increase collaboration in implementation science activities to build capacity beyond the funded centers to include practitioners.

Policy: The ISC^3 and the related consortium have identified policy implementation as an understudied topic and have made this a priority research area.

Research: The NCI is funding ISC^3 and supporting a related consortium to advance implementation science. These initiatives will help the field identify areas where additional capacity building and collaboration are needed.

BACKGROUND

National Cancer Institute (NCI) funded research has resulted in the development of hundreds of evidence-based practices that, if implemented, can demonstrably improve cancer outcomes at every stage of the care and control continuum [1]. Within one specific repository, the NCI's Research-Tested Intervention Programs (RTIPs) website [2], over 200 programs are available for local implementation. However, as leading researchers have argued, if we do not concentrate on the broad and effective implementation of these interventions, the benefit to the public's health will be limited with the unequal benefit of knowledge of cancer prevention across populations [3]. This disparity can be observed across the cancer control continuum in etiology, prevention, diagnosis, treatment, and survivorship. Closing this gap between what is known about cancer and what is provided as standard care will require significant advances in the science of implementation.

Since 2005, the NCI has been leading efforts at the National Institutes of Health (NIH) to promote implementation science [4] in the behavioral and social sciences by creating specific funding opportunity announcements (e.g., PAR-18-007) [4], leading an annual conference on the science of dissemination and implementation [5], and offering implementation science training programs to investigators [6]. Simultaneously, leading professional societies in cancer (such as the American Society for Clinical Oncology, American Society for Preventive Oncology, American Academy of Cancer Research, Society of Behavioral Medicine, American Institutes for Cancer Research, Academy Health, and the American Public Health Association, among others) have spotlighted implementation science in annual meetings to raise the profile of this growing field. The presence of implementation science as a key theme in the NCI

Cancer Moonshot (Moonshot Cancer Initiative) [7] has further increased awareness and demand for knowledge that can improve everyday clinical and community practice.

Across the NIH, progress on funding for implementation science has been made through a set of trans-NIH funding opportunity announcements (as well as other institute- and center-specific funding announcements (e.g., reducing the overuse of screening among older adults and tobacco cessation interventions to improve scalability), but there is still limited capacity at research institutions to conduct the range of implementation science investigations needed to close the gap between research and practice. Prospective trials, such as those solicited through other recent NCI Moonshot Initiative Requests for Applications (RFAs) on colorectal cancer screening (ACCSIS) [8], symptom management (IMPACT) [9], and cascade screening for hereditary cancers, will help to develop and test discrete approaches to specific implementation gaps but may not result in a broad-based effort to improve measurement or research designs, nor will they optimally build knowledge from ongoing efforts to implement and sustain evidence-based cancer control interventions in clinical and community settings. Furthermore, a number of high-priority areas in implementation science (e.g., local adaptation of evidence-based interventions [10], long-term sustainment of effective interventions [11], advancement of health equity, policy implementation, and de-implementation of harmful or suboptimal practices [12]) require additional research investment.

In order to grow the field of implementation science, NCI believes a targeted approach to building scientific capacity is needed. First, developing implementation laboratories where ongoing investigations on a range of scientific questions can occur "in vivo" will enable more rapid knowledge acquisition and hypothesis testing than a typical NIH R01 grant mechanism. Second, supporting the development of methods and measures will improve the assessment of key implementation outcomes [13]. Third, pooling data across studies will improve statistical power for outcomes in situations where sample size from any single study is likely to be insufficient (e.g., hospital/system or community-level outcomes). Fourth, building a consortium of investigators working in implementation science will create a mechanism that will provide ongoing support to investigators working in this field beyond training programs that provide foundational knowledge in dissemination and implementation research (e.g., NIH's Training Institute for Dissemination and Implementation in Health [14], NCI's Training Institute for Dissemination and Implementation Research in Cancer [15], NCI-funded R25 "Mentored Training-Dissemination and Implementation Research in Cancer" [16], and NCI's Speeding Research-Tested Interventions into Practice (SPRINT) program [17].

As a first step toward scaling up capacity in the field, the NCI released a set of funding announcements [18,19] in November 2018 for P50 Center Grants in Implementation Science ("Developing Centers for Implementation Science in Cancer Control" and "Advanced Centers for Implementation Science in Cancer Control"). The criteria for the scoring of applications submitted for this RFA are outlined in the RFA announcements [18,19]. In September 2019, following the submission of applications and scientific review, the NCI awarded six centers to form the Implementation Science Centers in Cancer Control (ISC^3 or "Centers") initiative. In this paper, we discuss a strategic and scientific vision for the NCI ISC^3 initiative and potential future directions for the field, as well as opportunities for the engagement of the broader research and practice community through the newly formed Implementation Science Consortium in Cancer (ISCC).

IMPLEMENTATION SCIENCE CENTERS IN CANCER CONTROL

The purpose of the ISC^3 is to build a network of U.S.-based research centers with the aim of rapidly and comprehensively advancing implementation science in cancer. This 5 year initiative will: (a) establish implementation science "laboratories" for cancer in both health and community settings that are capable of studying rapid innovations in local and national implementation of evidence-based cancer control interventions; (b) develop implementation science methods to advance the knowledge base in measurement and study design; (c) develop and execute innovative pilot projects to deliver evidence on optimal strategies for adopting, implementing, and sustaining evidence-based care; (d) improve understanding of ethical issues related to implementation and de-implementation; (e) develop data resources that will contribute to an implementation science data ecosystem; and (f) disseminate lessons learned to NIH grantees, service systems, practitioners, and other key stakeholders in the field. The name, institution affiliation, and major theme of each center that is a part of *ISC^3* are found in Table 1.

Each center includes the following "core" research components: Administrative Core, Research Program with Research and Methods Units, and an Implementation Laboratory Core. Centers will conduct two to four pilot research studies to be completed over the first 2 years of the grant cycle, develop and administer rapid implementation studies within an "implementation laboratory," and develop and initiate future pilots over the latter years of the project period.

Table 1 | Implementation Science Centers in Cancer Control (ISC^3)

Institution	Center name	Center theme
Harvard T.H. Chan School of Public Health	The Implementation Science Center for Cancer Control Equity	The Implementation Science Center for Cancer Control Equity at Harvard is improving community health by integrating health equity and implementation science for evidence-based cancer control.
Oregon Health and Science University	Building Research in Implementation and Dissemination to close Gaps and achieve Equity in Cancer Control (BRIDGE-C2) Center	The BRIDGE-C2 Center will focus on advancing implementation science to improve cancer screening and prevention in underserved populations.
University of Colorado School of Medicine	Colorado ISC^3	University of Colorado Denver will focus on pragmatic approaches to assess and enhance the value of cancer prevention and control in rural primary care.
University of Washington	Optimizing Implementation in Cancer Control: OPTICC	The OPTICC Center will develop, test, and refine innovative methods for optimizing the implementation of evidence-based interventions in cancer control.
Wake Forest School of Medicine	iDAPT: Implementation and Informatics—Developing Adaptable Processes and Technologies for Cancer Control	iDAPT will advance the field of implementation science by using technologies to support rapid-cycle and real-time deployment and testing of implementation processes and adaptations within cancer control.
Washington University in St. Louis	Washington University Implementation Science Center in Cancer Control (WU-ISC^3)	The WU-ISC^3 will build a rigorous, scientific evidence base for rapid-cycle implementation research to increase the reach, external validity, and sustainability of effective cancer control interventions. The Center's goal and activities capture three distinct features [1]: a focus on the elimination of cancer disparities [2]; the need for rapid-cycle studies; and [3] the use of systems science approaches to enhance methods and outcomes in implementation science.

The NCI has a growing portfolio in implementation science, and we have noted much progress but other questions remain in new and growing areas as the field continues to evolve and respond to changing health care and public health environment [20]. The NCI has noted that, to build capacity for the field, dual investments in both established areas of cancer control and implementation science would be needed while also investing in newer opportunities and areas to grow and increase capacity in the implementation science [18,19]. Consequently, NCI sought a set of center applications that focused on both advanced and developing scientific areas and issued two corresponding RFAs. Advanced centers focus on a specific implementation "grand challenge" reflected in ongoing Moonshot activities (e.g., scale-up of effective screening, sustained implementation of symptom management, and increase in cancer-related vaccination uptake). Developing Centers are designed to concentrate on an emergent implementation science theme for which developmental work is needed (e.g., system-wide de-implementation of ineffective practices and implementation of precision cancer care) to grow the field in new and innovative areas. The Developing Center calls for proposals were envisioned as more "high risk" and "high reward" and, consequently, structured to have fewer pilot studies compared to Centers that focused on more established areas of implementation science. Together, this range of themes across ongoing and new and emerging areas of science form the ISC^3 initiative.

STRATEGIC VISION FOR ISC^3 AND IMPLEMENTATION SCIENCE IN CANCER CONTROL

The Centers are designed to lead activities around proposed thematic areas of science in cancer control and implementation science [21]. Yet, the leadership, research, and advancement in tools and methodologies, as well as stakeholder engagement through laboratories, are positioned and charged to lead the implementation science field toward substantially improved implementation of evidence-based cancer control interventions in clinical and community practice. Centers should move the field of implementation science toward population health improvement by the following strategic themes: (a) generating scientific advances in the field of implementation science and cancer control; (b) collaborating across Centers to advance methodologies and measures; and (c) building capacity to grow the field of implementation science across research, practitioner, and policy audiences. Each of these thematic areas is interrelated and builds on the others. As noted in the RFA, a broader vision is for these Centers to form the leadership for an ISSC. The following describes each strategic theme and identifies potential future areas of advancement where the Centers could work with the broader field.

Scientific advances for the field of implementation science and cancer control

We have seen tremendous growth in the quantity and quality of implementation science projects across the cancer continuum. Indeed, the recent publication of an edited volume on this work in cancer control and implementation science [1] summarizes this progress. Within the Centers RFAs, NCI signaled a number of areas in which more work is needed. For one, many investigators have looked at strategies to introduce *new* interventions, while significantly fewer have developed strategies to "de-implement" interventions that are ineffective or even harmful [12,22]. More work on de-implementation would lead us closer to the optimal use of evidence-based interventions for maximum population health benefit [23].

In addition, the NCI, as well as the NIH, more generally, has seen growth in our portfolio around precision medicine, typically seen as the use of multiple streams of individual data (genomic, metabolomic, environmental exposure, and behavioral) to optimize personalized health and health care [24,25]. The implementation science community can play an important role in this area by generating knowledge on how precision medicine approaches can be adopted, implemented, and sustained in diverse practice settings [26]. In addition, ISC^3 investigators can make significant contributions to advancing our understanding of policy [27] as both a driver and moderator of cancer control implementation and improve the consideration of short- and long-term implementation costs.

Perhaps most impactful, ISC^3 investigators can build a knowledge base around how implementation science can eliminate health disparities and improve equity in cancer control across all populations. This theme, central to the overall NCI Cancer Moonshot, and consistent across all funded centers [21], asks us to consider the degree to which the design, execution, and analysis of implementation studies may inadvertently increase inequities by successfully implementing evidence-based interventions where care is already above average. ISC^3 investigators can improve design and measurement to better reflect diverse populations and settings, engage key stakeholders in community and health systems, and better understand how to tailor existing interventions to better fit the needs of patients and providers [27,28]. If we can make progress on closing the gap between research and practice across the country, we will see great strides in reducing the cancer burden [3].

Methodologic development and advancement in implementation science

In a health care and public health environment with rapidly changing policies, treatments, modalities, technology and evolving population health needs, the ISC^3 program has a unique opportunity to lead advancements in implementation science methods, frameworks, and theories and measures for the field. For example, technology, computing, and biomedical tools are evolving and consumers and health systems are rapidly adopting and integrating digital and social tools into daily lives. These advances create opportunities for stronger analytics, data sharing, data integration, and real-time data capture, thus, creating the potential for a coordinated data ecosystem for implementation science. A data ecosystem for the ISC^3 program encompasses a collection of data infrastructure elements, analytics, IT applications, and tools that would collectively and systematically capture and analyze data across the Centers and, potentially, across a broader consortium of research and data. The ISC^3 program should work to develop practices, systems, and protocols for developing a data ecosystem, common areas for data inclusion and capture, measurement development, analytics, and data access. Essential to the value of the data ecosystem is the ability to more rapidly learn from the data collected, to inform research and practice. The Centers can be leaders in advancing a research culture, norms and practice in the establishment of a data ecosystem. Key questions about how to implement this system and promote the uptake and sustainability of this system would be part of this work.

With a network of centers and movement toward a common data ecosystem, collaboration across centers can advance the development and rapid testing of new methods in implementation science, such as user-centered approaches for collaboration and engagement, rapid-cycle and iterative testing, systems science approaches to model complexity [29], and others. Conducting this work across different contexts, for a diverse range of cancer control problems, will advance our understanding as a field on the benefits and challenges of these approaches. The resulting data ecosystem can give us a window into the current state of implementation in clinical and community settings and permit pooled analyses of influences on adoption, implementation, sustainment, and de-implementation of interventions.

Measurement in implementation science remains in need of advancement [30]. As most frameworks for implementation science are multilevel [31], measures at each level, and across levels, will be essential [32]. Several recent reviews of implementation science measures across levels have identified challenges in limited psychometric information [33], inconsistent definitions of measures, and challenges with validity [34,35]. The complexity introduced by the fact that one construct can be measured differently across levels, the current lack of knowledge regarding mechanisms of interaction across levels, and the need to develop methods to capture the bidirectional nature of influences across levels are all opportunities for the

field. The field has encountered challenges, such as "scale-up costs" and lack of understanding of local adoption and adaptation, especially, in communities that experience health disparities. Common data elements on variables like contextual factors will advance a collective understanding of how context influences implementation across populations, settings, and geography to ultimately impact health equity. Further, as Neta et al. [36] have discussed, advances in measurement, as well as common measures and reporting, can promote the engagement of practitioners and policy makers to support decisions about how and what interventions can be integrated into practice or policy.

Capacity building for implementation science

There has been a recognized need to build capacity in implementation science for many years. Training programs have evolved over the years from 1 or 2 day workshops given during national meetings or conferences, such as the *Annual Conference on the Science of Dissemination and Implementation in Health,* to doctoral programs in implementation science. NCI, in collaboration with other institutes, centers, and offices at the NIH, has continuously supported training and education in implementation science. NCI helped launch the Training Institute for Dissemination and Implementation Research in Health (TIDIRH) in 2011. Over the past 9 years, over 300 investigators were selected from an applicant pool of more than 1,500 investigators to participate in TIDIRH. NCI has supported implementation science training specifically designed for cancer researchers through the Mentored Training in Dissemination and Implementation in Cancer (MT-DIRC) [20] training grant to Washington University and through a cancer-specific version of TIDIRH—Training Institute for Dissemination and Implementation Research in Cancer that was launched in 2018. The demand for training in implementation science continues to exceed the capacity for delivering training and education in the field.

The ISC^3 offers a unique opportunity to build capacity across multiple disciplines in implementation science through consortium networking, skills training, etc. This work could also include activities to accelerate the understanding of implementation science outcomes across various funded initiatives spanning different areas in cancer prevention and control. This work also impacts the dissemination of project findings across the participating Centers, to the cancer control implementation science community, and to community and clinical practices engaged in delivering cancer control interventions.

ISC^3 is designed to provide opportunities for junior investigators that have limited research experience to lead small innovative implementation studies that will prepare them for independent implementation research in the future. The implementation laboratory and the methods units in the research cores are responsible for catalyzing, selecting, and rapidly implementing pilot studies proposed by Center collaborators, including trainees, junior faculty, and new investigators. As part of the administrative core, a network unit is part of the overall ISC^3 organization and is designed to connect the awarded centers to build research capacity, enhance collaboration on data measures, and disseminate tools and findings across and within Centers, as well as in the broader research field. While many of the past implementation science efforts at NCI have focused primarily on

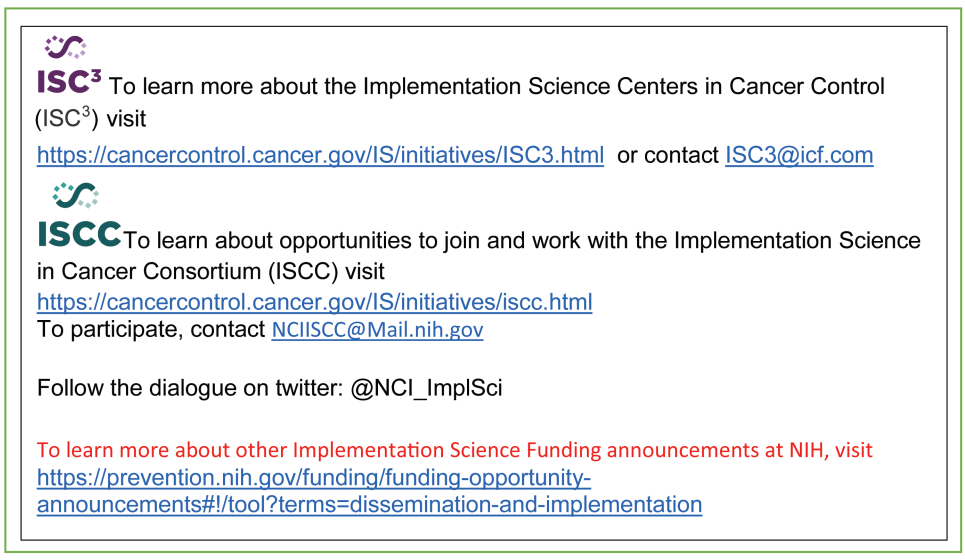

Fig 1 | Learn more about the Implementation Science Centers in Cancer Control (ISC^3) and Opportunities as part of the Implementation Science Consortium in Cancer (ISCC).

the research community, the design and structure of the implementation laboratories also create opportunities for building capacity in implementation science among stakeholders, including practitioners, community stakeholders, and health administrators working within the laboratory sites. This type of capacity building can contribute to future sustainability efforts across sites while also creating opportunities for future stakeholder-engaged research and pragmatic designs.

CLOSING

The NCI invites the research and practice community to learn about the ISC[3] program and discover opportunities to collaborate, receive training, and inform the implementation science and cancer control research agenda. The Centers are expected to be leaders and future partners in the field for strategic directions in implementation science, advancing measures and methods, and building capacity among and with stakeholders across patient, provider, practitioner, community, and policy groups. To enable broader engagement beyond the funded centers, the ISC[3]s will be leading an ISCC. In July 2019, the NCI hosted a foundational consortium meeting, where researchers across the country were invited to contribute to the conceptualization, necessary infrastructure, and capacities needed to support a nationwide consortium. Through large group discussions on thematic areas, such as technology, policy, rapid-cycle testing, health economics, and health equity, participants were invited to generate ideas of "public goods" that would advance research and collaboration in the field. We invite the research community to visit the ISCC website to learn about the discussions that took place at the meeting and to sign up to be a part of future discussions (Fig. 1).

We also encourage the TBM community to sign up for the NCI's Implementation Science listserve and to visit the website to find contact information and receive updates. The field is ripe with opportunity across the cancer prevention continuum and, through coordinated efforts across the country, we can begin to move from discovery and development toward practice and sustainability to reduce the burden of cancer.

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