

COMMENTARY

An Action Plan for Translating Cancer Survivorship Research Into Care

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To meet the complex needs of a growing number of cancer survivors, it is essential to accelerate the translation of survivorship research into evidence-based interventions and, as appropriate, recommendations for care that may be implemented in a wide variety of settings. Current progress in translating research into care is stymied, with results of many studies un- or underutilized. To better understand this problem and identify strategies to encourage the translation of survivorship research findings into practice, four agencies (American Cancer Society, Centers for Disease Control and Prevention, LIVE **STRONG** Foundation, National Cancer Institute) hosted a meeting in June, 2012, titled: “Biennial Cancer Survivorship Research Conference: Translating Science to Care.” Meeting participants concluded that accelerating science into care will require a coordinated, collaborative effort by individuals from diverse settings, including researchers and clinicians, survivors and families, public health professionals, and policy makers. This commentary describes an approach stemming from that meeting to facilitate translating research into care by changing the process of conducting research—improving communication, collaboration, evaluation, and feedback through true and ongoing partnerships. We apply the T0-T4 translational process model to survivorship research and provide illustrations of its use. The resultant framework is intended to orient stakeholders to the role of their work in the translational process and facilitate the transdisciplinary collaboration needed to translate basic discoveries into best practices regarding clinical care, self-care/management, and community programs for cancer survivors. Finally, we discuss barriers to implementing translational survivorship science identified at the meeting, along with future directions to accelerate this process.

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There are an estimated 14.5 million cancer survivors living in the United States in 2014 (1), and this number is expected to increase dramatically in the coming decade because of increased uptake of cancer screening, improved methods of early detection, better multimodal cancer treatments, and the aging of the population (2,3). Multiple reports have documented that survivors have unique and complex needs (4–8). These include management of chronic and late effects of cancer and comorbid conditions, surveillance and treatment for recurrence and second cancers, help with psychological, social, economic, and family concerns, support to improve lifestyle behaviors, and interventions to increase adherence to long-term treatment and follow-up care guidelines. The United States is currently struggling to identify a coordinated medical and public health approach to meet these diverse needs. Predicted shortages in oncologists (9), primary care practitioners (10), and other medical health professionals underscore the need for effective and efficient care for cancer survivors. The financial impact of cancer survivorship adds to this urgency: By 2020, the burgeoning population of cancer survivors is projected to drive up the cost of cancer care by 27% to \$157.77 billion (11). Further, national estimates of excess medical expenditures associated with being a cancer survivor range from \$25.2 to \$48.1 billion, and estimates of productivity loss among cancer survivors

range from \$8.2 to \$16 billion (12). To inform the development of better care, it is essential to accelerate the translation of survivorship research. Through translation, it is possible to provide the evidence needed to inform effective interventions and recommendations for policies that can be implemented and sustained in a wide variety of settings, including those with low community resources.

Several related communication and organizational infrastructure problems currently undermine the progress of translating scientific discoveries into care for cancer survivors. First, researchers often do not work collaboratively with survivors and family members to develop interventions. Lack of end user input and buy-in can result in irrelevant or poorly targeted interventions that survivors ultimately do not want or that they find impractical to use. Second, researchers, especially those representing different disciplines, often fail to communicate with each other, leaving them unaware of others working on aspects of the same survivorship research question and of opportunities for fruitful collaboration. Transdisciplinary collaboration is further inhibited by discipline-specific research terminology, methods, and measures, and structural segregation, such as discipline-specific scientific conferences or departments and buildings on university campuses. As other authors

have noted, these barriers to collaborative or team science delay progress by slowing or limiting the synthesis and dissemination of research findings (13,14). Similarly, lack of communication and collaboration, coupled with discipline-specific segregation, further limit translational research, because advances made in research outside of survivorship frequently fail to inform survivorship research. Third, researchers rarely work with transdisciplinary teams of clinicians, public health professionals, healthcare systems, and policy makers at the inception of a project to collaboratively design disseminable interventions or at the end, to plan for scalability or dissemination. Indeed, many interventions developed and tested in research settings are unrealistically intensive, complex, and impractical to implement in real-world environments (15–17). Intervention design may fail to consider sustainability after the research project is over. Additionally, interventions are seldom evaluated for costs and cost-effectiveness from the perspectives of survivors, providers, and healthcare systems. As a result, when grant funding ends and survivors or delivery systems have to pay for transportation, technology, or intervention costs, survivors may be unable to continue participation in intervention programs they still need. These issues may be particularly pronounced among post-treatment survivors who receive follow-up care from multiple providers unconnected to the original treatment team. Since costs and resource requirements are often the preeminent concern of adopting organizations, interventions designed without attention to costs or workflow implications are unlikely to be widely implemented through medical or public health channels after funding for the research project ends.

While many of these issues that limit the translation of survivorship interventions into care are not unique to the field of cancer survivorship, there are several characteristics of cancer survivorship that pose unique challenges to translation. These include the fact that: 1) Unlike other diseases, cancer is a heterogeneous set of diseases with varied treatments and toxicities and different phases of care (active curative treatment, disease-free, chronic treatment, end-of-life care) affecting individuals of various ages (children, adolescents and young adults, middle-age and older adults), and thus cancer survivors are heterogeneous with respect to their survivorship care needs; 2) Survivorship care itself is multifaceted—eg, it must encompass surveillance for recurrence, second cancers, and late effects, management of chronic effects and comorbidities, preventive health behaviors, etc.; 3) Unlike the case for cancer treatment trials, there is no standing infrastructure for testing or delivery of survivorship interventions once these are found to be effective; 4) Cancer treatments themselves are evolving rapidly, and hence the chronic and late consequences are constantly changing necessitating rapidly changing care; 5) Unlike care delivery for other diseases or active cancer treatment, there is a lack of well-defined/agreed-upon models of survivorship care; 6) Although the field of cancer survivorship has now grown into its adolescence, it is still a relatively young field and receives a much smaller proportion of the scientific research budget than does the field of cancer treatment.

There is an immediate need to develop a new way of conducting survivorship science that promotes collaborative partnerships with an iterative exchange of information, overcoming disconnection

between researchers, survivors and families, policy makers, and practitioners in diverse fields and practice/community settings to accelerate survivorship research into care. As a step toward meeting this need, four agencies (American Cancer Society, Centers for Disease Control and Prevention, LIVESTRONG Foundation, National Cancer Institute) hosted a meeting in June of 2012 (18), to bring together researchers from diverse fields of survivorship science, clinicians, public health practitioners, community partners, and survivor advocates, with the goal of understanding how to better translate survivorship science into medical and public health interventions.

Meeting sessions were explicitly structured to demonstrate how transdisciplinary partnerships and communication can be facilitated using a translational science framework. A primary goal of the meeting was to illustrate how different types of research can work together to facilitate the translation of basic discoveries into clinical care, self-care/management, and community programs. These programs can inform policies at various levels for cancer survivors, and, in turn, the implementation and outcomes of these programs and best practices can inform future research. Session discussants were encouraged to address how the science in each session was progressing along the translational process and to generate discussion between speakers and audience members about their roles in the translational process, how they could better work together, and about barriers to and facilitators of translation.

The purpose of this commentary is to build upon the findings of the meeting to propose a process for cancer survivorship research that will support the timely translation of research into actionable and evidence-based practices and provide evidence upon which policies can be based. We illustrate the model using recent examples from survivorship research, articulating how successful collaboration among multiple parties could drive the translational process. Finally, we identify barriers to implementing translational survivorship science highlighted at the meeting, along with key recommendations and suggestions for research directions to accelerate the pace of moving new discoveries into practice.

The Translational Process Model Applied to Survivorship Science

Khoury et al. initially described the Translational Science Process within the context of genomic medicine (19) and epidemiological research (20) as involving multiple phases (T0–T4), leading from scientific discoveries to population health impact. The Khoury model has since been updated to include “drivers” of translational research (21), including collaboration, technology, multilevel analysis, and synthesis of knowledge gained. While other researchers (22,23) have suggested incorporating parts of the translational science process into survivorship science, the survivorship field thus far lacks a map to fully articulate the translational process.

In light of limitations of the prior work and based in part on feedback from the meeting, we now present an updated model of the translational science process for survivorship (see Figure 1). The phases of translational research are represented by T0–T4. Each phase of research leads to a different research product, represented by the boxes. T0 research describes health outcomes and

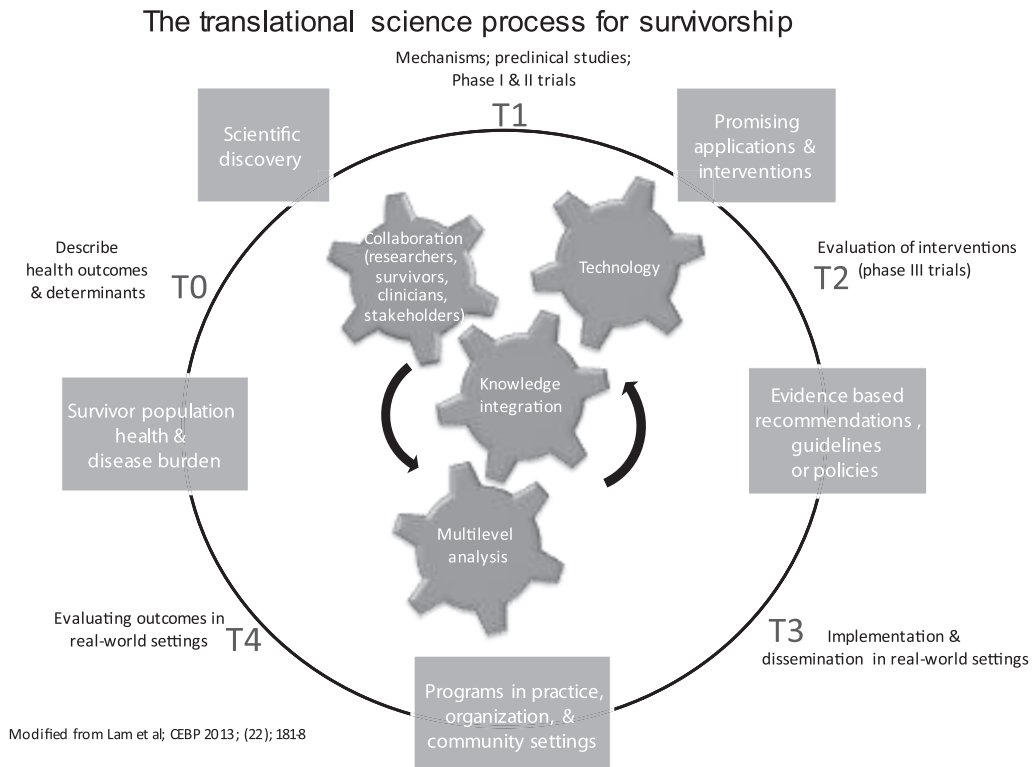


Figure 1. The translational science process for survivorship.

their determinants, which lead to a scientific discovery. T1 research translates scientific discoveries to promising interventions, products, or applications, including biomedical, psychosocial, and public health efforts. T1 research encompasses diverse science such as pre-clinical studies, basic research to identify the mechanisms underlying health phenomena or intervention success, measures development and early clinical trial development (eg, Phase I & II). T2 research provides full-scale tests of these candidate applications and interventions, including economic analyses to ascertain the cost and effects or benefits of different interventions. This phase of research ideally provides the evidence to inform the development of recommendations, guidelines, and policies based on best-available evidence. T3 and T4 represent dissemination and implementation research in real-world settings (24,25). Dissemination research investigates the processes and variables related to the widespread adoption of interventions, whereas implementation research supports the movement of interventions into the actual delivery contexts where they will be utilized and integrated into the existing operational culture. T4 research evaluates public health outcomes in multiple and large real-world settings, often drawing on surveillance or population-based data sets such as the National Program of Cancer Registries (NPCR), the Surveillance, Epidemiology and End Results program (SEER), or Medicare claims data. In turn, T4 research provides descriptions of survivor population health impact and disease burden. Feedback loops from discovery to impact can be built throughout the research continuum.

The gears in the middle of [Figure 1](#) illustrate how the translational science process is iterative, nonlinear, and driven by four key factors: collaboration, use of technology, multilevel analysis, and knowledge integration and synthesis.

Collaboration

When researchers partner with survivors, clinicians, public health practitioners, and other researchers working on different areas of the translational continuum, their work will be relevant to a wider variety of stakeholders, better positioned to inform other phases of research, and more likely to be integrated into practice and community settings (17). This process of collaboration is not linear—coordinated research at each of the phases may be occurring simultaneously, ideally with appropriate communication. For example, a T1 study need not be disseminable by itself, but through improved communication and partnerships it can be informed by multiple stakeholder perspectives, planned with translation in mind, and designed to inform better-targeted T2 studies that can eventually be disseminated into care settings.

Use of Technology

The smart and harmonized use of technology can drive translation. For example, incorporating information from electronic health records and bioinformatics at all phases of the translational science process could accelerate progress and relieve resource burden.

Multilevel Analysis

Translation is driven through incorporating information from multiple stakeholders. For example, assessing the effects of an intervention on relevant outcomes at the survivor, provider, practice, and healthcare system level will provide needed data to evaluate whether the intervention can and should become a standard of care (17). Focusing on only one or two levels to the neglect of others can often result in negative or unanticipated consequences, such as impractical interventions that are not implemented.

Knowledge Integration and Synthesis

Tools such as systematic reviews and meta-analyses help to monitor and track the progress being made disseminating research into care and help to reassess goals and formulate new strategic priorities based on remaining gaps in the process (26).

To illustrate the translational science process, Table 1 provides concrete examples of existing and possible survivorship research across the T0-T4 continuum in two areas of survivorship science: survivorship care planning and exercise interventions among survivors. We purposely selected examples that demonstrate how different content areas of survivorship research have strengths and weaknesses at different points in the translational process and to highlight how progress through the translational science process may be nonlinear. For example, survivorship care planning has been recommended by several professional as well as accreditation entities, but there is little research at this time supporting its efficacy or providing guidance on usability or costs of implementation. In Table 1, we also comment on how the two example areas are or could be accelerated by the four drivers of translational science. We note both the current state of the science and future goals in each area that would propel the science forward.

Barriers to Implementing Translational Survivorship Science and an Action Plan With Future Directions to Accelerate this Science

Information from the 2012 Biennial Cancer Survivorship Research Conference has been thematically summarized in Table 2, organized by the three main barriers to the translation of cancer survivorship research that were identified in the conference sessions. These include: 1) lack of synergy across groups working at the T0-T4 levels, 2) lack of appropriate research synthesis and knowledge integration, and 3) lack of transdisciplinary training needed to foster information exchange and partnerships across all stages of the T0-T4 model. In many cases, these barriers are not unique to the field of cancer survivorship; however, examples where survivorship issues pose specific challenges are listed. An action plan including future directions for the field to facilitate the translational science process is also listed in Table 2 and discussed below within the context of each of the three barriers.

Lack of Synergy Across Groups Working at the T0-T4 Levels

Overcoming this barrier and accelerating the translation of science into standards for clinical care will require a coordinated effort among the full array of stakeholders (researchers, survivors, clinicians, public health professionals, policy makers and payers), all providing input and expertise as well as learning from each other's efforts in a transdisciplinary, open and meaningful team science manner (14,27). It also will require focused attention to dissemination/implementation research and collaboration with practitioners and community programs, including communities with low resources.

In the past, some researchers have engaged stakeholders (eg, working with survivor-advocates to design an intervention) using community-based participatory research methods, and we applaud

these early efforts; however, we argue that translation of interventions into care will only happen if future efforts include the full gamut of stakeholders. Survivor, family, and practitioner input should be sought at every level of research to ensure interventions are relevant and feasible. New collaborations are especially needed between T1 preclinical, T1 clinical, and T2 trials researchers and implementation scientists to create better-targeted interventions. Survivorship interventions are likely to be more effective if they are created and the dose is determined based on basic mechanistic science (eg, targeting inflammation to reduce fatigue). Collaborations are also needed between survivorship researchers and those working on similar issues outside survivorship to learn from successes and failures in related fields; between researchers, clinicians, public health practitioners, and organizational decision makers to increase the feasibility and dissemination potential for effective interventions, and between researchers and policy makers to ensure the appropriate data (eg, cost effectiveness) are collected to inform implementation of care guidelines and other policy decisions.

The challenges outlined above present themselves at a time of unprecedented opportunity for sharing information and ideas aided by the emergence of big data and novel platforms for collaboration. Advances in these larger efforts can facilitate communication and understanding of how the pieces fit together and how one's area of work can be shaped to optimally contribute to the larger field. The level of coordination needed to create better research and better knowledge integration from multiple stakeholders will necessitate communication—aided by technology—to create better research and better knowledge integration from multiple stakeholders. Such coordination can be accomplished through shared activities such as interactive and transdisciplinary survivorship conference formats, such as the Biennial Cancer Survivorship Research Conference, developing more transdisciplinary survivorship research teams, and partnering in online discussion forums where multiple perspectives can be solicited and integrated.

Development of a coordinated translational science process for survivorship science will require organizational infrastructure changes to facilitate more transdisciplinary working environments and potential for cross-talk. Such changes are happening to science generally, for example, on campuses where researchers are housed in organizational units based on shared research interests, promoting scientific integration across systems instead of in traditional academic department silos. Survivorship research teams need to take advantage of these opportunities or create them where they do not exist. Transdisciplinary partnerships are also being facilitated by National Institutes of Health (NIH) grant mechanisms encouraging multiple principal investigators, which survivorship researchers are starting to use, innovative funding mechanisms such as the Stand up to Cancer Dream Teams, which could be used for survivorship questions, and changes in university policies that allow sharing “credit” and indirect cost recovery across academic units when scientists from different units work together on research teams. This coordinated strategy also may require changes in how scientific studies are funded to incentivize and facilitate integration of multiple perspectives. For example, future survivorship grant opportunities may need to allow for extra time at the beginning of a grant to work with groups of survivors, family members, clinicians, and/or relevant policy and payer stakeholders to ensure that the

Table 1. Illustration of how specific areas of survivorship science are progressing through the translational process using the T0-T4 map with future goals noted*

Phase	Description	Example 1: survivorship care planning	Example 2: exercise interventions
T0	Describe health outcomes in relation to determinants; initial basic science	Observational studies showing that: 1) survivors don't comply with surveillance (ie, screening for recurrence) guidelines at optimal rates; 2) survivors who see oncologists are more likely to be compliant with surveillance guidelines than those seen solely by primary care providers; 3) primary care providers do not feel they have all the knowledge necessary to provide survivor care	1) Cohort and case control studies showing survivors who exercise after cancer have lower rates of recurrence and longer survival; 2) observational studies showing survivors who exercise report better QOL & functional status
T0 Research leads to <i>scientific discovery</i>		Currently, transitional and long-term survivor care is suboptimal in US cancer populations	Exercise is linked with better QOL, functional status, prognosis and survival
T1	Characterize mechanisms and associations and develop applications (drugs, tests, interventions); includes preclinical studies; Phase I and II trials.	Clinical studies indicating that primary care providers can effectively provide surveillance if provided with material explaining surveillance guidelines; observational studies indicating that survivors who receive survivorship care plans have increased knowledge and/or empowerment	Observational studies and animal studies show exercisers (vs nonexercisers) have: 1) favorable differences in inflammation, immune, and endocrine biomarkers of cancer prognosis and 2) lower inflammation related to reduced symptoms like fatigue, depression (QOL)
T1 research leads to the <i>development of candidate applications/interventions</i>		Survivorship care planning (SCP) interventions	Exercise as a therapeutic intervention for cancer survivors
T2	Evaluate interventions (phase III trials)	Clinical trials of survivorship care planning efforts on relevant outcomes (eg, compliance with surveillance, communication, coordination of care, etc.) Studies intended to determine which elements of the survivorship care planning process are linked to desired outcomes (eg, is it enough to simply develop and deliver plans to survivors or should the process be more interactive?)	Clinical trials of exercise on prognostic biomarkers; symptoms, functional status, QOL
T2 research leads to the <i>development of evidence-based recommendations</i>		Recommendations defining the minimum elements of effective survivorship care planning, providing guidance on when and how to provide instructions to survivors; Institute of Medicine recommendations on treatment summaries and care planning; Commission on Cancer SCP standard	Current American Cancer Society, American College of Sports Medicine, and international recommendations advise survivors to exercise
T3	Implementation and dissemination in real-world settings	Studies of the factors (feasibility, acceptability, etc.) associated with uptake and use of care planning interventions among survivors, clinicians, healthcare organizations, and community settings (dissemination): for example, perceived efficacy or usability of SCP; approaches to increase uptake (implementation): for example, automatically generated SCP; economic evaluations; performance metrics	[Future goal] Studies on how to implement and deliver exercise programming in multiple settings effectively and efficiently; cost evaluations
T3 research leads to the <i>development of programs in practice, organization, and community settings</i>		[Future goal] To what degree are SCP interventions implemented according to guidelines by health professionals and organizations (and survivors?). What are essential aspects of programs that need to be replicated, and which can be adapted to local context?	LIVESTRONG at the YMCA program; American College of Sports Medicine certification for cancer exercise trainers
T4	Evaluate outcomes in real-world settings	[Future goal] Studies linking previous receipt of care planning in populations of survivors to relevant outcomes such as survivor morbidity, self-management of conditions, use of recommended follow-up care; provider-provider communication; determining the impact on health equity	[Future goal] Studies linking use of exercise programs to survivor health; large-scale economic evaluations; determining the impact on health equity; population effects

(Table continues)

Table 1 (Continued).

Phase	Description	Example 1: survivorship care planning	Example 2: exercise interventions
T4 research leads to <i>documenting impact on survivor population health and disease burden (public health impact)</i>		[Future goal] Estimates of population levels of implementation, compliance with surveillance guidelines, etc.	[Future goal] Exercise/physical activity consistently recorded in survivors around the country; consistent documentation of QOL, functional status, and recurrence/survival in relation to physical activity
How translation is being driven by: Collaboration		Successful SCP research requires input from oncologists to ensure medical information is accurate, primary care providers to coordinate survivorship care across providers, nurses, social workers, and other health professionals who will be administering survivorship care planning interventions, and behavioral scientists to provide insight into the acceptability of SCPs to survivors and providers and conversations with survivors and family members to ensure SCPs address the concerns most relevant to them	Among researchers: targeted funding announcements from the National Cancer Institute (Transdisciplinary Research on Energetics and Cancer initiative, PAR-12-228 and PAR 12-229) call for transdisciplinary research teams and approaches to physical activity-survivorship research Researcher/clinician: Clinicians are involved or leading exercise study teams; [future goal] establish referral patterns from clinicians to exercise programs Researcher/survivor/public health/policy makers: some exercise programs are being created in collaboration with survivors; programs like LIVESTRONG at the YMCA have potential for widespread dissemination; rapid research being conducted using Susan Love Army of Women; [future goals] implement exercise programs in wide variety of community settings; determine cost effectiveness and other value added metrics needed for healthcare decisions
Technology		Cancer surveillance systems could be used to trigger the need for SCP interventions. Electronic Health Records (EHRs) could reduce clinician time burden of creating and providing SCPs. Explorations of how technology platforms, EHRs, Personal Health Records and mobile applications may be used to align data collection, care planning and coordination efforts, and reflect survivors' preferences	Some smartphone apps, telephonic, and web-based interventions help survivors exercise; [future goal] exercise data uploaded in EHR and as part of survivorship care plan could flag survivors in need of exercise intervention and allow clinicians to refer to tailored (eg, by type/dose; supervised or home-based) intervention as needed
Multilevel analysis		Analyses providing insight into patient, family member, clinician, administrator, organization, and community and public health perspectives on survivorship care planning and care delivery that will facilitate thoughtful and expedient implementation of evidence-based best practices	[Future goal] Analysis of perspectives from survivors, clinicians, hospital administrators, community and public health personnel, and researchers are needed to create a network of best-practice exercise programs for referral and a referral algorithm to supervised or home-based intervention.
Knowledge integration		Studies of SCP use/nonuse in diverse patient and provider settings and populations can suggest essential elements and the need for tailoring within settings and survivor populations; systematic reviews and simulation modeling based on the evidence to date points to areas of success and gaps; suggests possible mechanisms to circle back to discovery	Numerous meta-analyses document positive effects of exercise on cancer-related symptoms, functional status, and QOL; synthesis of determinants of maintenance of exercise change after intervention circles back to discovery

* EHR = electronic health record; QOL = quality of life research; SCP = survivorship care planning.

Table 2. An action plan of future directions to overcome the barriers to the translation of survivorship research*

Barrier to translation of survivorship research	Action plan to overcome barrier
<p>Lack of synergy across groups working at the T0 – T4 levels:</p> <p>Almost no information flow between preclinical and clinical trials researchers, particularly in survivorship</p> <p>Early-phase trials are not designed to be feasible and inform later translation</p> <p>Almost no dissemination and implementation research is happening to facilitate uptake of new interventions in practice, organizations, or the community; particularly challenging given multifaceted survivorship care and lack of survivorship care standards and infrastructure to test and deliver new interventions</p> <p>Lack of appropriate data collection at each level T0-T4 needed to inform other phases of research, eg, the lack of cost data in clinical trials needed to inform clinical care and policy decisions</p> <p>Disagreements about the relative merits of rigorous vs pragmatic trials</p> <p>Lack of time and money available in the confines of a standard five-year R01 grant award to conduct the preliminary work needed to build key partnerships, eg, with survivors or healthcare administrators; this is particularly challenging where research requires collaboration of many sites, eg, for rare cancer types</p> <p>Lack of academic and other incentives or recognition of the importance of collaborative research</p>	<p>Form new collaborations especially between: 1) T1 preclinical, T1 clinical, and T2 trials researchers and implementation scientists; 2) survivorship researchers and those working on similar issues outside survivorship; 3) researchers, clinicians, public health practitioners, and organizational decision makers; 4) researchers and policy makers</p> <p>Base survivorship intervention development and dosing on basic mechanistic science (eg, target inflammation to reduce fatigue)</p> <p>Effectively use new/emerging technology to enhance communication, partnerships, and dissemination, eg, electronic health records can be used for survivorship surveillance activities and to make interventions more scalable</p> <p>Increase collaboration/coordination through shared activities (conferences, online discussion forums)</p> <p>Change organizational infrastructure of cancer centers and universities to facilitate more transdisciplinary working environments (eg, house transdisciplinary groups working on similar survivorship questions together)</p> <p>Change academic culture to reward transdisciplinary survivorship projects and allow “shared credit” among multiple investigators</p> <p>Create more transdisciplinary survivorship research funding announcements that allow for creation of teams of stakeholders; leverage existing funding mechanisms (eg, NIH multi-Principal Investigator mechanism) for survivorship teams</p> <p>Incorporate survivor and stakeholder perspectives in the review of grant proposals (like PCORI initiatives)</p> <p>Create adult survivor cohort and leverage data to create survivorship care guidelines like pediatric effort (Childhood Cancer Survivor Cohort Study)</p> <p>Design interventions for eventual dissemination: Carefully controlled T1 studies should inform better targeted T2 trials designed to be feasible, attentive to costs, and usable even in low resource settings. Collect outcome data of interest to potential adopters and payers (eg, costs, healthcare utilization)</p>
<p>Lack of appropriate research synthesis and integration:</p> <p>Meta-analyses and systematic reviews only exist for some survivorship areas; these are limited by lack of common definitions, measures, or methodologies that limit comparison across studies</p> <p>Publication bias stemming from the failure to submit null results for publication and reluctance of journal editors to publish null results compromise efforts to synthesize science</p> <p>Lack of transparency and appropriate data reporting in many papers limit the ability to abstract needed information for meta-analyses and reviews and for practitioners and decision makers to judge relevance; intervention cost data are particularly lacking in reports of survivorship studies</p>	<p>Use common measures of patient-reported outcomes (eg, from the NIH Patient-Reported Outcomes Measurement Information System [PROMIS] initiative) and toxicities (eg, from NCI’s common toxicity criteria) to facilitate comparison across studies</p> <p>All survivorship intervention studies should report data on factors such as personnel and intervention costs, training, etc., to inform decisions about adoption of evidence-based interventions</p> <p>Develop shared survivorship activities like integrated data analysis, data harmonization, and novel database linkage projects to fill scientific gap areas</p> <p>Hold transdisciplinary survivorship conferences to convene all stakeholders and promote synthesis of knowledge, create synergistic and strategic goals for addressing gap areas, and encourage the creation of future transdisciplinary teams</p> <p>Submit null results of trials to journals that accept “null results in brief” and encourage other journals to create such a section</p>
<p>Lack of transdisciplinary training needed to foster information exchange and partnerships across T0-T4 stages:</p> <p>Students rarely receive training outside of their primary discipline in areas such as community-based participatory research, health policy, population health or implementation science; this is particularly challenging since cancer survivorship training is also rare</p> <p>Students receive little training in knowledge integration techniques, multilevel data integration and modeling, and the use of technology to accelerate and enhance research</p>	<p>Integrate training on systems biology, systems science approaches, integrative data approaches, and implementation science into existing survivorship-related graduate or medical school programs and as ongoing career development (formal or informal courses, webinars, workshops, or career development grants) for more senior investigators</p> <p>Create survivorship-oriented integrated transdisciplinary degree programs to bridge multiple disciplinary perspectives; leverage university Clinical and Translational Science Award programs</p>

* NCI = National Cancer Institute; NIH = National Institutes of Health; PCORI = Patient Centered Outcomes Research Institute; PROMIS = Patient-Reported Outcomes Measurement Information System.

research is informed by these important perspectives. Alternatively, planning grant mechanisms could be targeted to this purpose to allow adequate preparation for larger trials. Additionally, new funding initiatives could be developed like those from the Patient Centered Outcomes Research Institute and others that incorporate patient and stakeholder perspectives in the review of proposals. New data resources may need to be created to generate research needed to inform survivorship care guidelines. This is already happening in the pediatric survivorship realm, where data from the Childhood Cancer Survivorship Cohort Study have been used to produce guidelines for pediatric survivorship (28). An equivalent effort for adult survivors is much needed.

Effective and timely translation of scientific findings into care will require more than increased communication and enhanced data integration from survivorship studies—it also will require explicit attention to key tenets of implementation science (25). Interventions need to be designed for eventual dissemination: Carefully controlled T1 studies should inform better targeted T2 trials designed to be feasible, attentive to costs, and usable even in low resource settings and those with limited infrastructure or capacity. Technology can be leveraged to aid transdisciplinary research (29), dissemination potential, and to create cost saving interventions that appeal to payers—for example, electronic health records and other health IT technology can be used for survivorship surveillance activities and to make interventions more scalable. Creating partnerships between researchers and policy makers can inform decisions about the data needed to inform future survivorship guidelines and policy decisions (14,30). Testing interventions in a variety of settings (such as community settings and integrated delivery systems) will increase dissemination potential. As the translation model becomes more widely understood, it could improve understanding between researchers from different parts of the continuum and temper debates about rigorous vs pragmatic trials: Deciding what kind of data would move the field forward could point to which trial design is best suited to a particular question. The development of risk stratification models for survivorship care would help predict who is in need of what intervention—for example, who can follow general public health guidelines for exercise vs who needs medically supervised, tailored interventions for safety.

Lack of Appropriate Research Synthesis and Integration

Shared activities like integrated data analysis, data harmonization, and novel database linkage projects can build new research teams, help answer novel questions, and promote synthesis of knowledge and the identification of new research agendas. Using common measures across studies whenever possible will help facilitate comparison across studies. For example, the Patient Reported Outcomes Measurement Information System includes measures of patient-reported health status for physical, mental, and social well being (www.nihpromis.org), and the National Cancer Institute (NCI) has developed common terminology criteria for adverse events (http://ctep.cancer.gov/protocolDevelopment/electronic_applications/ctc.htm). Additionally, the NCI-funded Grid-Enabled Measures project was developed using the collaborative expertise of the survivorship community to build consensus on process and outcome measures for use in studies of survivorship care planning and psychosocial distress (www.gem-measures.org). Future survivorship

conferences should convene all of the stakeholders and encourage information sharing in a way that promotes synthesis of knowledge, creates synergistic and strategic goals for addressing gap areas, and encourages the creation of transdisciplinary teams for future research projects. Finally, to address the problem of publication bias that limits research synthesis, investigators should submit null results of survivorship trials to journals that accept these for publication in “null reports in brief” sections and encourage editors of journals that do not have these sections to create them.

Lack of Transdisciplinary Training Needed to Foster Information Exchange and Partnerships Across T0-T4 Stages

Finally, a coordinated and forward-thinking approach to translational science in survivorship will require new training at multiple levels (27,31). New generations of students should learn systems science approaches to transdisciplinary research (14,30) and integrative data analysis methods and be encouraged to adopt a wider worldview than traditional academic department silos currently teach them. This is already happening, generally on campuses where integrated transdisciplinary degree programs are being created to bridge multiple disciplinary perspectives and in some NIH-funded Clinical and Translational Science Award centers (32). However, these efforts could be extended to survivorship training. The current workforce will also need ongoing training in these new types of science so that mid-level and senior leaders are able to adopt multiple perspectives and keep up with new hybridized scientific disciplinary knowledge. Training programs may be offered as formal or informal courses, webinars, workshops, or career development grants but need to address translational research, creating partnerships, implementation science, and systems science. Accelerating survivorship science into care will take a coordinated effort by researchers, survivors and families, clinicians, community stakeholders, and policy makers. Working together—and differently—using the key recommendations delineated here has the potential to overcome barriers and create rapid learning healthcare and public health systems capable of delivering the best possible care to meet the diverse needs of cancer survivors.

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Notes

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