J Canc Educ (2015) 30:664–669
DOI 10.1007/s13187-014-0771-2

A Framework for Training Transdisciplinary Scholars in Cancer Prevention and Control

Aimee S. James · Sarah Gehlert · Deborah J. Bowen · Graham A. Colditz

Published online: 16 December 2014

Abstract Traditionally, postdoctoral training programs largely have focused efforts within a single discipline or closely related fields. Yet, addressing the complex questions around cancer prevention and control increasingly requires the ability to work and communicate across disciplines in order to gain a perspective that encompasses the multilevel and multifaceted issues involved with this public health issue. To address this complexity, a transdisciplinary training program was implemented to cultivate the professional and scientific development of the postdoctoral fellows in Washington University in St Louis School of Medicine's Division of Public Health Sciences and NCI-funded centers (Community Networks Program Center and Transdisciplinary Research in Energetics in Cancer Center). Fellows are matched with primary mentors and assemble a multidisciplinary mentoring team. Structured programs support the transition of fellows from disciplinary trainees to independent transdisciplinary scholars and provide exposure to multiple disciplines. This article describes the training program, challenges encountered in implementation, solutions to those problems, and the metrics employed to evaluate the program's success. The goal of the program is to train emerging investigators in the conceptual bases, language, and practices that underlie a transdisciplinary perspective on cancer prevention and control research, to create an infrastructure for continued cross-discipline dialogue and collaboration, and to develop disseminable strategies for such training.

Keywords Transdisciplinary · Cancer prevention and control · Postdoctoral training

A. S. James (✉) · S. Gehlert · G. A. Colditz
Division of Public Health Sciences, Department of Surgery, Washington University in Saint Louis, 660 So. Euclid Ave, Box 8100, St Louis, MO 63110, USA
e-mail: jamesai@wudosis.wustl.edu

S. Gehlert
The Brown School, Washington University in Saint Louis, Campus Box 1196, One Brookings Drive, St Louis, MO 63130, USA

D. J. Bowen
Department of Bioethics and Humanities, University of Washington, 1107 NE 45th street, Seattle, WA 98105, USA

The public health burden of cancer continues to rise. Mortality has dropped over the last several years, but the sheer impact of cancer on the US population means that we have much work still to do. Advances in science have led to the identification of risk factors, prevention strategies, and early detection methods that have the potential to reduce cancer incidence and mortality, yet further work in refinement, implementation, and dissemination is needed in order to impact population levels. The area of cancer prevention and control increasingly requires a transdisciplinary approach to most effectively characterize—and reduce—the complex and multilevel factors that contribute to cancer onset, detection, and survival [1]. In today's environment, communication and collaboration across disciplines are critical for cancer prevention and control [2–4]. Few scholars, however, are explicitly trained to conduct such translational research within and across disciplines or are routinely exposed to the language and methods of other fields. Even fewer receive guidance into how to synthesize disciplinary knowledge and methods into a transdisciplinary approach [5]. Our multimodal training approach builds upon the success of other training programs but is unique in its added focus on translational and transdisciplinary research for the prevention and control of cancer.

The notion of transdisciplinarity originated in education and the social sciences in the middle of the twentieth Century. The approach aims to develop new, broader perspectives on topics through the integration of concepts, methods, and frameworks from different disciplines and often (though not always) using a team science approach. Transdisciplinary approaches are particularly relevant for complex social or

health problems, such as the complicated web of factors that contribute to cancer incidence and mortality, and those that exacerbate or mitigate cancer disparities. A transdisciplinary approach may facilitate a researcher's conceptualization of how different component parts come together to create the whole, compared to focusing research and interpretation on a small set of constructs, factors, or explanations. By moving beyond the often rigid discipline-specific definitions of phenomena and challenging those definitions based on the theories and empirical knowledge base of other disciplines, we can develop broader definitions, understandings, and connections that more closely approach complex realities.

Capturing complexity is crucial for ameliorating public health problems like cancer health disparities. The determinants of health disparities occur at multiple levels thus requiring an approach capable of capturing their multifaceted and complex nature [6–9]. The transdisciplinary approach relies on collaborations among social, behavioral, clinical, and biological scientists to represent the multileveled determinants of health disparities within the same analyses, often using shared models. Efforts that focus on one level or one orientation while failing to bring in other perspectives or methods can improve individual health outcomes but may not make a substantial impact on overall racial/ethnic and socioeconomic disparities [7].

Most researchers would agree that disciplines, as the primary units of academic communities, produce specialized knowledge that is essential to education and research and to addressing complex human health issues such as cancer. However, operating strictly within the boundaries of a single discipline can be restrictive and cause a scholar to minimize the complexity of problems or focus on a narrow perspective. Successful transdisciplinary functioning creates shared, and therefore often broader, boundaries and collaborations among scholars. In so doing, it contributes to their ability to address new problems and issues that arise. It involves learning the language of other disciplines and successfully navigating (or at least appreciating) those disciplines' cultures and norms. Few researchers ever receive more than anecdotal guidance on how to do this.

The State of Cross-Disciplinary Training

Calls for interdisciplinary and transdisciplinary training have been heard increasingly since the late 1990s. A 1996 report by the Organization for Economic Cooperation and Development, for example, encouraged universities to train across disciplines and form university-industry-government collaborations for the promotion and diffusion of knowledge [10]. In the following decade, the National Academies and Institute of Medicine produced two reports promoting cross-disciplinary education [11–13]. The first of these reports focused on public health education and recommended that graduate education programs in schools of public health include eight content areas, including informatics, genomics, communication, cultural competence, community-based participatory research, global health, policy and law, and public health ethics [11]. The report outlined responsibilities of schools of public health, including that schools serve as the focal point for multischool transdisciplinary research. In 2004, the National Academies and Institute of Medicine came together to draw up recommendations and feedback from university faculty and administrators, non-academic scientists, and business leaders to address undergraduate, graduate, and postgraduate education across a number of fields and disciplines, recommending that undergraduate students gain a solid foundation in one discipline but add courses from other disciplines to expand understanding of the techniques and cultures of other disciplines and to develop professional networks that go beyond one's discipline [12]. The report also suggested that graduate students should have multiple advisors from different disciplines and attend conferences outside of their primary fields. Postdoctoral fellows were encouraged to find institutions favorable to interdisciplinary research and mentors with histories of mentoring across departmental lines. Some scholars have argued that promoting transdisciplinarity too early in training can leave scholars with the disadvantage of weaker disciplinary skills or knowledge, while training late in one's career may occur after a scholar is more set in their methods and ways [14]. Thus, the postdoctoral period may be an ideal transition point to teach and support transdisciplinary orientations and approaches. At this stage, scholars have already obtained strong method and content training but may not have firmed up their research agenda or collaborations.

In this article, we outline our program for training postdoctoral scholars to function transdisciplinarily by broadening their exposure to perspectives on the cancer research continuum from discovery to implementation and dissemination in communities. At Washington University in St. Louis School of Medicine in the the Division of Public Health Sciences, postdoctoral fellows select a primary mentor and a two-to-three person mentoring team that represents a range of disciplines that span basic, clinical, and social/public health sciences. The specialized training program supports transdisciplinary growth and dialogue through multiple mechanisms and was informed by the growing literature in transdisciplinary research and training and our own experiences [14–17]. Our aim is to mentor postdoctoral scholars in transdisciplinary research, with an emphasis on translation in cancer prevention and control. We also aim to provide formal and individualized training to postdoctoral scholars and opportunities for transdisciplinary training and modeling through seminar presentations by both disciplinary and transdisciplinary scholars.

Training Infrastructure

Our training program is grounded in the idea that shared space and opportunity for interaction enables transdisciplinarity and can support success in transdisciplinary training. Our trainees sit near faculty mentors (rather than isolated just among other trainees) but they are in close proximity to other trainees and researchers. The space is designed in a way that makes faculty accessible when needed but also in a way that encourages informal interactions among the range of faculty, trainees, and students, such as an impromptu "hallway chat" or shared ideas over coffee.

Mentoring Team

Trainees in our program establish a mentoring team. The multiple-mentor model is a feature of several other transdisciplinary efforts and has been strongly encouraged [17–19]. A single mentor, even one who works transdisciplinarily, cannot offer the multiple perspectives that an emerging scholar needs. Each trainee is first linked to a primary mentor whose research interests or discipline correspond with that of the trainee. Then, over the course of the next few months, the trainee interacts with faculty from across the university to pull together a diverse mentoring team with the guidance of the primary mentor. For example, a social science trainee transitioning to health research may have a primary mentor from epidemiology, a secondary mentor from a clinical field in which his or her research is focused, and a tertiary mentor from his or her home discipline. The role of the primary mentor is to guide the trainee, identify opportunities for mentored research and career growth, support those opportunities, and provide overall mentorship for research and career development. The additional members of the mentoring team can help push trainees—and their other mentors—to consider alternative approaches, step outside of disciplinary boundaries, and resolve disagreements that may occur when two disciplinary approaches diverge. Trainees are encouraged to keep at least one mentor from their home discipline who can advise them in navigating changes in their focus, provide grounding for understanding key concepts, and serve as a critical resource should they wish to pursue faculty jobs in their home field. The training leadership committee ensures that trainees are receiving adequate mentoring by checking in regularly with both mentees and mentors. Mentors are encouraged to discuss progress and activities with mentees to see that expectations are clear and there is mutual agreement [20].

Mentored Research

Mentored research experiences come in multiple forms. In addition to research with their mentors, trainees are also encouraged to form research collaborations and networks with faculty members from a variety of backgrounds. As an example of the activities of the training program that foster a holistic perspective on cancer control and cancer disparities, two trainees from very different disciplines (Urban Planning and Microbiology) worked together with a team of scientists from the four sites in the Transdisciplinary Research in Energetics and Cancer (TREC) initiative to examine the relationship between African Americans' disparities from obesity and poor breast cancer outcomes. This study will examine inflammation biomarkers in ER+ breast cancer tumors in postmenopausal African American and Caucasian women with varying levels of body mass indices. The long-term objective of this work is to suggest ways to improve treatments for women at high risk for poor outcomes by modifying inflammatory markers in the tumor microenvironment via dietary and/or exercise interventions. Each trainee contributes a vital disciplinary perspective and adds to the synthesis of disciplines and approach to address the problem.

Additionally, trainees are regularly exposed to the wide range of research activities and approaches through participation in bi-monthly division-wide "Works in Progress" presentations and attendance at regularly occurring seminars sponsored by our cancer center's Prevention and Control Program, the university-wide Institute of Public Health, and other collaborating departments. The key difference from traditional programs is the broad range of exposure and interaction, the push to consider how other fields would conceptualize and research an issue, and the support to do so.

Individual Development Plan

Transdisciplinary training requires trainees to expand their own skill level and, sometimes, change their behavior in approaching and researching a question and composing a study team. With their mentoring team in place, trainees create an *Individual Development Plan (IDP)* that outlines short-term (6-month), 1-year, and 2-year goals, any proposed didactic or skills training, and overall career development goals, including how they will incorporate transdisciplinary experiences into their learning. This includes anticipated manuscripts, presentations, and conference attendance. For example, a trainee might seek out a conference outside of their discipline in order to broaden their knowledge, exposures, and professional networks. Trainees write the IDP using a standard form with guidance from their mentors and the training leadership; thus, the IDP is designed to reflect the input from multiple disciplines and transdisciplinary approaches. It also helps ensure that mentor and mentee expectations are aligned [20]. IDPs are updated every 6 months to account for emerging opportunities and to ensure regular discussion of career development goals between the mentee and mentors. IDPs are also reviewed by the training leadership. This allows the training leadership to monitor whether trainees have adequate

opportunities for publication and presentation, if they are making adequate progress toward their stated goals and to scholarly independence, and if they need additional mentoring or support in their own or in other disciplines.

Transdisciplinary Journal Club

Traditional journal clubs are often disciplinary or topical in nature, such that only those closely related to the method or topic at hand actively participate, and scholars from outside disciplines might not be invited or might not engage in the discussion. As we built our training program, we realized our Journal Club was not always conducive to trainee growth. We recognized that postdoctoral scholars were often quiet and hesitant to ask questions or provide input in a journal club predominated by faculty, particularly when the article was outside of the trainee's discipline. We re-developed our format to be a trainee-focused group and one that encouraged the respectful exchange of ideas across disciplines, learning of the language and methods of other disciplines, and learning to critically appraise the scientific literature outside the bounds of a single discipline. We include topics such as mouse model studies, meta-analyses and systematic review, large national dataset analysis, epidemiology, interventions, and ethnography.

Each week, a trainee presents a set of readings on a topic of his or her choosing. Because the topic is likely to be unfamiliar to other attendees, the presenters often include a background article and use the few first minutes to orient the attendees to the topic or method. This both provides instruction to attendees (and experience to the presenter) and sets the group up for an informed and productive discussion. For most sessions, the group discusses the topic or methods, compares and contrasts with methods from their own area, and attempts to learn the language and methods of other fields—or at least how to interpret studies from other disciplines. In some cases, trainees have selected two articles that address a similar topic from multiple disciplines or asked a trainee with another background to co-present. For example, a basic science trainee paired an epidemiology article on fish oil benefits with a basic science article testing the impact of fish oil supplementation in mice. This led to a discussion of the metrics and methods of the two areas of research and set the tone for a respectful and engaging discussion of how to draw findings from one discipline to inform research questions from another. During another session, a qualitative study of adolescents' dietary practices was paired with an article on high-fat diet and neurocognitive outcomes in juvenile mice. A sample of presenters and topics covered is listed in Table 1.

Trainees thus learn to understand, respect, and advance research ideas and methods from other disciplines, and the group provides a safe forum for learning how to critically evaluate and integrate perspectives from outside their home disciplines. Although trainees invite a different faculty member each week to contribute to the discussion, a member of the training executive committee is usually present to provide continuity of contact with trainees.

Professional Development Sessions

Research skills are only one part of cultivating long-term trainee success. Scholars also need to learn how to navigate

Table 1 Sample of topics covered in TD journal club

Trainee discipline	Faculty discipline	Article focus
Microbiology	Social work	Allostatic load; racial differences; disparities
Economics	Public health	Socio economic factors and health; disparities
Economics	Epidemiology	Obesity and mortality; modeling obesity effects
Epidemiology	–	Alcohol consumption, lifestyle, and breast cancer risk
Anthropology	Public health	Tobacco and culture and risk
Economics	Epidemiology	Obesity and infertility
Biology	Basic science Clinical medicine	Prostate cancer and dietary intake
Epidemiology	–	Diet and breast cancer risk
Exercise science	Public health	Physical activity and built environment
Microbiology	Public health	Measuring stress responses and disease risk
Anthropology	Social work	Race and disease
Economics	–	Uses of observational data, meta analysis methods
Exercise science	–	Physical activity and cancer survivorship
Urban design	Public health	Social factors, built environment, and health status
Biology anthropology (joint presentation)	–	Dietary intake in adolescence

Missing information under faculty discipline indicates that either no faculty member was present or it was not recorded

the university and research culture to ultimately succeed. This is probably truer for transdisciplinary researchers who might find themselves in environments quite different that in which they completed their graduate training or working with collaborators from disciplines or departments with different expectations, norms, and standards. Monthly professional development sessions for trainees provide a forum to address professionalization and career development topics. These sessions have covered topics such as presentation skills, grant preparation, grant writing career trajectories, curriculum vitae preparation, NIH funded research publication guidelines, the academic job search, and authorship negotiation. One session addresses communication between mentors and mentees and helps fellows identify their own styles and how they might contribute to transdisciplinary research. Topics such as presentation styles, authorship norms and expectations, and job talks are prime examples of where disciplines vary considerably and where it is important for transdisciplinary collaborators to have a sense of what other fields value and expect. Most sessions are led by a cross-disciplinary panel of investigators from different parts of the university. This ensures that trainees are well versed in the expectations of various disciplines and that the information disseminated is relevant to their own past and current experience and that they can successfully traverse those disciplinary boundaries. As with the Journal Club, this provides an avenue for informal and frequent contact with each other, other faculty, and the training leadership.

Responsible Conduct of Research

At the start of our training program, we relied on university-wide ethics training to address responsible conduct of research and to supplement the day-to-day informal training by mentors. However, we realized that many responsible conduct of research (RCR) trainings do not address the complexities of disciplinary differences and do not incorporate critical discussion of the challenges and ethics of working across disciplines to conduct and publish research. We developed a multidisciplinary RCR training that addresses the required RCR components while bringing together investigators from different fields to compare and contrast their ways of working and to come to an understanding of the ethical challenges encountered in a variety of disciplines. For example, a session is held on collaboration and working in teams and another session on publication and authorship. Fellows are also encouraged to attend other ethics seminars or lectures sponsored by the university. RCR topics are integrated throughout the training from one-on-one conversations and role modeling by mentors to weaving them into journal club and professional development discussions.

Evaluation

As is the case with any successful training program, transdisciplinary programs must conduct comprehensive evaluation of program processes and outcomes in order to ensure both sustainability and ongoing support from administrations and funders. This evaluation should include longitudinal measures of program graduates that map their career trajectories and the impact of the training program on professional practice. Programs have been encouraged to use both qualitative and quantitative methods to demonstrate program outcomes [17, 21]. Others have proposed the need for core competencies in cancer prevention and control research training [22, 23]. Trainees' progress can be measured using a rather standard bibliographic approach in which manuscripts, presentations, and funding proposals are tracked over time [24]. Qualitative measures may address the involvement of the trainee in different aspects of research and development and add nuance to the evaluation. Metrics are not yet available, however, to measure improvement in trainee's science through time.

The challenge in transdisciplinary programs lies on how to assess the actual *transdisciplinarity* of the work above and beyond standard measures. We expect transdisciplinary trainees will be more likely to include authors/investigators from disciplines other than their own and in higher numbers than discipline-specific trainees. With regard to journal club, we expect transdisciplinary trainees to bring articles that originate from disciplines that differ from one another (e.g., when two articles are presented) and from their own home disciplines or to choose to co-present with a trainee from a different discipline, but we also expect increasing awareness of other disciplines when presenting their own views and broader content knowledge across cancer prevention and control. We will also qualitatively ask trainees about their experience, comfort, and confidence in discussing literature and methods from disciplines other than their own. We expect that transdisciplinary trainees will be more open to—and more likely to draw upon—research from multiple disciplines in publicizing their work and developing research questions.

Summary

Increasingly, the questions faced by cancer prevention and control researchers today involve a level of complexity and broadness of scope that is best addressed using a transdisciplinary approach. This requires investigators to work both within and across disciplines, yet many training programs are not designed to encourage—let alone teach—these skills. Working with a transdisciplinary team often means living with a level of ambiguity and compromise, and this is something that develops with practice over time. It is still the case that disciplines train within their own curricula (and often rightly

so) and that most researchers will need to find a disciplinary home if they pursue faculty positions. We developed a transdisciplinary training program for postdoctoral fellows to produce scholars who, while firmly grounded and highly skilled within their own disciplines, are able to "speak" the language of multiple disciplines, and are trained to seek out transdisciplinary perspectives to solve the complex cancer prevention and control challenges faced by society today and in the future.

Acknowledgments We thank our internal and external advisors, mentors, and trainees for their feedback as we developed and refined our training programs. The training program was supported in part by grant numbers U54 CA155496 and U54 CA153460 from the National Cancer Institute. All opinions expressed herein are the sole responsibility of the authors and do not reflect the views of the National Institutes of Health. We also thank the Barnes-Jewish Hospital Foundationand Siteman Cancer Center for support of training efforts.

Conflict of Interest The authors have no conflicts of interest to report.

References

1. Hiatt RA, Breen N (2008) The social determinants of cancer: a challenge for transdisciplinary science. Am J Prev Med 35(2 Suppl):S141–S150
2. Chang S, Cameron C (2012) Addressing the future burden of cancer and its impact on the oncology workforce: where is cancer prevention and control? J Cancer Educ 27(2 Suppl):S118–S127
3. Correa-Fernandez V et al (2011) Educating cancer prevention researchers in emerging biobehavioral models: lessons learned. J Cancer Educ 26(4):633–640
4. Teegarden D et al (2011) Cancer prevention interdisciplinary education program at Purdue University: overview and preliminary results. J Cancer Educ 26(4):626–632
5. Matthews-Juarez P (2013) Developing a cadre of transdisciplinary health disparities researchers for the 21st century. J Health Care Poor Underserved 24(1 Suppl):121–128
6. Gehlert S, Browne T (2013) Transdisciplinary training and education. In: Haire-Joshu D, McBride T (eds) Transdisciplinary public health: research, education, and practice. Jossey-Bass, San Francisco
7. Gehlert S, Colditz GA (2011) Cancer disparities: unmet challenges in the elimination of disparities. Cancer Epidemiol Biomarkers Prev 20(9):1809–1814
8. Gehlert S et al (2010) The importance of transdisciplinary collaborations for understanding and resolving health disparities. Soc Work Public Health 25(3):408–422
9. Emmons KM, Viswanath K, Colditz GA (2008) The role of transdisciplinary collaboration in translating and disseminating health research: lessons learned and exemplars of success. Am J Prev Med 35(2 Suppl):S204–S210
10. Development, Organization for the Economic Cooperation and Development (1996) Shaping the 21st century: the contribution of development co-operation. Paris
11. Gebbie K, Rosenstock L, Hernandez KM (eds) (2003) Who will keep the public healthy? Educating public health professionals for the 21st century. National Academies Press, Washington, DC
12. Research, Committee on Facilitating Interdisciplinary, et al (2004) Facilitating interdisciplinary research. Washington, DC
13. Medicine IO (2006) Genes, behavior, and the social environment: moving beyond the nature/nurture debate. The National Academies Press
14. Nash JM (2008) Transdisciplinary training: key components and prerequisites for success. Am J Prev Med 35(2 Suppl): S133–S140
15. McDaniel AM, Champion VL, Kroenke K (2008) A transdisciplinary training program for behavioral oncology and cancer control scientists. Nurs Outlook 56(3):123–131
16. Nash JM et al (2003) Training the transdisciplinary scientist: a general framework applied to tobacco use behavior. Nicotine Tob Res 5(Suppl 1):S41–S53
17. Blazer KR et al (2006) Creating tomorrow's leaders in cancer prevention: a novel interdisciplinary career development program in cancer genetics research. J Cancer Educ 21:216–222
18. Chang S et al (2005) Adapting postdoctoral training to interdisciplinary science in the 21st century: the Cancer Prevention Fellowship Program at the National Cancer Institute. Acad Med 80(3):261–265
19. Fleming M, Burnham EL, Huskins WC (2012) Mentoring translational science investigators. JAMA 308(19):1981–1982
20. Huskins WC et al (2011) Identifying and aligning expectations in a mentoring relationship. Clin Transl Sci 4(6):439–447
21. Gehlert S et al (2008) Targeting health disparities: a model linking upstream determinants to downstream interventions. Health Aff (Millwood) 27(2):339–349
22. Brownson RC et al (2009) Developing competencies for training practitioners in evidence-based cancer control. J Cancer Educ 24(3):186–193
23. Faupel-Badger J, Cameron C, Chang S (2014) Invigorating cancer prevention: proposing core competencies in cancer prevention research training. J Cancer Educ 29(1):6–8
24. Dores GM et al (2006) Evaluating research training outcomes: experience from the cancer prevention fellowship program at the National Cancer Institute. Acad Med 81(6):535–541