

The Evolution of Cancer Control Research: An International Perspective from Canada and the United States

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Abstract

Four phases in the evolution of cancer control frameworks are reviewed, highlighting how national Canadian and United States planning and implementation activities have built on each other's work to define and guide cancer control research. Hallmarks have come to be: (a) coordination of the cycle that applies research to practice and policy decisions; (b) synthesis of knowledge at each phase of cancer control framework; (c) a focus on populations and public health with feedback loops between fundamental and applied research; and (d) interdisciplinary integration of the biological, behavioral, social, and other population sciences. Current research priorities and initiatives based on the research framework now common to both Canada and the United States are described. We conclude by calling for an international forum for the systematic advancement of cancer control research, and closer ties between the cancer control communities in North America.

Introduction

Cancer control research is the creation and application of knowledge and strategies to prevent and detect cancer, and to increase survival and quality of life for those who develop cancer. We provide a historical accounting of the concept of cancer control and our shared view of this field of research. Our goal is to advance cancer control research in Canada and the

United States, and to promote a coordinated international research agenda.

Cancer control science arises out of the interface of fundamental discovery and its "translation" into both clinical and public health applications. The scope of cancer control activities and the research that supports them have evolved over time, in response to changes in science and society (1, 2). In recent years, while there has been an explosion of discovery in the basic or fundamental sciences (*e.g.* genomics and proteomics, and imaging technologies for early detection), the behavioral and social sciences have matured so that they are better able to address mechanisms and strategies for individual, community, and societal change. It is increasingly clear that an understanding of the social and environmental determinants of health and how they operate through behavioral and biological pathways is key to the prevention of cancer (3–5). Thus, it is important to view "translational research" to encompass not only the pervasive view of transfer of basic science discoveries into clinical applications ("bench to bedside"), but also its transfer into effective interventions at the population level with active community participation in the process ("bench to trench"; Ref. 6). Collaboration between research producers and research consumers in this translational approach is critical to reduce the cancer burden at the population level, the ultimate measure of benefit to all people (7).

This shared concept of the scope, content, and goals of cancer control research has been built on the work of those who have come before us. We recount a 20-year history of interaction between fundamental and behavioral cancer research that has resulted in the modern field of cancer control. Cancer control can find its roots in the formation of the precursor to ACS⁴ in 1913 and in legislation that authorized the United States NCI in 1937 and the National Cancer Act of 1971 (1, 2). In its modern form, it is best reflected in the frameworks that have defined and guided cancer control research over the last 25 years (8). We review this modern evolution in the context of the interplay between cancer control research programs in the United States and Canada, two countries that have built on each other's planning and development in a synergistic, if not always intentional, manner.

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⁴ The abbreviations used are: NCI, National Cancer Institute; NCIC, National Cancer Institute of Canada; DCPC, Division of Cancer Prevention and Control; DCCPS, Division of Cancer Control and Population Sciences; CSCC, Canadian Strategy for Cancer Control; CTCRI, Canadian Tobacco Control Research Initiative; CBRPE, Centre for Behavioural Research and Program Evaluation; CCS, Canadian Cancer Society; CDC, Centers for Disease Control and Prevention; ACS, American Cancer Society; TRIO, Translating Research into Improved Outcomes; SEER, Surveillance, Epidemiology, and End Results; Center Control PLANET, Cancer Control Plan, Link, Act, and Network with Evidence-based Tools; NIH, National Institutes of Health.

Table 1 Milestones in evolution of cancer control frameworks

Initial dates	Origins	Distinctive features
1982	United States NCI cancer control review	<ul style="list-style-type: none"> ● Introduce concept of national strategy of programmatic intervention research, from hypothesis generation to demonstration projects in defined populations
1985	Greenwald & Cullen, 1985	<ul style="list-style-type: none"> ● Focus on intervention research to translate etiologic significance into population impact ● Redefine “cancer control” as a <i>research</i> endeavor ● Highlight “impact on defined populations” as key endpoint ● Described model for evidence-based strategic decisions ● Introduced dissemination research as distinct field
1988	NCIC creation of senior Advisory Committee on Cancer Control	<ul style="list-style-type: none"> ● Conceptualize knowledge synthesis as the shared responsibility of those in fundamental and intervention research, surveillance and monitoring, and program development and delivery ● Highlight the importance of shared language and values across diverse stakeholders
1994	ACOCC, 1994	<ul style="list-style-type: none"> ● Place priority of funding research likely to make population impact ● Shift paradigm from cancer control research to coordinated cancer control research, program and policy in service of population-public health
1997	United States NCI Cancer Control Program Review	<ul style="list-style-type: none"> ● Highlight need to assess societal trends in setting research priorities ● Emphasize importance of continuous reinvestment in fundamental research to support next generation of interventions
1999	Hiatt & Rimer, 1999	<ul style="list-style-type: none"> ● Highlight need for greater integration of biobehavioral and population-public health perspectives ● Broaden conceptualization of outcomes to balance biomedical indicators with population impacts ● Broaden role of scientist to include knowledge synthesis ● Invested in and operationalized cancer control research dissemination ● Introduce key concept of transdisciplinary research to cancer control
1999	Canadian Strategy for Cancer Control	<ul style="list-style-type: none"> ● Introduce plan for a “comprehensive, coherent, and integrated” national strategy uniting research producers and research consumers ● Focus on broad and extensive collaboration among these stakeholders as key to bridge basic to applied research, research to application, and to actualize transdisciplinary/transsectoral principles
2001	Canadian Cancer Research Strategy	<ul style="list-style-type: none"> ● Development of a national research agenda ● Attention to roles and infrastructure required to support research to application

Frameworks for Cancer Control Research

Four milestone initiatives define phases or chapters in the evolution of cancer control research frameworks in North America, as summarized in Table 1.

The United States NCI Five Phase Model. The United States NCI, one of the government’s NIHs, conducted a comprehensive review of cancer control research in 1982 and formed the DCPC a year later. Cancer control was defined then as: “the reduction of cancer incidence, morbidity, and mortality through an orderly sequence from research on interventions and their impact in defined populations to the broad, systematic application of the research results.”

The seminal paper by Greenwald and Cullen (8) highlighted groundbreaking aspects of the definition, which stressed the connection between research and practice. “Orderly sequence” meant the use of science as it moves through explicit stages of development from research to practice. They presented a five-phase model to guide the process: (a) hypothesis generation; (b) methods development; (c) controlled intervention trials; (d) studies in defined populations; and (e) demonstration projects. Higher stage research was considered more desirable. “Intervention” underscored the evolution from etiologic to intervention research. Although cancer control may include etiologic and fundamental research, it was distinguished by its specific focus on applications to improve patient and population outcomes. However, not all of the cancer control research entailed intervention. “Impact on defined populations” highlighted the distinction between clinical and population health perspectives, opening the door to greater emphasis on prevention and an impact on populations at risk of cancer.

The most important function of the paper by Greenwald and Cullen (8) was to conceptualize cancer control *research*. Before their effort to codify a model for cancer control, research was not regarded as a central feature of cancer control; the emphasis was on a service or delivery function with a focus on demonstration projects (1). Their paper signaled other pivotal shifts. Greenwald and Cullen (8) postulated that cancer control research benefits from a national strategy that guides research priorities rather than relying exclusively on investigator-initiated studies, arguing that the research to practice sequence often unfolds too slowly otherwise. The model laid the foundation for the United States NCI to adopt funding guidelines that progressively moved cancer control research investment from an emphasis on the early stages of hypothesis and methods development to a greater emphasis on demonstration projects. The five phases were positioned as a strategic decision-making model that informed the state of the science, telling us when there was a sufficient body of evidence to move the primary focus to the next phase. Greenwald and Cullen (8) expected that there would be an active process of synthesis and diffusion. Such research could focus on factors that influence research transfer and uptake, and ways to promote greater population application of research findings. However, synthesis and diffusion occurred in only limited ways; no infrastructure or processes were developed to assure that they would occur in a systematic manner. Finally, the decision framework shaped targeted funding initiatives in tobacco control, chemoprevention, diet, occupation and environment, screening and detection, and community-wide treatment strategies. The American Stop Smoking Intervention Trial (ASSIST) (9) was one exam-

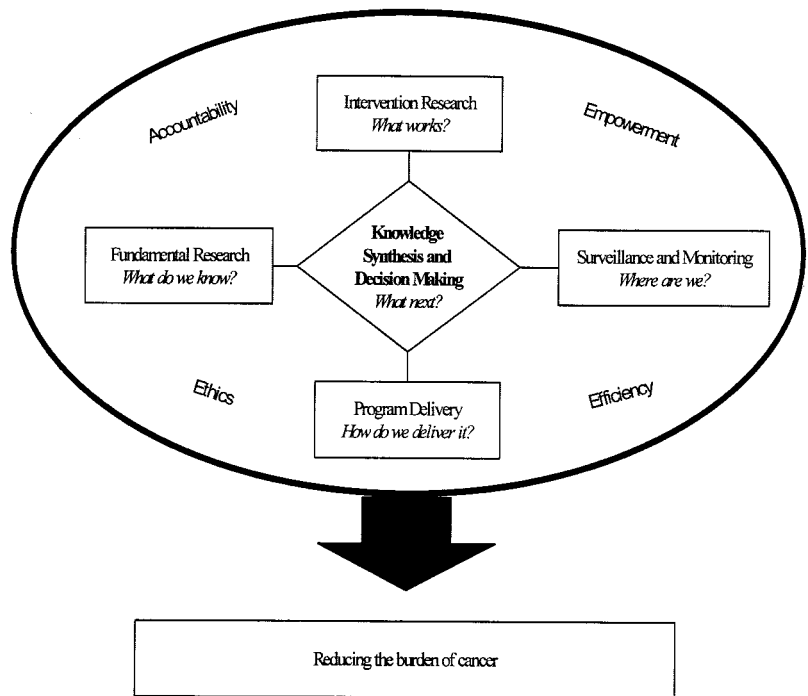


Fig. 1. NCIC (1994) cancer control framework.

ple of such a demonstration project following this framework that was based on controlled intervention trials (*e.g.* Ref. 10) and studies in defined populations (11, 12), and then attempted to apply what had been learned at the state and national level. **NCIC Model.** The NCIC Advisory Committee on Cancer Control (13) authored a key report in 1994 that comprises the second chapter in this saga. The NCIC enjoys a special relationship with the CCS, which provides and advocates for cancer services and also raises most of the NCIC budget. This partnership has created a commitment to support not only fundamental/basic research but also research designed to contribute quickly to improvements in cancer prevention and cancer care. Moreover, it has fostered consistency in the national message about cancer control priorities. The inherent emphasis on the research to practice sequence set the stage for the value added by a 1994 framework paper. Building on a decade of United States success with the cancer control research strategy, the Canadian framework (Fig. 1) added important refinements.

The principle that a successful cancer control strategy must guide both the research endeavor and its application is inherent in the framework. To be effective, it should: "(a) provide a common comprehensible language applicable to the full range of cancer control activities; (b) demonstrate the relationships between research, program delivery, and surveillance; (c) promote a disciplined and systematic approach to synthesize existing knowledge and identify the initiatives most likely to reduce the burden of cancer; and (d) reflect societal values such as inter-sectoral collaboration, participatory decision-making for patients and the public, a focus on prevention, and public accountability." In essence, this reframing expanded the cancer control framework from the research domain into health care, broadly conceived at the population and public health level. The framework was positioned in the health reform demands of the 1990s. Cost-control and thus efficiency, an aging population, and a need for coordinated planning and resource allocation became part of the equation. The bottom

line became the utility of the framework for cancer control planning, resource allocation, and monitoring.

Perhaps the most important NCIC refinement was the principle of bringing key stakeholders to the table to make determinations based on the knowledge synthesis and decision-making process. People who conduct fundamental and intervention research, program providers, and those responsible for surveillance and monitoring were key to this process. Rather than rely solely on knowledge gleaned from the trials emphasized in the Greenwald and Cullen (8) model, a decade later there was now explicit recognition that other research approaches and perspectives generate valid and useful knowledge. The knowledge synthesis process might lead to the conclusion that more research was needed as the next step, that programs should be developed or refined, or that programs should be fine-tuned to do a better job of reaching target populations.

The framework identified four principles or values: ethics, empowerment, efficiency, and accountability. These are fundamental for cancer control and provide a shared foundation upon which diverse perspectives can build collaboration. Finally, the NCIC framework recognized that the five phases of intervention research described by Greenwald and Cullen (8) had close parallels in the program development process. These phases can be used to guide both research and practice across the cancer continuum: health promotion, disease prevention, screening, treatment, rehabilitation, and palliation.

A New Strategy for Cancer Control Research in the United States The Cancer Control Program Review,⁵ conducted at the request of the United States NCI Director in 1996–1997, recognized important societal trends that were having a major impact on cancer prevention and control: an aging and more

⁵ A New Agenda for Cancer Control Research: Report of the Cancer Control Program Review Group. National Cancer Institute web site. Internet address: http://deainfo.nci.nih.gov/advisory/bsa/bsa_program/bsacentrmin.htm.

diverse population, the revolutions in communications and informatics, the explosion of discovery in molecular biology and genetics, a rich knowledge base in the fundamental sociobehavioral sciences, fundamental changes in the organization of health care delivery, and the need to aggressively diffuse and disseminate what is known about effective interventions into practice and policy. The recommendations of the panel were designed to meet the challenges presented by these trends. The review produced an updated definition of cancer control research: "Cancer control research is the conduct of basic and applied research in the behavioral, social, and population sciences that, independently, or in combination with biomedical approaches, reduces cancer risk, incidence, morbidity, and mortality, and improves quality of life."

The linear stages of the Greenwald-Cullen model (8) had also run their course over the prior 15 years, placing increasing resources and emphasis on the latter phases (IV and V: large, expensive diffusion trials and demonstrations) at the expense of fundamental and more focused research (phases I-III). The Program Review Panel recommended that fundamental scientific research in cancer control needed significant investment to reinvigorate the discovery process and to drive the next generation of applications. A major evolution from the Greenwald-Cullen model (8) into the new framework was to stress the reciprocal "feedback loops" between fundamental and applied science, in particular, from the later stages to the earlier ones, ensuring a constant interplay of fundamental science and applications, each informing the other.

Recommendations from the panel also supported the formation of a United States NCI division focused on the research highlighted by the refined definition. The DCCPS was formed in 1997, in part from the old DCPC, along with the extramural epidemiology program. Several entirely new areas were added as well. The new division recognized the focus on populations and the need to integrate individual biobehavioral and population-public health perspectives, as was being done in tobacco control sciences during the 1990s (14). A sister Division of Cancer Prevention was formed at the same time with programs from DCPC that had a more biomedical orientation (2).

In the formation of DCCPS, Hiatt and Rimer (2) offered a long-term review and update of United States NCI cancer control research that explicitly adopted the 1994 NCIC framework as a point of departure. Consistent with progress seen over the 15 years since the original United States NCI model, the new definition added five important elements: (a) a central role for behavioral and social sciences in combination with epidemiological and health services research as important foundations for cancer control science; (b) recognition that effective cancer control does not always or exclusively occur through biomedical channels; (c) a broadening of key outcomes to include both risk reduction and quality of life, at the individual level and aggregate outcomes, such as indicator measures of health-supporting social and physical environments at the population level (e.g. in school, workplace, neighborhood, health care delivery system, and community); (d) awareness that progress does not always occur in the linear fashion outlined by the Greenwald-Cullen Five Phase Model, but often (i) requires fundamental and applied scientists working together, providing input from other sciences through the creation of transdisciplinary teams (14, 15); and (ii) must allow for a continuing (and nonlinear) reexamination of the underlying knowledge base; and (e) a need to identify research-based interventions that meet standards of evidence, to broker their transfer and widespread dissemination nationwide in partnership with other stakeholders (e.g. the CDC, the ACS, and state and local health depart-

ments), and to measure with "report cards" the fidelity and degree of penetration of these interventions and improve on them over time.

The organization of DCCPS was designed to reflect the nature of cancer control research at the close of the 20th century, and as presented in the adapted 1994 Canadian NCIC framework. Thus, there are major programs in epidemiology and genetics, behavioral (including fundamental biobehavioral research), applied (including outcomes and health services research), surveillance and survivorship research, as well as a unique leadership commitment to dissemination and diffusion activities.

The Hiatt and Rimer (2) paper wove together the many threads of modern cancer control strategy, reflecting the increased appreciation of the importance and integration of the perspectives and languages of a broad range of disciplines and practices, and the introduction of transdisciplinary thinking into cancer control research (14-16). In defining disciplinary integration, the new United States NCI strategy made a distinction between three forms of cross-disciplinary research (17): (a) multidisciplinary; (b) interdisciplinary; and (c) transdisciplinary research. *Multidisciplinarity* refers to a process whereby researchers in different disciplines work independently or sequentially, each from his or her own disciplinary-specific perspective, to address a common problem. *Interdisciplinarity* is a process in which researchers work jointly, but from each of their respective disciplinary perspectives, to address a common problem. *Transdisciplinarity* is a process by which researchers work jointly using a shared conceptual framework that draws together discipline-specific theories into a new synthesis of concepts, methods, measures, and approaches to address a common problem.

The movement toward transdisciplinary science represents the latest evolution of conceptual models for cancer control research. As illustrated in Fig. 2, transdisciplinary domains can range across the levels of complexity (cellular and molecular to individual to interpersonal to organizational/institutional, community and societal). These include the fundamental or basic research disciplines that span biological, psychosocial, and population/public health sciences. Transdisciplinary concepts can also be used to ensure that linkages are strengthened between fundamental and applied sciences (translational clinical and dissemination research). Transdisciplinary strategies can improve the efficiency and impact of applied research (e.g. by enhancing identification of the interaction between individual risk and contextual factors to inform screening and tailoring). Finally, an important and neglected dimension that lends itself to transdisciplinary thinking is time frame, including a lifespan developmental perspective with sensitive periods (e.g. *in utero* exposure to nicotine as an early environmental pathogen that may alter gene expression) and the idea that changes may occur in minutes, days, months, years, or even decades, depending on the problem focus (14, 18).

An early example of this new concept in action is the teams within the Transdisciplinary Tobacco Use Research Centers (19) that foster transdisciplinary activities in a programmatic and planned manner. Understanding tobacco use behavior is ideal for a transdisciplinary approach precisely because it is a complex behavior involving multiple influences, pathways, and interactions over time. It operates from the level of cells and brain reward circuits, which act within seconds of exposure to nicotine, but also is responsive to family and peer group influences, which influence adolescent initiation of smoking during a period of a few years, as well as to exposure to carcinogens in burnt tobacco, which lead to greatly increased

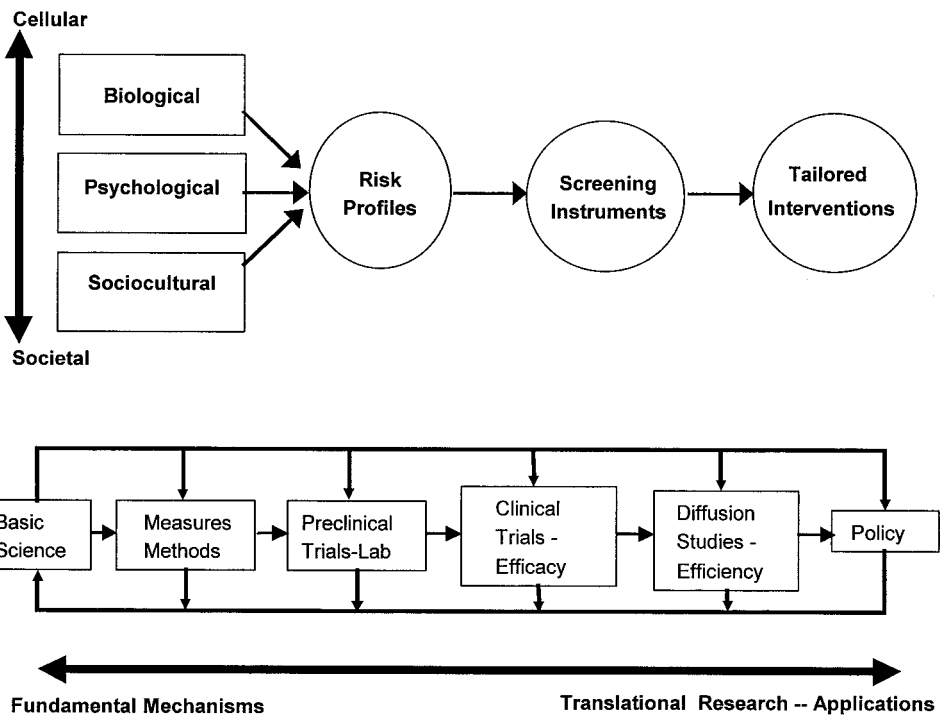


Fig. 2. Domains of transdisciplinary research.¹⁵

rates of lung cancer, and to the macroeconomic and marketing vectors that govern societal uptake and the massive disease burden that plays out over many decades to a century or more (14–16, 20). One example of a transdisciplinary conceptual synthesis is the Koob and Le Moal model of addiction (15) that integrates basic animal research in neuroscience with human experimental and clinical treatment research, thereby including many levels of complexity (cellular to brain circuitry to individual behavior) and translational perspectives in their model. Using such transdisciplinary models of individual differences and gene-environment interaction will better inform pharmacogenomics, improve treatment, and guide policy.

Transdisciplinary research will develop over time, as the basic science evolves and matures in various areas, and provides tools for behavioral and other scientists to use. Thus, with the exception of tobacco control, few examples exist in other domains of cancer control research. However, several areas of cancer control research are multi- and interdisciplinary, such as cancer communications and the interrelated areas of diet, weight, and physical activity research. These and other areas are poised to become additional examples of transdisciplinary cancer control research, following the lead of tobacco control research. Taken together, the three major elements of the transdisciplinary paradigm (cells to society; fundamental to applied; time frame/lifespan development) appear to build on and consolidate many of the previous generations of models of cancer control science both in the United States and Canada. However, this is hardly the last word on the continually evolving process of scientific discovery.

In summary, the Cancer Control Program Review launched the third chapter in the evolution of cancer control research frameworks. Major advances are summarized in Table

1. The chapter was the most significant to date, producing an updated definition of cancer control, important organizational changes with the development of the DCCPS, and conceptual advances including the emphasis on transdisciplinarity and dissemination. Whereas the fourth chapter described in the following section is just beginning, it seems likely to result in equally fundamental organizational and conceptual evolution.

CSCC Model. As the United States NCI and the Canadian NCIC became even more strongly aligned behind a single model of cancer control science, the fourth chapter in this evolution of international cancer control research began. The CSCC was initiated in late 1999 by a consortium of major national and provincial agencies with lead roles in cancer control. The aim was to formulate, adopt, and implement a comprehensive, coherent, integrated strategy to improve cancer control in all of the jurisdictions across Canada. The CSCC emphasized that if cancer control research was to realize the full benefits of its efforts to move research into practice, a sound infrastructure was pivotal. A CSCC Working Group explicitly built on the new United States NCI definition of cancer control to provide a more detailed description of the role for sociobehavioral research: “Sociobehavioural research covers a wide range of research activities, including behavioral epidemiology, development and testing of theoretical models to understand health behavior, prediction of risk-relevant behaviors, research to develop and evaluate interventions, evaluation of multifaceted community interventions, research to analyze and evaluate the impact of policy and other environmental measures, knowledge synthesis and dissemination research. It has many levels of analysis, including individual processes, biobehavioral systems, interpersonal relationships and behavior, organizational practices and macrosocial processes.”

Scanning current research in Canada and future directions for cancer control, the CSCC Working Group reached consensus on several sociobehavioral research priorities, categorizing

¹⁵ Adapted from: Abrams, D. B. Nicotine addiction: Paradigms for research in the 21st century. *Nicotine Tobacco Res.*, 1: S211–S215, 1999.

them in terms of the 1994 framework, which was by then being used by the national programs in both countries. The points of consensus serve to illustrate the value of the evolving framework, highlighting ways in which sociobehavioral research touches on all of the key strategic functions for cancer control research: specifically, fundamental, intervention, and surveillance research.

Fundamental sociobehavioral research was needed to improve understanding of the etiology of tobacco use, especially among adolescents, and how to effectively intervene in the developmental (age-appropriate) and cultural context in which tobacco use evolves. A priority was placed on research on self-management to help people learn and take greater responsibility for evidence-based decision-making in cancer prevention and control.

The Working Group recommended investment in the full continuum of health behavior *interventions*, from hypothesis generation through mediating mechanisms and efficacy and effectiveness studies to dissemination. They saw a major role for sociobehavioral research in fostering of integrative health services, coordination of care, and balancing proven conventional, complementary, and behavioral medicine strategies.

Surveillance and monitoring systems are critical to track and unravel trends not only in cancer incidence and mortality, but also in the contributing health risk behavior, health systems variables, and other important psychosocial factors (e.g., quality of life). The explosion of information technology offered the possibility of sufficiently comprehensive data sets to start modeling the health of populations in ways that integrate biopsychosocial knowledge to: (a) support planning, intervention monitoring, accountability, and research functions; and to (b) permit comparisons across jurisdictions and studies, and between research and practice settings.

Finally, reflecting on these priorities as a whole, the CSCC emphasized that improved theory and research on the practice of dissemination and diffusion need to be part of the foundation for cancer control research. The research to practice and policy cycle needs explicit planning, study, and resources. This requirement is not specific to sociobehavioral research, but it is a particularly critical issue for the application stage of sociobehavioral research. For many of the priorities suggested above, an integrated approach through concurrent fundamental, intervention, and surveillance research will serve the field better than linear approaches that favor investment in isolated areas.

Canadian Cancer Research Strategy. Driven by the CSCC, the major Canadian organizations responsible for funding cancer control research, and translating this research into practice (NCIC, Institute of Cancer Research, and the Canadian Association of Provincial Cancer Agencies) committed themselves to collaborating in the development of a Canadian Cancer Research Strategy. The process being used to develop the research strategy is innovative in several respects: it (a) is coordinated across funding agencies; (b) incorporates the perspective of the treatment system; (c) includes input from the public (through participation of nongovernmental organizations and lay people concerned with cancer); and (d) is informed by the planning of the CSCC. The planning process recognizes the importance of aligning research with practice to achieve impact.

This fourth CSCC chapter in the progression still is being written. However, it is timely to reflect on implications for future initiatives in both countries.

Perspective on the Conceptual Evolution: Pushing the Envelope

The NCIs of the United States and Canada have been working in parallel for many years, enjoying good informal relationships, the creativity of cross-fertilization, and a striking degree of synergy. The convergence in Canadian and United States thinking about cancer control research is striking, although some differences in approach are apparent. This is expected given the inherent differences between the countries in organization, planning, and funding of their respective cancer control research enterprises. Progress in cancer control began to have an impact on overall cancer mortality beginning in the mid-1990s. This can be attributed in large part to sociobehavioral changes and dramatic decreases in tobacco use. Breast cancer mortality began to decline in the United States around 2000, in part due to increased use of mammography, a major focus of cancer control efforts over the last decade. Other specific examples of progress in cancer control activities of the last 25 years have followed in the wake of the conceptual and organizational changes just reviewed (2). However, as we move toward greater synergy between United States and Canada in cancer control research, what kinds of programs and infrastructure will take us into the future . . . the next chapter? To answer this question, we illustrate the importance of this evolution in our shared framework with recent program initiatives from both NCIs.

New Initiatives from Canada and the United States in Cancer Control Research

Canada has emphasized collaboration among research funders and the development of cancer control research capacity, whereas the United States NCI has mounted a range of directed funding initiatives designed to support specific research programs in priority areas and to complement investigator-initiated research. However, the United States NCI increasingly has linked its research activities with those of other partners, such as the ACS, the CDC, and the Robert Wood Johnston Foundation. The shared 1994 framework serves to position initiatives in both countries so that they may be understood as building a shared concept of cancer control research. There are several new directions we wish to highlight.

Fundamental Research. Social Determinants of Cancer. The United States NCI, along with other institutes of the United States NIH, has initiated Centers for Population Health and Health Disparities to stimulate interdisciplinary research in understanding the social, cultural, and environmental factors that influence health.⁶ Psychosocial and behavioral pathways in the context of community-based participatory research are emphasized, and collaborative arrangements for international interchange with the Canadian Institutes of Health Research Institute of Population and Public Health are planned.

Genes and the Environment. The United States NCI is supporting a large consortium of existing epidemiological cohorts to unravel the important interactions of genetic susceptibility and environmental influences on cancer, a national Early Detection Research Network for biomarker development, validation, and clinical resource sites,⁷ and the Cancer Genetics Network,⁸ which shares knowledge, epidemiological data, and

⁶ National Cancer Institute. Population Health Sciences website. Internet address: <http://cancercontrol.cancer.gov/populationhealthcenters/>.

⁷ National Cancer Institute. Early Detection Research Network. Internet address: <http://www3.cancer.gov/prevention/cbrg/edrn/>.

⁸ National Cancer Institute. Cancer Genetics Network. Internet address: <http://epi.grants.cancer.gov/CGN/>.

biospecimens to produce a resource for moving fundamental genetic discoveries into clinical and public health applications. These infrastructures were designed to enable the translation of fundamental discoveries to medical and public health practice, including the behavioral and ethical implications of genetic testing and use of biomarkers, the impact on cancer survivors and their families, and the implications of this evolving area of science to population subgroups defined by race, ethnicity, culture, and social class. However, constant vigilance will be required to assure that translation/dissemination efforts receive adequate resources and accomplish their objectives.

Intervention Research. CTCRI. The 4 year-old CTCRI is a collaboration among a group of Canadian agencies and governments to stimulate a sustained and coordinated tobacco control research agenda that has a direct impact on tobacco control programs and policies. Partner organizations are represented on a governance board, set common strategic direction, and develop and cofund strategic initiatives where there is a research gap and need to stimulate programs likely to have high impact on the research to practice cycle. The first CTCRI funding stream supported team development and feasibility studies for traditional grants, whereas a new program has been launched to increase the volume and quality of policy research.

Tobacco and Tobacco-Related Research. Seven Transdisciplinary Tobacco Use Research Centers, funded by the NCI and the National Institute of Drug Addiction from 1999 to 2004, integrate scientists from a range of disciplines, who work collaboratively, using common theoretical models, to accelerate discovery and develop more effective interventions for tobacco use prevention and cessation.⁹ The NCI intends to continue the initiative. Also, building on what has been learned over the last 20 years, the United States State and Community Tobacco Control Initiative supports research to develop and test interventions as well as to assess the impact of macro-level programs and policies using media, policy, and legislative interventions against tobacco use.¹⁰

Centers of Excellence in Cancer Communications Research. Communications research is an area of heightened emphasis for the United States NCI, following directly from the increasing importance and societal relevance of information technology and also recognition of the role of communication in quality cancer care. Interdisciplinary centers will be the infrastructure for a larger effort to build new cancer control research in this area and will support research on topics that include cancer information seeking, use of new communications technologies for decision making under conditions of uncertainty, understanding how people process information, and how best to translate cancer communications theory and research into practice.¹¹

CBRPE. To link practice with social and behavioral research, CCS and NCIC launched CBRPE. Evaluation of CCS cancer control programs is being built around a set of core indicators that facilitate comparisons across programs, over time, and across jurisdictions; this approach permits field research based on natural experiments, while informing CCS practice decisions. CBRPE has, for example, stimulated development of new funding mechanisms, like the CTCRI, a national Sociobehavioural Cancer Research Network that engages researchers

across Canada, and the development of unique software to support provincial telephone smoking cessation lines.

Surveillance Research. Expansion of Surveillance. The United States NCI expanded its SEER program in 2001 to obtain quality surveillance data on a larger and more demographically diverse portion of the United States population.¹² SEER collaborates with the CDC National Program for Cancer Registries and the North American Association of Central Cancer Registries, in which Canada and the United States are partners, to monitor all populations of both countries with high quality cancer registry data on incidence, treatment, survival, and mortality data. This comprehensive system of population-based cancer registration is an essential tool for cancer control research and programs.

Quality of Cancer Care Research. This broadly based United States initiative seeks to better understand and monitor cancer care delivered across diverse health system settings by identifying core measures of the quality of cancer care and cancer outcomes, fostering empiric research on the relationship of process measures of quality care to important cancer outcomes, like the Cancer Care Outcomes and Surveillance initiative,¹³ incorporating quality outcomes measures into cancer clinical trials and better communications into the care process.

Dissemination and Diffusion. Coordinated Planning for the NCIC and the CCS. Ongoing use of the Fig. 1 conceptual framework has resulted in coordinated planning for performance objectives by the NCIC and CCS, thus ensuring continuity from research to practice. This partnership has given rise to the funding of special initiatives (including the CTCRI, CBRPE, and the Sociobehavioural Cancer Research Network) designed specifically to tighten the connection between research and practice, to achieve cancer control system impact through research.

Comprehensive Cancer Prevention and Control in the United States. The CDC, in collaboration with the ACS and the NCI in the United States, has been advocating and supporting comprehensive and integrated state-based programs to apply evidence-based interventions nationwide (21). This approach is data driven and explicitly based on knowledge and decision-making from cancer control research. The planning framework (21) is designed to help states and national organizations apply cancer data from registries and surveys to describe state and national disease burdens, to evaluate cancer control activities, and to identify populations at high risk for certain cancers. It is now a national goal for every United States state to have a comprehensive cancer control plan by 2003 and the plan implemented by 2005.

TRIO. The United States NCI is developing dissemination activities specifically designed to bring research knowledge and evidence-based interventions to those who practice cancer control. TRIO is comprised of three approaches that work with partners to: (a) use cancer surveillance data to identify needs, track progress, and motivate action; (b) develop tools for accessing, and promoting adoption of, evidence-based cancer control interventions; and (c) support regional and local partnerships to expand capacity and integrate evidence-based approaches into comprehensive cancer control planning and implementation. An example of a TRIO program is a partnership

⁹ National Institutes of Health. Transdisciplinary Tobacco Use Research Centres. Internet address: <http://www.partnersturc.com/>.

¹⁰ National Cancer Institute. State and Community Tobacco Control Initiatives. Internet address: <http://www.cancer.gov/newscenter/tobaccocontrol>.

¹¹ National Cancer Institute. Division of Cancer Control and Population Sciences. Internet address: <http://cancercontrol.cancer.gov/communicationcenters/>.

¹² National Cancer Institute. SEER. Internet address: <http://seer.cancer.gov/about/expansion.html>.

¹³ National Cancer Institute. Cancer Care Outcomes and Surveillance. Internet address: <http://appliedresearch.cancer.gov/areas/quality.html>.

with the ACS, CDC, and the Substance Abuse and Mental Health Services Administration to build the Cancer Control PLANET, a universal web portal designed to help bridge the research discovery to program delivery gap. PLANET will allow access to a series of research/practice partnership tools that are being developed by the sponsoring organizations including: (a) State Cancer Profiles that provide access to behavioral and cancer surveillance data at the state and county level; (b) state and regional cancer control contacts for cancer information and services; (c) the Guide to Community Prevention Services that identify evidence-based effective intervention practices; (d) Research-Tested Intervention Programs that provide easy access to peer-reviewed programs and products for interventions; and (e) guidelines for implementation of comprehensive cancer control programs.¹⁴ However, a greater national commitment of resources and other support will be required to reap the benefits of TRIO.

All of these activities relate directly to the shared cancer control research framework as examples of the application and delivery of new knowledge gained from research. As we move into the next phase of cancer control, there will be a further evolution in our thinking about the worlds of research and practice. There remains, however, a need to develop indicators of the impact of such programs on cancer control practice and, ultimately, on measures of cancer outcomes as we seek to reduce the cancer burden. These and other steps in advancing cancer control science might be taken more swiftly and surely if there were more of a formal collaboration of cancer control sciences between the United States and Canada. We believe that we should be more purposeful in the future, actively seeking ways to interact internationally and collaborate, building on the strengths of the United States and Canadian systems. Thus, we propose that the next chapter be a collaboration between our two countries to create a forum for the exchange of ideas, programmatic information, and results, and for the building of functioning international work groups in all of the domains of cancer control.

Conclusion

We have reviewed the evolution of systematic efforts to frame cancer control research in ways that are meaningful to scientists, funding agencies, cancer control practitioners, and the public who ultimately stand to benefit from such research. This evolution has occurred in four milestones or chapters, which have represented a serial exchange, sometimes unplanned, of ideas between cancer research programs in the United States and Canada. We have tried to make the case that science and practice must be linked more effectively if the investment in cancer control research is to pay off in improved health. The concept and even the definition of cancer control research must evolve in response to the needs of society for programs that are not only evidence-based, but also efficient and cost-effective. Innovative initiatives to tighten the linkage between science and practice are now in place, but there will be additional chapters, and the conclusion remains unwritten. The opportunity now is to build on the myriad activities that have been spawned by these systematic and parallel efforts to learn from each other's successes and failures, and create more international synergy. We can systematically learn from successes (e.g. tobacco control and how it can be applied to other risk factors) and failures address new priority challenges (e.g. health disparities).

We see a clear benefit in creating an international forum

for the systematic advancement of cancer control research and, to this end, urge the cancer control communities of Canada and the United States to initiate closer ties, building on what already is a mutually agreeable framework and a productive record of accomplishment. We challenge the respective NCIs and voluntary health organizations to move now to create the forum. There has never been a better time, and the stakes in a shared vision have never been higher.

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¹⁴ National Cancer Institute. Cancer Control PLANET. Internet address: <http://cancercontrol.cancer.gov/D4D>.