



Exercise in clinical cancer care: a call to action and program development description

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ABSTRACT

A large and convincing body of evidence demonstrates the benefits of exercise for cancer survivors during and after treatment. Based on that literature, more cancer survivors should be offered exercise support and programming. Unfortunately, exercise programs remain an exception rather than the norm in cancer care. Not surprisingly, common barriers to the implementation of exercise programs in oncology include limited resources, expertise, and awareness of benefits on the part of patients and clinicians. To improve the accessibility and cost-effectiveness of cancer exercise programs, one proposed strategy is to combine the resources of hospital and community-based programs with home-based exercise instruction. The present paper highlights current literature regarding exercise programming for cancer survivors, describes the development of an exercise program for cancer patients in Toronto, Canada, and offers experiential insights into the integration of exercise into oncologic care.

KEY WORDS

Exercise program, physical activity, exercise program development, knowledge translation

1. BACKGROUND

Cancer remains a leading cause of death for Canadians of all ages, with incidences increasing since the year 2000, largely because of greater screening in an aging population ^{1,2}. Fortunately, people are living longer after a cancer diagnosis because of earlier cancer detection and advancements in treatment and surveillance ³. However, this situation also means that younger cancer survivors are living longer with the disease and with treatment-related side effects that may significantly compromise health-related quality of life and increase risk for comorbidities and

disability. Chronic side effects of cancer and its treatment include fatigue, anxiety, depression, reduced functional and cognitive capacity, and deleterious changes in body composition ⁴⁻¹³. Exercise has been proposed as an ameliorative intervention for those and a number of other cancer- and treatment-related side effects.

Medical advisory organizations have observed that cancer survivors and their families are lacking the resources and support to adequately address survivorship challenges ¹⁴. To counteract such deficits in cancer care, comprehensive rehabilitation programs aim to help survivors sustain optimal physical, psychosocial, and vocational function ¹⁵. Strong evidence indicates that exercise can positively affect cancer survivorship, and benefits can accrue to even the most frail cancer patients ¹⁶⁻¹⁹. Courneya and Friedenreich ²⁰ proposed a framework that describes the clinical benefits of exercise across 6 phases of the cancer continuum: pre-screening, screening, pre-treatment, treatment, survivorship (post-treatment), and end of life. During treatment, benefits include improved physical functioning, body composition, immune and cardiopulmonary system functioning, appetite, sleep, and health-related quality of life ²¹⁻²³. Many of the same benefits extend into the post-treatment phase ^{21,22}. Beyond the positive impact on side effects, post-treatment exercise has also been associated with a survival advantage in breast ²⁴, colorectal ²⁵, and prostate cancer ²⁶. Given this strong and growing body of evidence, it is clear that exercise should become a mainstay of cancer care ^{15,27-29}. It is also clear that cancer survivors are interested and willing to participate in cancer exercise programs, with reported survivor preferences for exercise interventions in many cancers ³⁰⁻⁴⁴. Furthermore, the motivation of patients to follow cancer exercise programs has been explained by their belief that exercise may improve the course of their cancer, which ultimately contributes to increased demand for such programs ^{42,43,45,46}.

Responding to overwhelming scientific literature that describes the benefits of exercise for cancer survivors, evidence-based exercise guidelines were created for cancer prevention and for the treatment and post-treatment periods^{47–49}. To implement those guidelines, clinical and academic organizations developed certification courses to train exercise professionals in the safe and effective training of cancer survivors (for example, <http://www.unco.edu/rmcric/>, <http://certification.acsm.org/acsm-cancer-exercise-trainer>). Unfortunately, the aggregate effect of clinical guidelines, qualified personnel, and research about the demands and preferences of cancer survivors for exercise programming has not been sufficient to yield widespread implementation. Thus, there appears to be a gap in translating knowledge about exercise and cancer research into practice in tertiary-care centres, and subsequently, lost patient benefit.

The slow maturation process from exercise research to clinically integrated cancer programming is similar to that experienced in cardiac rehabilitation. Despite initial resistance to the integration of exercise into coronary intervention, compelling evidence about the benefits of early postoperative exercise and the detriment of physical inactivity stimulated a paradigm shift in cardiac care⁵⁰. An exercise-oriented approach to cardiac rehabilitation was implemented in the 1960s and has since become essential to post-treatment care^{50–53}. Accordingly, cardiac rehabilitation specialists are now important allied health professionals in this field. A half century later, cancer exercise researchers and clinicians have compiled a body of empirical evidence and experience comparable to that achieved by the cardiac group and are now at the cusp of an integrated model. However, challenges to knowledge translation in this field persist and require strategic approaches to ensure that the benefits of exercise are more widely available to cancer survivors. Reasons for poor knowledge translation include

- an impression among clinicians that exercise may increase the risk of injury, fatigue, and exacerbation of symptoms in the patient^{54–56}.
- overwhelmed and financially drained clinical programs.
- physical space restrictions.
- overall lack of clinicians with relevant exercise and clinical education and experience.
- lack of discussion between patient and physician about exercise⁵⁷.

Despite obstacles to implementation, evidence from more than eighty controlled exercise trials demonstrates that the oncologic community must strive to include exercise in cancer care. The question of a benefit of exercise for cancer patients no longer predominates the literature; researchers are now examining the most beneficial types and delivery methods of

exercise interventions (for example, Segal *et al.* and Newton *et al.*^{58,59}). At this stage of empirical maturity, it is the responsibility of oncology programs to start delivering exercise programming for cancer patients. In the sections that follow, we describe our exercise intervention and integration strategy, and we offer insights about the facilitators and barriers to exercise program implementation within oncology.

2. IMPLEMENTATION OF THE SURVIVORSHIP EXERCISE PROGRAM

2.1 Guiding Principles

The mandate of the Survivorship Exercise Program (SEP) is to improve the physical and psychosocial well-being of cancer survivors during and after cancer treatment through structured exercise. Linked with that mandate is the advancement of cancer and exercise research by systematic collection and analysis of participant outcomes, allowing for the most efficient use of clinical and research resources in the service of patient care. Finally, the program seeks to increase the number of experienced and qualified exercise physiologists and clinical researchers within exercise and cancer by providing meaningful learning opportunities to students interested in exercise and oncology.

2.2 Personnel and Staffing

The SEP is a multidisciplinary program that includes exercise physiologists, physicians, clinical psychologists, researchers, nurses, and student interns. The organizational structure starts with a medical director who oversees the health of the patients and a program director who manages the clinical and research agendas. Exercise programming is provided by certified exercise physiologists with oncology-specific education and training—a preference identified by many patients^{31,40,41,43,44,54}. At the core of program development, research staff contribute expertise in developing novel approaches to the delivery of exercise and maintenance interventions, undertake data entry and statistical analyses, and assist with grant application and manuscript preparation. Undergraduate and graduate student interns, typically from the kinesiology, physical education, and medical faculties, assist with various program and research priorities.

2.3 Facility

The SEP is situated in a comprehensive cancer treatment and research centre in downtown Toronto, Ontario, Canada. The advantages of a downtown location are proximity to public transit and physical connection to the oncology clinics in which many patients receive care. Those factors are particularly

useful for physician awareness of the SEP and program referral, acknowledging physician support as a key predictor of exercise program participation and adherence^{60,61}. The SEP operates out of a single 3×5-m office that is used to conduct fitness assessments, physical activity appraisals, and consultations. The office contains the essential equipment for cardiovascular and musculoskeletal fitness testing (for example, treadmill, heart rate monitors, oxygen saturation monitors, dynamometer, and flexibility testing apparatus) and body composition assessment (for example, scale, stadiometer, and skinfold calliper). The office is adjacent to inpatient care areas equipped with emergency medical equipment and response team access. Exercise instruction and demonstration, and group exercise classes of 10–12 participants are held in an exercise room in an affiliated on-site cancer survivorship program (<http://www.ellicsr.ca/>) in a 50-m² exercise space.

Consultation and weekly group exercise sessions are held at the hospital, but the SEP functions primarily as a home-based exercise program. Encouraging home-based exercise is an effective and economic alternative to facility-based training, significantly reducing the requirements and costs for exercise staffing, facility, and equipment⁶². Moreover, the convenience of exercise has been the root of preference on the part of many cancer survivors for home-based exercise^{34,35,41–43}. Because concerns about patient adherence to home-based exercise prescription in the absence of direct supervision are valid, the SEP has implemented adherence-boosting strategies that are further discussed later in this article.

2.4 Institutional Support and Funding

Collegial support from the medical and patient support and education departments has been vital to the initiation, maintenance, and advancement of the SEP. To facilitate that support, staff must be educated about the benefits of exercise and informed of new services that will support clinical care and improve the experience and health outcomes of cancer patients. The SEP generated institutional support through interprofessional workshops and presentations at clinical rounds and departmental meetings.

Partial funding for the SEP is provided by the hospital foundation and by fundraising initiatives that have financed basic overhead costs and pilot research projects. Pilot data from a small study funded by the hospital foundation formed the basis for national and international peer-reviewed research grant submissions. A cost-recovery model was also implemented to cover ongoing expenses associated with program delivery. The cost-recovery model includes donations from participants. The participants have generously supported the SEP and have viewed the donation as nominal compared with the equipment (exercise bands, a stability ball, and a yoga mat) and services

received in the SEP. It should be noted that participants are not obligated to contribute any money and that they receive the exercise program and associated materials regardless of their donations.

2.5 Referrals and Assessments

The SEP accepts ambulatory cancer patients undergoing any type of treatment. Participants may be self-referred or referred by in-house allied health professionals, attending physicians, and community affiliates. Community affiliates and external physicians that refer patients to the SEP are required to submit a standard SEP referral form and the Physical Activity Readiness—Medical Examination form (available for download at <http://www.csep.ca/english/view.asp?x=698>). This form is a 4-page checklist-style medical screening form completed by patients and their physicians that conveys clearance for physical activity. Upon referral, each participant is screened by the exercise physiologist or the medical director, or both. During the screening, a participant interview and detailed chart review are used to determine eligibility based on general and oncology-specific contraindications to exercise⁶³.

Participants complete standardized assessments at program entry, and at 12, 24, and 48 weeks. Each assessment is conducted by the exercise physiologist and includes measurements consistently utilized in current literature and those recommended by active cancer exercise programs^{28,29}. See Table 1 for a summary of the physical measures. For specific research projects, serum may be collected and stored for biomarker analysis. Physical assessments are complemented by cancer-specific measures of fatigue⁷⁸ and health-related quality of life⁷⁹.

2.6 Program Components

Participants are offered a variety of exercise-related services depending on their needs assessment and interests. Participants can receive a consultation to discuss integration of exercise into their daily routine, including a discussion of basic physical activity and exercise principles. For participants who prefer more structured exercise, an individualized exercise prescription may be provided. The exercise prescriptions are based on the participant's fitness assessment and are accompanied by an exercise manual that details the aerobic or resistance exercises (with variations for beginner, intermediate, and advanced exercisers to allow for progression within the program) and an exercise log. Participants are encouraged to follow their exercise program at home, and they are provided with the exercise equipment described earlier. Participants may also attend weekly 90-minute group exercise classes that include a 10-minute warm-up, 20 minutes of low-impact aerobic exercise, 20 minutes of resistance training, and 10 minutes of cool-down,

TABLE 1 Summary of a standard physical fitness assessment

<i>Component</i>	<i>Description</i>	<i>Rationale</i>
Aerobic capacity	Cardiovascular fitness is assessed using the modified Bruce treadmill protocol ^{64,65} . Participants walk at progressively higher speed and incline until they can no longer continue. Peak volume (VO ₂) is estimated using standard American College of Sports Medicine (ACSM) metabolic equations ⁶⁶ . The ACSM Termination Criteria are used to discontinue tests before a participant reached maximum exertion ⁶⁶ .	Cardiovascular fitness assessment provides important information about the participant's functional capacity and exercise prescription parameters. The modified Bruce treadmill protocol was selected because it uses a prolonged warm-up and walking (rather than running) combined with increases in grade (incline) to bring participants to maximum intensity and because it is used frequently in cancer populations ²⁹
Grip strength	Grip strength is measured using a Jamar dynamometer (Sammons Preston, Bolingbrook, IL, U.S.A.) according to the Canadian Society for Exercise Physiology protocol ⁶⁷ . The dynamometer is held laterally away from the body and maximally squeezed for 3–5 s.	Grip strength is an independent predictor of mortality in older adults and may identify patients, including those with a high level of function, who are at risk of deteriorating health ^{68,69} . Grip strength has frequently been used as a measure of physical function in cancer patients ^{70–73} .
Height, weight, body mass index (BMI) waist circumference and skinfold measurements	Height is measured to the nearest half centimeter using a wall-mounted stadiometer. Weight is measured to the nearest 0.5 kg using an analog scale. The calculation for BMI is weight in kilograms divided by height in square metres. Waist circumference is measured using anthropometric tape according to protocols defined by the World Health Organization (tape placed horizontally mid-way between the bottom of the rib cage and the iliac crest ⁶⁴). Measurements are taken to the nearest 0.5 cm. Skinfolts are assessed using skinfold calipers (FitSystems, Calgary, AB) at various sites (sex-specific) and are used to calculate body density and body fat percentage.	Body composition changes are highly prevalent in patients receiving treatment and are associated with poor prognosis ^{74,75} . Beneficial augmentation of body composition with exercise has been demonstrated in cancer populations ^{70,71,76,77} .
Resting heart rate, Resting blood pressure	Resting heart rate is taken before any other physical fitness tests and is measured by palpation or heart rate monitor (FS2 Heart Rate Monitor: Polar Electro, Kempele, Finland). Blood pressure is assessed manually using a stethoscope and sphygmomanometer.	Assessing resting heart rate and blood pressure provides an opportunity to screen for cardiovascular abnormalities such as frank arrhythmias (including tachycardia or bradycardia) and hypo- or hypertensive responses before more extensive fitness testing.

followed by 30 minutes of class discussion based on Booster Sessions designed by Culos–Reed *et al.*^{70,71}.

Adherence to exercise is critical for the maintenance of benefit. Previous studies have shown that discontinuing exercise results in a return of cancer and treatment-related side effects^{70,80}. The SEP uses several features to promote compliance to the exercise prescription and long-term adherence. First, the training staff regularly communicates with participants (by telephone or e-mail) to address any specific barriers to exercise. Second, in addition to the home-based exercise equipment, participants are provided with an exercise manual that reinforces specific strategies for chronic behaviour change, including goal-setting, identification of facilitators and barriers to exercise, exercise preference lists, and detailed exercise instruction with pictures. Previous studies have shown that tailored print materials are effective in increasing exercise motivation in various cancer groups⁸¹. Third, home-based exercise is supported by weekly group-based exercise classes

to encourage social support. Fourth, participants may consult with clinical psychologists and cognitive behavioural therapists who specialize in healthy behaviour change to address cognitive or emotional barriers to routine exercise. Finally, educational seminars on physical activity for cancer survivors are offered on a monthly basis to improve the understanding of the benefits of an active lifestyle. The foregoing program components accommodate the identified preferences of cancer survivors for access to a multifaceted approach to exercise, including flexibility in structure, social support, print educational material, home-based exercise equipment and instruction, and routine follow-up from the cancer exercise specialists^{28,29,31,32,34,37,40–44,82}.

2.7 Research

Research—through hypothesis generation and testing, and the provision of pilot data for research funding opportunities—is the driving force behind

the SEP. Data from each assessment are collected and stored for longitudinal analyses. The intake of patients with a range of cancer diagnoses and treatments means that populations can be stratified into subgroups that allow for population- or treatment-specific research. Moreover, the exercise assessment facility is comparable to those available in other cancer exercise research programs and can therefore function as a participating site in large, multicentre trials. Finally, the multidisciplinary nature of the program is conducive to examining outcomes from basic science to the behavioural and psychosocial implications of exercise throughout the cancer continuum.

2.8 Community Partners

Hospitals are a rich source of patients as well as of medical and research expertise, but they often lack the physical space, exercise equipment, and access to exercise specialists to deliver routine programming for cancer patients. By contrast, community-based survivorship programs often have greater geographic accessibility and more physical space, and they may even have access to qualified cancer exercise specialists, but they often lack the research capabilities and direct affiliations with physicians and patients. Thus, collaborations between hospital-based and community-based programs may offer an ideal opportunity for patients to transition into independent exercise. For example, a participant may receive an exercise consultation and fitness evaluation at the SEP, transition to a community-based program for supervised exercise, and finally transition to home-based exercise.

The Wellspring Cancer Exercise Program (<http://www.wellspring.ca/Centre-of-Innovation/Centre-of-Innovation-Programs/Cancer-Exercise.aspx>) is an example of a community-based cancer exercise program that may function in an intermediary role. Wellspring uses a multidisciplinary rehabilitative approach led by physiotherapists and kinesiologists to provide a comprehensive exercise training program that is complemented, when needed, with manual therapy and assisted rehabilitation and education. Participants are assessed and receive an individualized, supervised exercise program that typically includes interval training, resistance training, stretching and balance exercises, twice weekly for 10 weeks, followed by once weekly for 20 weeks. Wellspring's Cancer Exercise Program is free to access, and participants are graduated to home-based training after safe levels of exercise education and fitness are reached.

3. DISCUSSION

Evidence demonstrating the benefits of exercise for cancer survivors has reached a pivotal point. At this time in empirical maturity, a more concerted effort

toward knowledge translation in this field needs to be made by clinicians, health care administrations, and health policymakers. Although clinical trials examining exercise and cancer patients are abundant, theory-based knowledge translation strategies for the integration of exercise into oncologic care remain noticeably absent in the literature and should advance in priority for researchers. Furthermore, few approaches to implementing cancer rehabilitation programs have been published (for example, Segal *et al.*, Schneider *et al.*, Demark-Wahnefried, Grabois, and Schmidt^{28,29,82–84}).

In the absence of extensive evidence for successful knowledge translation, simple strategies may assist in accelerating the availability of cancer exercise programs. First, oncologists and patients must be made aware of the extensive empirical evidence regarding the efficacy and safety of exercise during and after cancer treatment. National organizations that provide research overviews and exercise recommendations (for example, the American Cancer Society⁴⁹ and the National Comprehensive Cancer Network⁸⁵) can facilitate an awareness of benefits and joint discussion during clinical interaction. Joint discussion and oncologist recommendation are critical to patient participation in cancer exercise programs and ongoing physical activity⁶⁰. Although the trend appears to be changing, few physicians capitalize on their motivational influence with respect to lifestyle intervention guidance, emphasizing the continual need for physician education regarding the benefits of exercise for their cancer patients^{54,57,86}. Second, oncology programs must intensify their pursuit of funding to develop, implement, and maintain cancer exercise programs. Financial support may come from the government (in jurisdictions in which health care is publicly funded), national granting agencies, insurance companies, private donors, or corporate sponsors. Through successful grant applications, small amounts of research funding may be acquired for feasibility studies, followed by larger grants to support adequately powered randomized controlled trials. This approach will not only improve the body of evidence in cancer and exercise, but finance the capital equipment costs and generate institutional support for sustained cancer exercise programming. Third, partnership with private and community health-and-fitness clubs may be an option to provide facility space, exercise equipment, and in-kind professional support. Moreover, community survivorship or fitness clubs remove the barrier of distance and travel time associated with tertiary care centres, a known barrier to participation in physical activity⁸⁷.

The SEP represents one oncology institution's attempt at bridging the gap between cancer exercise research and clinical practice by making exercise assessment, prescription, and education a part of standard care. The SEP has several strengths to highlight. The SEP program is delivered by certified exercise

physiologists, with cancer-specific training, under the guidance of oncologists and psychologists. Accordingly, the SEP is well-suited to accommodate survivors coming from a variety of cancer diagnoses and treatment histories with various physical and psychosocial considerations. To facilitate participation, prescription compliance, and chronic behaviour change, the SEP provides a comprehensive adherence maintenance program. Included in that program is the provision of a detailed exercise manual and exercise equipment for participants to do their exercises at home. This approach is sustainable with even nominal contributions from participants to cover the basic costs of the materials. Additionally, group exercise sessions encourage social support and opportunities for patients to discuss various barriers and facilitators in a welcoming environment. Finally, community partners provide an outlet for SEP participants to exercise with additional support and fewer geographic and financial barriers. The transitional approach from hospital to community and ultimately to independent home-based exercise, is likely to promote chronic exercise and accommodate a variety of exercise preferences.

The SEP also has several limitations. It is limited by a lack of in-hospital physical space and funding to conduct highly specialized fitness testing and training. The location of the SEP (within an urban, oncologic institution) may be perceived as a strength in some ways (as noted earlier), but it can also be a barrier to participation. Anecdotal evidence from our experience echoes previous reports suggesting that some patients prefer not to come to the hospital to exercise because of negative associations formed with the hospital setting (for example, testing, diagnosis, treatments, and so on)⁸². Furthermore, the urban location presents commuting challenges: parking can be expensive, road congestion can increase travel time, and public transit can be intimidating. The SEP is also ill-equipped to assist patients who are available only outside of regular business hours.

Many lessons have been learned in our pursuit of an integrated model of exercise and cancer care. The primary lesson learned is that it is essential to have the collegial support and commitment of oncologists to drive the development of this type of survivorship programming. The SEP has benefitted from significant personal and professional investment by several oncologists and nurses—investments have lent gravity to the program within the administration. Equally important is the commitment of the exercise specialists to ensure that the delivery of the program is safe, effective, and enjoyable for the participants. The voice of the participants has proved to be the most effective marketing tool for the SEP; positive reviews of the program have driven program growth. We have also found that survivors are more likely to be referred to the SEP after diagnosis or when initiating primary or adjuvant treatments. That finding is consistent with previous reports of the response

by cancer survivors to the “teachable moment” and their preference to start a lifestyle intervention after a diagnosis or shortly thereafter^{54,88}.

Inevitably, the literature will grow, yielding new understandings of the benefits and risks of exercise for cancer patients. It is also important to review the cancer survivor’s perspective of participating in cancer exercise programs to ensure that their needs are adequately addressed. Program evaluation may use efficacy metrics (that is, assessing changes in cancer-specific outcomes associated with exercise) or client satisfaction and participation assessments. Ideally, outcomes are examined concurrently in a way in which participants in randomized trials are also assessed for satisfaction, adverse events, and attendance or adherence. Participant satisfaction questionnaires could be accompanied by qualitative assessment to provide deeper insight regarding satisfaction and program preferences that have not previously been captured.

Ultimately, research in this field must extend beyond efficacy trials, addressing questions pertaining to effective and efficient intervention delivery models, strategies to boost exercise adherence, and systematic knowledge translation approaches at the institutional and health policy levels. Finally, a key research area that would stimulate health care investment would be strong evidence of cost-effectiveness of cancer exercise programs. Although research has demonstrated survival benefits for cancer survivors with exercise^{24–26}, no evidence has, to our knowledge, described the cost savings that may result from reduced hospitalizations, treatment complication rates, or overall health care utilization. Assessing the potential savings associated with the improved health of cancer survivors will likely be key to establishing consistent implementation of cancer exercise programs.

4. CONCLUSIONS

Amid their acclaim as centres of excellence in oncology, many tertiary care institutions fail to adopt cancer exercise programming, which has proved to provide substantial benefit to cancer survivors. The barriers to implementation are numerous, but we urge the medical and research community to continue with high-quality cancer exercise research in the areas identified in this article and to forge ahead with the development and advancement of cancer rehabilitation and survivorship programs that incorporate exercise as a standard of care. The SEP is merely one example of an approach to integrating exercise. Future publications on implementation approaches are required.

5. ACKNOWLEDGMENTS

The authors acknowledge the generous contributions of time, expertise, resources, and support from the

following individuals and programs: Jack and Anne Weinbaum and Family, Mr. Lloyd Hudson, Prostate Cancer Canada Network (formerly Man-to-Man), the nurses of the Prostate Centre at Princess Margaret Hospital, The Electronic Living Laboratory for Interdisciplinary Cancer Survivorship Research, Karla Fisher–Schlombs, Sara O’Neill, Ashley Kornblum, Meysam Pirbaglou, Shalini Moonsammy, Helga Stein, Kristen L. Currie, Michael E. Nesbitt, Holly Bradley, Dr. George Tomlinson, Dr. Sara Urowitz, Dr. David Wiljer, Dr. Jennifer Jones, Dr. Pamela Catton, Dr. Neil Fleshner, and Dr. Michael Connor.

6. CONFLICT OF INTEREST DISCLOSURES

The authors have no competing interests or conflicts of interests to declare.

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