HHS Public Access

Author manuscript

PM R. Author manuscript; available in PMC 2018 September 01.

Published in final edited form as:

PM R. 2017 September ; 9(9 Suppl 2): S415–S428. doi:10.1016/j.pmrj.2017.08.403.

A Focused Review of Safety Considerations in Cancer Rehabilitation

Susan Maltser, DO[1], **Adrian Cristian, MD, MHCM**[2], **Julie K. Silver, MD**[3], **G. Stephen Morris, PT, PhD**[4], and **Nicole L. Stout, DPT, FAPTA**[5]

[1]Department of Physical Medicine and Rehabilitation, Hofstra Northwell School of Medicine; Long Island Jewish Medical Center, Manhasset, New York [2]Department of Rehabilitation Medicine, Northwell-Glen Cove Hospital, Glen Cove, New York [3]Department of Physical Medicine and Rehabilitation, Harvard Medical School; Spaulding Rehabilitation Hospital, Massachusetts General Hospital; and Brigham and Women's Hospital [4]Department of Physical Therapy, Wingate University, Wingate, NC [5]National Institutes of Health, Clinical Center, Rehabilitation Medicine Department, Bethesda, Maryland

Abstract

Cancer and its treatments introduce various adverse effects that may impact survivors' physical, cognitive and psychological functioning. Frequently both tolerance to activity and exercise are affected as well. Rehabilitation providers should have substantive knowledge about the effect of cancer progression and common side effects associated with anti-neoplastic treatment to safely integrate rehabilitation interventions. Rehabilitation may mitigate loss of function and disability; however, these patients are among the most medically complex that providers treat. This report provides a focused review that synthesizes the current evidence regarding disease progression and oncology-directed treatment side effects within the context of safety considerations for rehabilitation interventions throughout the continuum of cancer care. Descriptive information regarding the evidence for precautions and contraindications is provided so that rehabilitation providers can promote a safe plan of rehabilitation care. It is incumbent upon but also challenging for rehabilitation providers to stay up to date on the many advances in cancer treatment, and there are many gaps in the literature regarding safety issues. Although further research is needed to inform care, this review provides clinicians with a framework to assess patients with the goal of safely initiating rehabilitation interventions.

Corresponding Author: Nicole L. Stout DPT, CLT-LANA Office of Strategic Research Department of Rehabilitation Medicine Clinical Center National Institutes of Health MSC 1604 10 Center Drive Bethesda, Maryland 20892-1604 Nicole.stout@nih.gov (301) 443-9071 (VM) (215) 668-4361 (mobile).

Disclaimer:

The opinions expressed in this article are the authors' own and do not reflect the view of the National Institutes of Health, the Department of Health and Human Services, or the United States government.

Keywords

safety; rehabilitation; prehabilitation; safety; physical therapy; cancer; exercise

Introduction

Cancer and oncology-directed treatments introduce a variety of side effects that can adversely impact multiple body systems during and after disease treatment. [1] Each disease treatment modality (e.g., surgery, chemotherapy, radiation) may individually or collectively introduce risk for a host of potential safety issues. Additionally, a complex array of biopsychosocial factors such as an individual's pre-existing comorbidities, polypharmacy, and other lifestyle factors also impact and amplify risk for adverse side effects during treatment.

It is incumbent upon rehabilitation providers to be knowledgeable about safety issues related to the disease or progression of the cancer as well as side effects and serious adverse events associated with antineoplastic therapies that may impact care. Early identification and management of emerging adverse events may impact morbidity and survival.[2] The purpose of this report is to provide a focused narrative review of the current literature regarding safety with rehabilitation interventions for individuals with cancer with consideration for the disease process, side effects of disease treatment and associated precautions and contraindications.

Pre-treatment risk assessment

Pre-treatment risk assessment helps to identify potential safety problems and establish a patient's baseline physical and functional status. Understanding the disease and treatment trajectory provides an opportunity to assess the potential risk for problems that may impact rehabilitation interventions. Prior to initiating antineoplastic therapies, an extensive medical work up is undertaken to diagnose, stage, and determine a treatment plan for the disease. Baseline imaging, laboratory, and other testing provides insight to various markers and system functions. In addition to a comprehensive medical history to identify existing co-morbidities and medication regimens, assessing functional measures is important in predicting mortality, disease free survival and prognosticating functional decline. An ideal construct for rehabilitation professionals is to obtain a comprehensive functional assessment prior to the initiation of any cancer-directed intervention as this may optimize performance outcomes during and after treatment[3] and will help identify early functional status decline.[4]

Various models of pretreatment assessment and planning have been investigated and typically involve an interdisciplinary team-based approach. These include the prospective surveillance model, multi-modal prehabilitation, enhance peri-operative surgical recovery programs.[5]

Safety Considerations with Anti-Neoplastic Treatment Adverse Effects

During active oncology-directed treatment, various modalities are sequentially and sometimes concurrently delivered. Rehabilitation providers must be aware of post-surgical precautions and contraindications regarding movement and activity restrictions so that a plan of care can be developed that facilitates tissue healing, prevents restrictions in function, and optimizes functional status. These precautions however should be balanced with evidence-based mobilization and post-operative activity recommendations and informed by surgical precautions and guidance. Mobility and exercise participation in the acute post-operative stage of treatment may reduce the risk of adverse events,[6,7] impact overall length of stay,[8] and reduce readmissions and complications in various cancer populations.[6,9]

Chemotherapeutic interventions typically include multi-drug therapies administered cyclically over a standardized period of time. Chemotherapy side effects contribute to multi-system dysfunction and have considerable influence on the safe administration of a rehabilitation plan of care. Table 1 identifies common chemotherapy, immunotherapy, and hormonal drugs and side effects[i] that may be particularly relevant to rehabilitation specialists.

Hematological Compromise

Myelosuppression is a common side effect associated with nearly all chemotherapy and immunosuppressive agents, particularly corticosteroids, and thus present significant implications for rehabilitation interventions. Hematologic compromise can result in cytopenias which increase risk for infection, compromise metabolic function, and alter physiological responses to exercise in severe circumstances. Table 2 provides an overview of laboratory values and safety thresholds for consideration by the rehabilitation provider.

The cancer population, as a cohort, has a higher rate of transfer to acute care hospital during inpatient rehabilitation and it is important to identify the risk factors for transfer.[10] In a study by Guo et al of 98 individuals with cancer undergoing inpatient rehabilitation, hemoglobin levels, absolute neutrophil and platelet counts at the time of admission were not associated with acute care transfers.[11] In another study by Fu et al, 143 lymphoma patients undergoing inpatient rehabilitation, male gender, creatinine > 1.3, and hematopoietic stem cell transplantation were associated with higher rate of transfer to acute service hospitals.[12]

Anemia is a frequent complication of cancer and cancer treatment including chemotherapy and radiation.[13] Worsening anemia reduces exercise tolerance and endurance leading to symptoms of fatigue, dizziness and hemodynamic instability.[14] While aerobic capacity is improved with higher hemoglobin levels, it is unclear whether there is a level of hemoglobin below which functional outcomes are compromised.[14] Precaution should be used in prescribing progressive resistive and moderate to high intensity aerobic exercise in individuals with severe anemia (hemoglobin ≤8 g/dL).[15,16] Low intensity exercise may be beneficial to promoting improvements in blood counts. Rehabilitation professionals should

[i] www.cancer.gov

monitor hemodynamic, functional, and exertional status as well as patient symptoms such as chest pain, lightheadedness, and inappropriate dyspnea.[17]

Thrombocytopenia occurs with myelosuppression therapies and impacts the red blood cell counts. Individuals with platelet counts below 10,000 k cells/uL are at significant risk for spontaneous hemorrhage and as per current guidelines will receive prophylactic transfusions.[18] Those with counts below 20,000 k cells/uL are at increased risk and special consideration for rehabilitation intervention should be considered, generally activity is restricted to walking and activities of daily living.[19] Individuals with counts >20,000 k cells/uL can complete light exercise with close symptom monitoring. In general, this includes maintaining blood pressures below 170/100 mmHg and screening the patient for symptoms of bleeding including bruising and bleeding around the gums.[20] Those with counts > 30,000 k cells/uL can engage in moderate exercise and light resistive exercise within tolerance.[19]

Chemotherapy induced neutropenia (absolute neutrophil count less than 500 mc/L) typically occurs 3–7 days following administration of chemotherapy at. Neutropenia predisposes patients to infection. Typical signs and symptoms of infection are often absent in neutropenia, and fever remains the earliest sign of occult infection. Primary sites of infection are the GI tract, sinuses, lungs and skin.[21] Clinicians should practice hand hygiene with antimicrobial soap during every patient encounter. The use of barrier precautions such as gowns, gloves and masks are usually unnecessary, as patients are more likely to get infected with their own flora.[22] The Centers for Disease Control guidelines advise against barrier protection except when “the risk of infection from healthcare providers is excessive”.[23] There is no compelling evidence that rehabilitation interventions are contraindicated due to neutropenia, but special consideration should be given to individuals experiencing side effects such as fatigue, malaise, dizziness or lethargy and rehabilitation therapy should be self-limited based on the patients preferences.[16] Further consideration is warranted to prevent infection by reducing exposure to potential pathogens such as those found in public therapy spaces.[24] Neutropenic infections are a major cause of morbidity and mortality in individuals undergoing cancer treatment.[21] Common infections include sepsis, cellulitis, pneumonia, urinary tract infections and colitis.[25,26] Rehabilitation providers should closely monitor at-risk patients for early signs and symptoms of infection so that medical management can be expedited when needed.[27]

Hematological considerations are particularly important in patients undergoing Bone Marrow Transplantation (BMT). Pre-transplant induction treatment involves high dose chemotherapy, frequently with concurrent irradiation. BMT is typically undertaken after traditional antineoplastic therapies have failed to put an individual into remission. These patients are cytopenic at the time of transplant and remain so for weeks afterwards. There is additional concern as these individuals have a history of antineoplastic therapies that can result in other adverse effects such as neurotoxicities impacting peripheral nerve function, myopathy due to chronic corticosteroids use, prolonged immobility, nutrition deficits, and cognitive dysfunction.[28] Given the substantial need for rehabilitation services in this population, it is imperative to provide safe rehabilitation interventions. Dimeo et al suggest that exercise not only mediates better physical performance at discharge in this population,

but a shorter duration of anemia, neutropenia, thrombocytopenia and length of hospitalization.[29]

Cardiopulmonary Toxicity

Malignant tumors are more likely to involve the lungs than the heart—either as primary or metastatic disease. In advanced cancer, there may be significant compromise of pulmonary function due to metastatic disease. Individuals with advanced cancer may have cachexia with severe muscle wasting that may affect cardiac function as well ("cardiac cachexia"). Antineoplastic therapies such as chemotherapy and immunotherapy drugs, as well as radiation therapy to the chest wall, can impact cardiac and pulmonary function both during and after cancer-directed treatments.[30] Once of the most commonly used chemotherapy drug classes, anthracyclines, may have significant and irreversible impact on cardiac function, primarily resulting in reduce left ventricular function. Over time, this reduces overall ejection fraction and compromises long term cardiac function. Trastuzumab is a targeted drug that is frequently used in breast and other cancers and has well known potential for cardiac toxicity. The implications manifest in symptoms of systemic edema, shortness of breath, dyspnea, and lung congestion in severe cases. Bleomycin and methotrexate are agents that commonly lead to pulmonary compromise including pulmonary inflammation and fibrosis.

Exposure of the chest wall to radiation has the potential to adversely impact both cardiac and pulmonary function and may be progressive over time. Individuals receiving > 30 – 35 Gy exposure to the chest wall are at risk for radiation-associated heart damage.[30] These dose levels are typically eclipsed with standard breast, lung, and various Hodgkin's treatments, elevating the risk in these populations. Radiation-related changes include structural damage to the myocardium, coronary arteries, valves, and the conduction system. These complications often lead to diastolic dysfunction and blood flow abnormalities. Cardiac changes typically manifest clinically at least 6 to 12 months following radiation, necessitating awareness and monitoring for symptoms of cardiovascular and pulmonary dysfunction. The impact on cardiac function however, can be identified even 20 years following the completion of radiation therapy, impacting long term morbidity and function.[31]

Vital sign monitoring throughout the duration of cancer-directed treatments is recommended. A baseline echocardiogram is usually obtained in individuals undergoing cardiotoxic chemotherapeutic regimens and may be repeated at various stages of treatment or post-treatment. Low intensity exercise, administered during chemotherapy cycles, may be protective against anthracycline-induced cardiotoxicity[32] but recommendations regarding timing, frequency, intensity, and mode of exercise are lacking.[33] When prescribing exercise interventions for this population, risk factors such as dose scheduling, prior cardiac comorbidities and baseline vital signs should be considered. Edema monitoring is necessary to observe and differentially diagnose cardiopulmonary edema symptoms from the onset of lymphedema.

Late effects of cardiovascular compromise are especially prominent and warrant consideration in adult survivors of childhood and adolescent cancers. The deleterious impact

on cardiac function is prevalent, nearly 50% demonstrate cardiac-related co-morbidity that compromises function 20 to 30 years after completion of treatment.[34]

Rehabilitation providers seeking to implement a plan of care should be aware of the risk for reduced tolerance to exercise, altered baseline vital signs and altered physiological responses to rehabilitation interventions. Monitoring during rehabilitative interventions should include focus on patient self-report of tolerance to exercise via the Borg Scale, or another index. Observation for symptoms that may herald undetected cardiac dysfunction or exercise that is too vigorous for someone with known heart disease include excessive fatigue, sweating, or pallor changes with exercise or activity and severe shortness of breath.

Neurotoxicity

Chemotherapy induced peripheral neuropathy (CIPN) is a well-known complication with taxane-based as well as platinum-based chemotherapeutic agents. Acute presentation of neuropathies includes sensory manifestation in the distal extremities. The neuropathic changes are typically progressive with additive chemotherapy cycles. The progression of sensory changes presents in a stocking/glove pattern. In more severe cases motor disturbance is noted, primarily in the lower extremities.

While neuropathies occur during chemotherapy cycles, the symptoms tend to abate after the completion of treatment. However, persistent impact on sensation and proprioception are notable and are shown to have a negative impact on balance, gait, and mobility even > 5 years after the completion of treatment.[35] Individuals who receive neurotoxic doublets are at greater risk for persistent neuropathic impairment. Of importance is the evidence elucidating the significantly increased risk of falls in the population of individuals treated with neurotoxic chemotherapy agents. Fall risk is two to three times greater in the population of individuals with a history of receiving neurotoxic chemotherapeutic agents.[36]

There are significant rehabilitation implications for the population of individuals treated with neurotoxic chemotherapeutic agents. Ideally a baseline assessment of sensation, strength, and balance is completed prior to initiating chemotherapy. Continued screening for balance change over time, observation of gait deviation and triage for rehabilitation intervention to manage emerging impairments is recommended.[37] Severe neuropathy with motor changes may impact safety and may necessitate intervention to mitigate balance deficits and enhance gait and stability.[38] A comprehensive falls prevention program is an effective strategy that should be proactively implemented to improve functioning.[39,40] Providing assistive devices and/or orthoses may be required to maintain patient safety.

Lymphedema

The natural history of lymphedema is typically a slow, progressive, swelling that appears asymmetrically in the limb s following lymphadenectomy or radiation therapy. New onset lymphedema is an important safety concern due primarily due to the risk of deep vein thrombosis, cancer recurrence or infection.[41]

Several studies have examined the safety of exercise on development and exacerbation of lymphedema and found that, under controlled circumstances, exercise does not exacerbate

the condition nor have significant impact on worsening symptoms.[42–44] There is no strong evidence basis for the use of compression garments during exercise for prophylactic purposes, however early use of compression therapy in the presence of early, sub-clinical lymphedema is safe and effective.[45] Individuals with lymphedema should be advised to exercise with some form of compression on their limb to prevent fluid accumulation. Any signs of redness, erythema, pain, new onset or exacerbation of swelling should be referred for more extensive medical management. Cellulitis infections are common in individuals with lymphedema and require antibiotic therapy prior to continuation of rehabilitation interventions.

For individuals in whom lymph nodes have been resected as a standard part of cancer surgery, astute observation of any changes in the limb that indicate an emerging infection should be addressed. An individualized rehabilitation treatment plan should be developed for this at-risk population with precaution to avoid unnecessary strain and injury to the limb that may cause the onset of lymphedema.[45]

Frailty

Frailty is a clinical syndrome found in those over the age of 65 and characterized by a loss of physiologic reserve secondary to reduced physiological capacity, weight loss, weakness, slow walking speed, self-reported exhaustion and low physical activity.[46,47] Because cancer occurs disproportionally among people over the age of 70, many cancer survivors have frailty symptoms compounded by the negative effects of cancer directed treatments.[48] Frailty is associated with falls, hospitalizations and increased mortality.[49] A recent study analyzing more than 12,000 patients ≥ 65 years found that the prevalence of falls was significantly higher post cancer treatment than pre-treatment among individuals with prostate and lung cancer and the prevalence of balance/walking problems were significantly higher post-diagnosis in non-Hodgkin's lymphoma and breast, prostate and lung cancer.[50] Frail patients, specifically, pose a challenge to rehabilitation physicians who work with cancer survivors. Frailty has been associated with poorer rehabilitation outcomes and functional gains.

The Comprehensive Geriatric Assessment (CGA) has received attention as a comprehensive battery of tests that assess various domains of functioning and can be used to stratify patients into high versus low risk categories to predict their tolerance to cancer therapies and risk for side effects of chemotherapy.[51] The CGA may be a more comprehensive and sensitive indicator to identify functional decline than the current performance status measures used in oncology practice.[52] Interventions such as optimizing nutrition and muscle mass may delay frailty and are safe in the geriatric population.[9] In a review of studies on exercise interventions in frail institutionalized adults, balance and functional training were shown to be effective in improving functional performance, activities of daily living and quality of life.[53]

Osseous Fragility

Osteoporosis and secondary bone loss affect bone health in cancer survivors, most commonly in hormonally-driven breast and prostate cancer.[54,55] Osteoporosis worsens with

prolonged exposure to hormonal therapies increasing fracture risk with increased duration of treatment.[56,57] Rehabilitation providers should identify meaningful changes over time that may suggest increased risk and should modify rehabilitative interventions to optimize safety. Weight bearing exercise may have a protective effect in mitigating bone density depletion during hormonal therapy interventions.[58]

Bone metastases occur prevalently in the most commonly occurring cancers; breast, lung, and prostate.[59,60] Bone lesions often result in pain, spinal cord compression, fracture, and hypercalcemia reducing quality of life and limiting functional mobility.[61,62] While rehabilitative weight bearing activities can have a positive impact on bone density, mobilizing individuals with bone lesions is challenging due to pain and fracture risk during therapeutic exercise.[63]

Metastatic lesions of the long bones and spine present the greatest risk of pathologic fractures making fracture risk assessment of great importance to rehabilitation providers.[60] A scoring system developed by Mirels et al[64] assigns a severity score to each of four factors associated with fracture; site, size, type of lesion, and the type of pain reported. (Table 3) This system enables an aggregate score that supports fracture risk stratification so that appropriate mobility interventions may be initiated.

According to Mirels' recommendation, prophylactic fixation is indicated for a lesion with a score of ≥ 9. A lesion with a score of ≤ 7 can be managed using radiotherapy and drugs. A score of 8 presents a clinical dilemma and requires clinical judgement of the criteria. Functional pain has been identified as the single best predictor of pathological fracture.[64]

Another stratification system by Harrington suggests that lytic and blastic lesions in long bones can develop pathologic fractures when > 50% of the cortex is destroyed and lesions of the proximal femur are more likely to fracture if they are > 2.5 cm or if they are associated with avulsion of the lesser trochanter. Such lesions should be referred for prophylactic fixation.[65]

Rehabilitation is indicated in the presence of bone metastases to maintain function and promote safety and fracture prevention with activities of daily living (ADLs).[66] Of importance are fall prevention strategies and education for safety with activities that require lifting and carrying heavy objects. A comprehensive mobility assessment is necessary, as sheer number of bone lesions and location of metastatic sites may not be associated with functional mobility loss in the short term.[67] Rehabilitation interventions are generally safe and effective and do not increase the risk for fractures.[66,68–70] General safety measures are outlined in Table 4 and target restricting excessive resistive, compressive, or rotational torque-like forces on an involved limb or region.[71] Individuals with more severe fracture risk may benefit from offloading the affected limb and using assistive devices or orthoses to safely enhance function and mobility. Caregiver education should be emphasized in the rehabilitation care plan to optimize safety and function in the home environment.

Advanced Cancers

Functional impairments are prevalent in patients with advanced cancer and can lead to disability, increased caretaker dependency, and psychological distress.[72] Safety considerations should be broadened and rehabilitation assessment should extend beyond the primary functional limitation as the multi-system impact from advanced cancer jeopardizes safe functioning.[73] Patients with advanced cancer often have a range of comorbid conditions and polypharmacy considerations and impact functioning and require a more complex rehabilitative prescription.[72,74]

Cachexia is a common condition related to advanced cancer. Symptoms include marked weight loss, loss of lean muscle and muscle atrophy, fatigue, weakness, and loss of appetite which negatively impacts function. Sarcopenia is a condition of lean muscle loss and muscle atrophy. Sarcopenia may also be seen in advanced cancer populations but is a different condition than cachexia, although sarcopenia may be a component of cachexia not all individuals with sarcopenia are cachectic.[75] Sarcopenia can be identified by low muscle mass and reduced gait speed. This differentiation is important as exercise, in the absence of appropriate protein and energy balance may pose a risk for further functional decline in the cachectic population.[76] Rehabilitation interventions should be undertaken with insight and input from an interdisciplinary team that includes an understanding of nutritional support and inflammatory profiles of the patient balanced with physical activity and muscle training interventions.[77]

Central and peripheral neural structures may be affected by a primary or metastatic tumor as well as oncology-directed treatment (e.g. chemotherapy). Neurological changes may be the first presenting sign of metastatic disease and warrant close follow up and triage for medical management. Neurological symptoms are often consistent with the spinal level or central location of the lesion. Patients may present with cognitive changes, memory loss, affective and personality changes, altered mental status, speech and word finding complications as well as sensory or motor dysfunction including radiculopathy or myelopathy.[78] Autonomic dysfunction may also occur related to chemotherapy or other anti-neoplastic treatment issues. Rehabilitation providers should monitor for any neurological status changes during and after intervention, and should monitor pain and vital sign changes during intervention. Caregiver education is also important as patients may have altered safety judgement, reduced reflexive reactions, poor visual acuity, and word finding issues that make it difficult to function independently.

Assessment for home modifications and adaptive equipment evaluations should be considered to help reduce the risk of falling and improve overall safety in the home. Education for compensatory strategies using assistive devices, orthotics, and wheelchairs can improve the safety of individuals while promoting optimal functioning. Partnering with palliative care services to develop patient centered protocols that span the oncologic spectrum, can combine rehabilitation interventions with the treatment of cancer related pain, anxiety, psychosocial and spiritual needs.[79]

Safety Considerations with Rehabilitation Interventions

Exercise

Exercise has been extensively studied across the cancer care continuum including interventions pre-treatment[6,80,81], during active treatment[82,83], and following the completion of treatment.[82,84] Timing and type of exercise impacts various biological and physiological markers, psychosocial factors, and functional impairments differently.[82,85] Overall, tolerance to treatment and functional outcomes in a variety of cancer types are improved when exercise is initiated before or during cancer treatment.[6,44,81] Unique considerations are necessary based on the type of cancer and the body structures impacted by cancer-directed therapies.

Exercise training and maximal and sub-maximal exercise testing in persons with breast cancer is relatively safe.[42,43,86–88] However, because 35–58% of breast cancer survivors report persistent shoulder and arm pain[89], it is important to minimize the risk of musculoskeletal injuries which may result from surgical intervention or hormonal therapies. Since women with breast cancer commonly receive cardiotoxic chemotherapeutic agents, awareness for cardiac compromise is warranted. Ideally, a tailored exercise program is developed and initially supervised by a rehabilitation provider.[90]

Exercise interventions are generally safe during and after prostate cancer treatment.[69,91] Greater than 50% of individuals undergoing prostate cancer treatment will receive androgen deprivation therapy (ADT) to alter hormonal impact on tumor growth. ADT is associated with muscle mass depletion and bone density loss which directly impact safety with rehabilitation interventions. Aerobic and resistive exercise interventions mitigate the impact of ADT and promote restoration of muscle mass and mitigate bone density loss.[92]

Numerous prehabilitation and rehabilitation trials have identified positive benefits of exercise as well as its safety and feasibility in the lung cancer population.[93] Exercise is generally well tolerated and beneficial in controlled clinical settings and evidence supports moderate intensity exercise for this population.[6,94,95] Vital signs, oximetry, and respiration should be closely monitored during exercise and individual interventions and testing should be self-limited by the patient.[74]

Evidence supports exercise as a safe interventions in women during and after gynecological cancer treatment.[96,97] Lymphedema of the lower extremities may be associated with gynecological cancer and its treatment warranting consideration for lower extremity monitoring for individuals who have had inguinal lymph node dissection and/or radiation therapy.[41]

Exercise interventions such as walking, stationary cycle, resistance training and virtual reality appear to be safe for individuals with leukemia.[98–101] Exercise may be limited by complications of the cancer and its treatment such as infection, thromboembolic disease and hemorrhage.[102] Aerobic and strength training exercises can be safely performed by persons with a stem cell transplant; however exercises should be less intense, progress slowly and avoid overtraining. [103]

Modalities and manual therapy

Physical modalities such as heat[104], cryotherapy[105], electrotherapeutic modalities[106–108], laser[109,110], and manual therapy[104,111] are used as adjuncts to reduce pain and facilitate tissue healing and to minimize pain during rehabilitation interventions.[105,112] Modalities and physical agents require astute understanding of the impact on cancer and the risk of promoting metastatic disease.[113,114] Numerous indications exist for the use of modalities in pain management but should be applied with precaution.[104] Table 5 summarizes contraindications of modalities in cancer survivors.

Oncologic Emergencies

During the course of cancer treatment there may be signs of emergent conditions and the need for care to manage the sudden onset of serious adverse events. These oncologic emergencies should be recognized by rehabilitation providers in order to promote acute medical management so as to limit the impact on outcomes.

Morris et al categorized oncologic emergencies according to the mechanism of injury and organ system involved and outlined 3 categories of oncologic emergencies: 1)structural/mechanically induced, 2) metabolic, 3) hematological.[17]

Table 6 outlines the common presenting symptoms of the conditions associated with these categories of emergencies and their implications for rehabilitation providers.

Conclusion

Rehabilitation is generally safe in oncology patients; however, there are numerous important considerations that are unique to this population. Moreover, oncology-directed therapies and protocols are constantly advancing and rehabilitation specialists need to keep up to date in order to ensure the safety of the patients they treat. Rehabilitation provides therapeutic interventions that may mitigate loss of function and disability in cancer survivors; however, the frailty of the patients, co-morbid conditions, advanced cancer, side-effects of oncology-directed therapies and a host of other factors contribute to making this one of the most medically complex populations that rehabilitation professionals treat. Assessing each patient through the lens of providing safe rehabilitation interventions in a medically supervised setting is required.

References

1. Miller KD, Siegel RL, Lin CC, et al. Cancer treatment and survivorship statistics, 2016. CA: A Cancer Journal for Clinicians. 2016; 66(4):271–289. [PubMed: 27253694]
2. Marchese VG, Morris GS, Gilchrist L, et al. Screening for chemotherapy adverse late effects. Topics in Geriatric Rehabilitation. 2011; 27(3):234–243.
3. Partridge J, Harari D, Martin F, Dhesi J. The impact of pre-operative comprehensive geriatric assessment on postoperative outcomes in older patients undergoing scheduled surgery: a systematic review. Anaesthesia. 2014; 69(s1):8–16. [PubMed: 24303856]
4. Stout NL, Binkley JM, Schmitz KH, et al. A prospective surveillance model for rehabilitation for women with breast cancer. Cancer. 2012; 118(S8):2191–2200. [PubMed: 22488693]

5. Carli F, Silver JK, Feldman LS, et al. Surgical prehabilitation in patients with cancer: state-of-the-science and recommendations for future research from a panel of subject matter experts. Physical medicine and rehabilitation clinics of North America. 2017; 28(1):49–64. [PubMed: 27913000]
6. Sebio Garcia R, Yáñez Brage MI, Giménez Moolhuyzen E, Granger CL, Denehy L. Functional and postoperative outcomes after preoperative exercise training in patients with lung cancer: a systematic review and meta-analysis. Interactive cardiovascular and thoracic surgery. 2016; 23(3): 486–497. [PubMed: 27226400]
7. McNeely ML, Campbell KL, Rowe BH, Klassen TP, Mackey JR, Courneya KS. Effects of exercise on breast cancer patients and survivors: a systematic review and meta-analysis. Canadian Medical Association Journal. 2006; 175(1):34–41. [PubMed: 16818906]
8. Ahn K-Y, Hur H, Kim D-H, et al. The effects of inpatient exercise therapy on the length of hospital stay in stages I–III colon cancer patients: randomized controlled trial. International journal of colorectal disease. 2013; 28(5):643–651. [PubMed: 23417645]
9. Singh I, Gallacher J, Davis K, Johansen A, Eeles E, Hubbard RE. Predictors of adverse outcomes on an acute geriatric rehabilitation ward. Age Ageing. 2012; 41(2):242–246. [PubMed: 22301571]
10. Alam E, Wilson RD, Vargo MM. Inpatient cancer rehabilitation: a retrospective comparison of transfer back to acute care between patients with neoplasm and other rehabilitation patients. Arch Phys Med Rehabil. 2008; 89(7):1284–1289. [PubMed: 18586130]
11. Guo Y, Persyn L, Palmer JL, Bruera E. Incidence of and risk factors for transferring cancer patients from rehabilitation to acute care units. Am J Phys Med Rehabil. 2008; 87(8):647–653. [PubMed: 18645323]
12. Fu JB, Lee J, Smith DW, Shin K, Guo Y, Bruera E. Frequency and reasons for return to the primary acute care service among patients with lymphoma undergoing inpatient rehabilitation. PM R. 2014; 6(7):629–634. [PubMed: 24384360]
13. Groopman JE, Itri LM. Chemotherapy-induced anemia in adults: incidence and treatment. J Natl Cancer Inst. 1999; 91(19):1616–1634. [PubMed: 10511589]
14. Carson JL, Terrin ML, Jay M. Anemia and postoperative rehabilitation. Canadian journal of anaesthesia= Journal canadien d'anesthesie. 2002; 50(6 Suppl):S60–64.
15. Wing, JR. Hematologic Complications. In: Stubblefield, M., O'Dell, M., editors. Cancer Rehabilitation: Principles and Practice. New York: Demos Publishing; 2009. p. 773-785.
16. Values, AToL. Laboratory Values Interpretation Resource. Academy of Acute Care Physical Therapy; 2017.
17. Morris GS, Brueilly KE, Paddison NV. Oncologic Emergencies: Implications for Rehabilitation. Topics In Geriatric Rehabilitation. 2011; 27(3):176–183.
18. Kaufman RM, Djulbegovic B, Gernsheimer T, et al. Platelet transfusion: a Clinical Practice Guideline From the AABBPlatelet transfusion: a clinical practice guideline from the AABB. Annals of internal medicine. 2015; 162(3):205–213. [PubMed: 25383671]
19. Goodman, CC., Fuller, KS. Pathology for the Physical Therapist Assistant - E-Book. Elsevier Health Sciences; 2011.
20. Elter T, Stipanov M, Heuser E, et al. Is physical exercise possible in patients with critical cytopenia undergoing intensive chemotherapy for acute leukaemia or aggressive lymphoma? Int J Hematol. 2009; 90(2):199–204. [PubMed: 19629631]
21. Segal BH, Freifeld AG, Baden LR, et al. Prevention and treatment of cancer-related infections. J Natl Compr Canc Netw. 2008; 6(2):122–174. [PubMed: 18319048]
22. Shelton BK. Evidence-based care for the neutropenic patient with leukemia. Semin Oncol Nurs. 2003; 19(2):133–141. [PubMed: 12830737]
23. Siegel, J., Rhinehart, E., Jackson, M., Chiarello, L. US Centers for Disease Control and Prevention. [Accessed September] 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. 2016. p. 1Available at: cdc.gov/hicpac/pdf/isolation/isolation2007.pdf
24. Paul KL. Rehabilitation and exercise considerations in hematologic malignancies. Am J Phys Med Rehabil. 2011; 90(5 Suppl 1):S88–94. [PubMed: 21765268]
25. Stern, MLC. Infectious Complications of Cancer. In: Stubblefield, M., O'Dell, M., editors. Cancer Rehabilitation: Principles and Practice. New York: Demos Publishing; 2009. p. 405-409.

26. Shannon SAN, Begal BH. Epidemiology and Management of Opportunistic Infections in Immunocompromised Patients with Cancer. Abstr Hematol Oncol. 2005; 8(3):20–30.
27. Mylotte JM, Graham R, Kahler L, Young L, Goodnough S. Epidemiology of nosocomial infection and resistant organisms in patients admitted for the first time to an acute rehabilitation unit. Clin Infect Dis. 2000; 30(3):425–432. [PubMed: 10722423]
28. Gillis TA, Donovan ES. Rehabilitation following bone marrow transplantation. Cancer. 2001; 92(4 Suppl):998–1007. [PubMed: 11519026]
29. Dimeo F, Bertz H, Finke J, Fetscher S, Mertelsmann R, Keul J. An aerobic exercise program for patients with haematological malignancies after bone marrow transplantation. Bone Marrow Transplant. 1996; 18(6):1157–1160. [PubMed: 8971388]
30. Bovelli D, Plataniotis G, Roila F, Group EGW. Cardiotoxicity of chemotherapeutic agents and radiotherapy-related heart disease: ESMO Clinical Practice Guidelines. Annals of oncology. 2010; 21(suppl_5):v277–v282. [PubMed: 20555097]
31. Harris EE, Correa C, Hwang W-T, et al. Late cardiac mortality and morbidity in early-stage breast cancer patients after breast-conservation treatment. Journal of Clinical Oncology. 2006; 24(25): 4100–4106. [PubMed: 16908933]
32. Chicco AJ, Hydock DS, Schneider CM, Hayward R. Low-intensity exercise training during doxorubicin treatment protects against cardiotoxicity. Journal of Applied Physiology. 2006; 100(2):519–527. [PubMed: 16210442]
33. Chen JJ, Wu P-T, Middlekauff HR, Nguyen K-L. Aerobic exercise in anthracycline-induced cardiotoxicity: a systematic review of current evidence and future directions. American Journal of Physiology-Heart and Circulatory Physiology. 2017; 312(2):H213–H222. [PubMed: 27923793]
34. Lipshultz SE, Adams MJ, Colan SD, et al. Long-term cardiovascular toxicity in children, adolescents, and young adults who receive cancer therapy: pathophysiology, course, monitoring, management, prevention, and research directions. Circulation. 2013; 128(17):1927–1995. [PubMed: 24081971]
35. Winters-Stone KM, Horak F, Jacobs PG, et al. Falls, Functioning, and Disability Among Women With Persistent Symptoms of Chemotherapy-Induced Peripheral Neuropathy. J Clin Oncol. 2017:JCO2016713552.
36. Wildes TM, Dua P, Fowler SA, et al. Systematic review of falls in older adults with cancer. Journal of geriatric oncology. 2015; 6(1):70–83. [PubMed: 25454770]
37. Stubblefield MD, Burstein HJ, Burton AW, et al. NCCN task force report: management of neuropathy in cancer. Journal of the National Comprehensive Cancer Network. 2009; 7(Suppl 5):S-1–S-26.
38. Kerckhove N, Collin A, Conde S, Chaleteix C, Pezet D, Balayssac D. Long-Term Effects, Pathophysiological Mechanisms, and Risk Factors of Chemotherapy-Induced Peripheral Neuropathies: A Comprehensive Literature Review. Front Pharmacol. 2017; 8:86. [PubMed: 28286483]
39. Gu Y, Dennis SM. Are falls prevention programs effective at reducing the risk factors for falls in people with type-2 diabetes mellitus and peripheral neuropathy: A systematic review with narrative synthesis. Journal of diabetes and its complications. 2017; 31(2):504–516. [PubMed: 27825536]
40. Stubblefield MD, McNeely ML, Alfano CM, Mayer DK. A prospective surveillance model for physical rehabilitation of women with breast cancer. Cancer. 2012; 118(S8):2250–2260. [PubMed: 22488699]
41. Cormier JN, Askew RL, Mungovan KS, Xing Y, Ross MI, Armer JM. Lymphedema beyond breast cancer: a systematic review and meta-analysis of cancer-related secondary lymphedema. Cancer. 2010; 116(22):5138–5149. [PubMed: 20665892]
42. Schmitz KH, Ahmed RL, Troxel A, et al. Weight lifting in women with breast-cancer-related lymphedema. N Engl J Med. 2009; 361(7):664–673. [PubMed: 19675330]
43. Schmitz KH, Ahmed RL, Troxel AB, et al. Weight lifting for women at risk for breast cancer-related lymphedema: a randomized trial. JAMA. 2010; 304(24):2699–2705. [PubMed: 21148134]

44. Cheema B, Gaul CA, Lane K, Fiatarone Singh MA. Progressive resistance training in breast cancer: a systematic review of clinical trials. Breast Cancer Res Treat. 2008; 109(1):9–26. [PubMed: 17624588]
45. Shaitelman SF, Cromwell KD, Rasmussen JC, et al. Recent Progress in Cancer-Related Lymphedema Treatment and Prevention. CA: a cancer journal for clinicians. 2015; 65(1):55. [PubMed: 25410402]
46. Winters-Stone KM, Bennett J, Mick D. Preventing Frailty in Older Cancer Survivors. Topics in Geriatric Rehabilitation. 2015; 31(4):241–245.
47. Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci. 2001; 56(3):M146–156. [PubMed: 11253156]
48. Handforth C, Clegg A, Young C, et al. The prevalence and outcomes of frailty in older cancer patients: a systematic review. Ann Oncol. 2015; 26(6):1091–1101. [PubMed: 25403592]
49. Retornaz F, Monette J, Batist G, et al. Usefulness of frailty markers in the assessment of the health and functional status of older cancer patients referred for chemotherapy: a pilot study. J Gerontol A Biol Sci Med Sci. 2008; 63(5):518–522. [PubMed: 18511757]
50. Huang MH, Blackwood J, Godoshian M, Pfalzer L. Prevalence of self-reported falls, balance or walking problems in older cancer survivors from Surveillance, Epidemiology and End Results-Medicare Health Outcomes Survey. J Geriatr Oncol. 2017; 8(4):255–261. [PubMed: 28602712]
51. Mohile, SG., Magnuson, A. Cancer and Aging. Vol. 38. Karger Publishers; 2013. Comprehensive geriatric assessment in oncology; p. 85-103.
52. Jolly TA, Deal AM, Nyrop KA, et al. Geriatric assessment-identified deficits in older cancer patients with normal performance status. The oncologist. 2015; 20(4):379–385. [PubMed: 25765876]
53. Weening-Dijksterhuis E, de Greef MH, Scherder EJ, Slaets JP, van der Schans CP. Frail institutionalized older persons: A comprehensive review on physical exercise, physical fitness, activities of daily living, and quality-of-life. Am J Phys Med Rehabil. 2011; 90(2):156–168. [PubMed: 20881587]
54. Stubblefield MD, Schmitz KH, Ness KK. Physical functioning and rehabilitation for the cancer survivor. Semin Oncol. 2013; 40(6):784–795. [PubMed: 24331197]
55. van Londen, G., Taxel, P., Van Poznak, C. Cancer therapy and osteoporosis: Approach to evaluation and management. Paper presented at: Seminars in oncology; 2008.
56. Poulsen M, Frost M, Abrahamsen B, Gerke O, Walter S. 70 Osteoporosis among men with prostate cancer during treatment with androgen deprivation therapy. European Urology Supplements. 2016; 15(3):e70.
57. Bouvard B, Soulié P, Hoppé E, et al. Fracture incidence after 3 years of aromatase inhibitor therapy. Annals of oncology. 2014; 25(4):843–847. [PubMed: 24608193]
58. Zerzan S, Smoot B, Lee JQ, Lui A, Allen DD. The Effect of Bone-Loading Exercise on Bone Mineral Density in Women Following Treatment for Breast Cancer: A Systematic Review and Meta-analysis. Rehabilitation Oncology. 2016; 34(4):144–155.
59. Eastley N, Newey M, Ashford RU. Skeletal metastases - the role of the orthopaedic and spinal surgeon. Surg Oncol. 2012; 21(3):216–222. [PubMed: 22554913]
60. Coleman RE. Clinical features of metastatic bone disease and risk of skeletal morbidity. Clin Cancer Res. 2006; 12(20 Pt 2):6243s–6249s. [PubMed: 17062708]
61. Costa L, Badia X, Chow E, Lipton A, Wardley A. Impact of skeletal complications on patients' quality of life, mobility, and functional independence. Support Care Cancer. 2008; 16(8):879–889. [PubMed: 18392862]
62. Healey JH, Brown HK. Complications of bone metastases: surgical management. Cancer. 2000; 88(12 Suppl):2940–2951. [PubMed: 10898338]
63. Silver JK, Baima J, Mayer RS. Impairment-driven cancer rehabilitation: an essential component of quality care and survivorship. CA Cancer J Clin. 2013; 63(5):295–317. [PubMed: 23856764]
64. Mirels H. Metastatic disease in long bones. A proposed scoring system for diagnosing impending pathologic fractures. Clin Orthop Relat Res. 1989; (249):256–264.
65. Harrington KD. Impending pathologic fractures from metastatic malignancy: evaluation and management. Instructional course lectures. 1986; 35:357–381. [PubMed: 3819423]

66. Bunting RW, Shea B. Bone metastasis and rehabilitation. Cancer. 2001; 92(S4):1020–1028. [PubMed: 11519029]

67. Cheville AL, Murthy NS, Basford JR, et al. Imaging and Clinical Characteristics Predict Near-Term Disablement From Bone Metastases: Implications for Rehabilitation. Archives of physical medicine and rehabilitation. 2016; 97(1):53–60. [PubMed: 26435301]

68. Bunting R, Lamont-Havers W, Schweon D, Kliman A. Pathologic fracture risk in rehabilitation of patients with bony metastases. Clin Orthop Relat Res. 1985; (192):222–227. [PubMed: 3967425]

69. Cormie P, Newton RU, Spry N, Joseph D, Taaffe DR, Galvao DA. Safety and efficacy of resistance exercise in prostate cancer patients with bone metastases. Prostate Cancer Prostatic Dis. 2013; 16(4):328–335. [PubMed: 23917308]

70. Cormie P, Galvao DA, Spry N, Joseph D, Taaffe DR, Newton RU. Functional benefits are sustained after a program of supervised resistance exercise in cancer patients with bone metastases: longitudinal results of a pilot study. Support Care Cancer. 2014; 22(6):1537–1548. [PubMed: 24424484]

71. O'Toole, GBP., Herklotz, M. Bone Metastases. In: Stubblefield, M., O'Dell, M., editors. Cancer Rehabilitation: Principles and Practice. New York: Demos Publishing; 2009. p. 773-785.

72. Pergolotti M, Deal AM, Lavery J, Reeve BB, Muss HB. The prevalence of potentially modifiable functional deficits and the subsequent use of occupational and physical therapy by older adults with cancer. Journal of geriatric oncology. 2015; 6(3):194–201. [PubMed: 25614296]

73. Silver JK, Raj VS, Fu JB, Wisotzky EM, Smith SR, Kirch RA. Cancer rehabilitation and palliative care: critical components in the delivery of high-quality oncology services. Supportive Care in Cancer. 2015; 23(12):3633–3643. [PubMed: 26314705]

74. Jones LW, Eves ND, Mackey JR, et al. Safety and feasibility of cardiopulmonary exercise testing in patients with advanced cancer. Lung Cancer. 2007; 55(2):225–232. [PubMed: 17113185]

75. Muscaritoli M, Anker S, Argiles J, et al. Consensus definition of sarcopenia, cachexia and pre-cachexia: joint document elaborated by Special Interest Groups (SIG)"cachexia-anorexia in chronic wasting diseases" and "nutrition in geriatrics". Clinical nutrition. 2010; 29(2):154–159. [PubMed: 20060626]

76. Hopkinson JB. The nursing contribution to nutritional care in cancer cachexia. Proceedings of the Nutrition Society. 2015; 74(4):413–418. [PubMed: 26220689]

77. Aapro M, Arends J, Bozzetti F, et al. Early recognition of malnutrition and cachexia in the cancer patient: a position paper of a European School of Oncology Task Force. Annals of Oncology. 2014; 25(8):1492–1499. [PubMed: 24569913]

78. Giglio P, Gilbert MR. Neurologic complications of cancer and its treatment. Curr Oncol Rep. 2010; 12(1):50–59. [PubMed: 20425608]

79. Raj VS, Silver JK, Pugh TM, Fu JB. Palliative Care and Physiatry in the Oncology Care Spectrum: An Opportunity for Distinct and Collaborative Approaches. Phys Med Rehabil Clin N Am. 2017; 28(1):35–47. [PubMed: 27912999]

80. Schmid D, Leitzmann MF. Association between physical activity and mortality among breast cancer and colorectal cancer survivors: a systematic review and meta-analysis. Ann Oncol. 2014; 25(7):1293–1311. [PubMed: 24644304]

81. Singh F, Newton RU, Galvao DA, Spry N, Baker MK. A systematic review of pre-surgical exercise intervention studies with cancer patients. Surg Oncol. 2013; 22(2):92–104. [PubMed: 23434347]

82. Speck RM, Courneya KS, Masse LC, Duval S, Schmitz KH. An update of controlled physical activity trials in cancer survivors: a systematic review and meta-analysis. J Cancer Surviv. 2010; 4(2):87–100. [PubMed: 20052559]

83. Fong DY, Ho JW, Hui BP, et al. Physical activity for cancer survivors: meta-analysis of randomised controlled trials. BMJ. 2012; 344:e70. [PubMed: 22294757]

84. De Backer IC, Schep G, Backx FJ, Vreugdenhil G, Kuipers H. Resistance training in cancer survivors: A systematic review. International Journal of Sports Medicine. 2009; 30(10):703–712. [PubMed: 19585401]

85. Mishra SI, Scherer RW, Geigle PM, et al. Exercise interventions on health-related quality of life for cancer survivors. Cochrane Database of Systematic Reviews. 2012; (8) N.PAG–N.PAG.

86. Cheema BS, Kilbreath SL, Fahey PP, Delaney GP, Atlantis E. Safety and efficacy of progressive resistance training in breast cancer: a systematic review and meta-analysis. Breast Cancer Res Treat. 2014; 148(2):249–268. [PubMed: 25324019]
87. Johansson K, Klernas P, Weibull A, Mattsson S. A home-based weight lifting program for patients with arm lymphedema following breast cancer treatment: a pilot and feasibility study. Lymphology. 2014; 47(2):51–64. [PubMed: 25282871]
88. Bloomquist K, Karlsmark T, Christensen KB, Adamsen L. Heavy resistance training and lymphedema: prevalence of breast cancer-related lymphedema in participants of an exercise intervention utilizing heavy load resistance training. Acta Oncol. 2014; 53(2):216–225. [PubMed: 24195690]
89. Kootstra JJ, Dijkstra PU, Rietman H, et al. A longitudinal study of shoulder and arm morbidity in breast cancer survivors 7 years after sentinel lymph node biopsy or axillary lymph node dissection. Breast Cancer Res Treat. 2013; 139(1):125–134. [PubMed: 23588950]
90. Galantino ML, Stout NL. Exercise interventions for upper limb dysfunction due to breast cancer treatment. Physical therapy. 2013; 93(10):1291–1297. [PubMed: 23907077]
91. Bourke L, Smith D, Steed L, et al. Exercise for men with prostate cancer: a systematic review and meta-analysis. European urology. 2016; 69(4):693–703. [PubMed: 26632144]
92. Gardner JR, Livingston PM, Fraser SF. Effects of exercise on treatment-related adverse effects for patients with prostate cancer receiving androgen-deprivation therapy: a systematic review. Journal of Clinical Oncology. 2013; 32(4):335–346. [PubMed: 24344218]
93. Granger CL, Chao C, McDonald CF, Berney S, Denehy L. Safety and feasibility of an exercise intervention for patients following lung resection: a pilot randomized controlled trial. Integr Cancer Ther. 2013; 12(3):213–224. [PubMed: 22801943]
94. Driessen EJ, Peeters ME, Bongers BC, et al. Effects of prehabilitation and rehabilitation including a home-based component on physical fitness, adherence, treatment tolerance, and recovery in patients with non-small cell lung cancer: A systematic review. Crit Rev Oncol Hematol. 2017; 114:63–76. [PubMed: 28477748]
95. Crandall K, Maguire R, Campbell A, Kearney N. Exercise intervention for patients surgically treated for Non-Small Cell Lung Cancer (NSCLC): a systematic review. Surgical oncology. 2014; 23(1):17–30. [PubMed: 24529937]
96. Newton MJ, Hayes SC, Janda M, et al. Safety, feasibility and effects of an individualised walking intervention for women undergoing chemotherapy for ovarian cancer: a pilot study. BMC Cancer. 2011; 11:389. [PubMed: 21899778]
97. Babatunde OA, Adams SA, Orekoya O, Basen-Engquist K, Steck SE. Effect of Physical Activity on Quality of Life as Perceived by Endometrial Cancer Survivors: A Systematic Review. International Journal of Gynecological Cancer. 2016; 26(9):1727–1740. [PubMed: 27654260]
98. Zhou Y, Zhu J, Gu Z, Yin X. Efficacy of Exercise Interventions in Patients with Acute Leukemia: A Meta-Analysis. PLoS One. 2016; 11(7):e0159966. [PubMed: 27463234]
99. Smith-Turchyn J, Richardson J. A systematic review on the use of exercise interventions for individuals with myeloid leukemia. Support Care Cancer. 2015; 23(8):2435–2446. [PubMed: 25947256]
100. Alibhai SM, O'Neill S, Fisher-Schlombs K, et al. A pilot phase II RCT of a home-based exercise intervention for survivors of AML. Support Care Cancer. 2014; 22(4):881–889. [PubMed: 24240647]
101. Jarden M, Adamsen L, Kjeldsen L, et al. The emerging role of exercise and health counseling in patients with acute leukemia undergoing chemotherapy during outpatient management. Leuk Res. 2013; 37(2):155–161. [PubMed: 23021021]
102. Bergenthal N, Will A, Streckmann F, et al. Aerobic physical exercise for adult patients with haematological malignancies. Cochrane Database Syst Rev. 2014; (11):CD009075. [PubMed: 25386666]
103. Tsuda K, Sudo K, Goto G, et al. A Feasibility Study of Virtual Reality Exercise in Elderly Patients with Hematologic Malignancies Receiving Chemotherapy. Intern Med. 2016; 55(4):347–352. [PubMed: 26875958]

104. Cheville AL, Basford JR. Role of rehabilitation medicine and physical agents in the treatment of cancer-associated pain. J Clin Oncol. 2014; 32(16):1691–1702. [PubMed: 24799472]

105. Pfalzer LA. Physical agents/modalities for survivors of cancer. Rehabilitation Oncology. 2001; 19(2):12.

106. Boon AJ, Gertken JT, Watson JC, et al. Hematoma risk after needle electromyography. Muscle & nerve. 2012; 45(1):9–12. [PubMed: 22190299]

107. Pearl ML, Fischer M, McCauley DL, Valea FA, Chalas E. Transcutaneous electrical nerve stimulation as an adjunct for controlling chemotherapy-induced nausea and vomiting in gynecologic oncology patients. Cancer Nurs. 1999; 22(4):307–311. [PubMed: 10452208]

108. Crary MA, Carnaby GD. Adoption into clinical practice of two therapies to manage swallowing disorders: exercise based swallowing rehabilitation and electrical stimulation. Current opinion in otolaryngology & head and neck surgery. 2014; 22(3):172. [PubMed: 24675153]

109. Migliorati C, Hewson I, Lalla RV, et al. Systematic review of laser and other light therapy for the management of oral mucositis in cancer patients. Supportive Care in Cancer. 2013; 21(1):333–341. [PubMed: 23001179]

110. e Lima JGM, de Andrade MFC, Bergmann A. Low-level laser therapy in secondary lymphedema after breast cancer: systematic review. Lasers in medical science. 2014; 29(3):1289–1295. [PubMed: 23192573]

111. Corbin L. Safety and efficacy of massage therapy for patients with cancer. Cancer Control. 2005; 12(3):158–164. [PubMed: 16062163]

112. French SD, Cameron M, Walker BF, Reggars JW, Esterman AJ. A Cochrane review of superficial heat or cold for low back pain. Spine. 2006; 31(9):998–1006. [PubMed: 16641776]

113. Sicard-Rosenbaum L, Danoff JV, Guthrie JA, Eckhaus MA. Effects of energy-matched pulsed and continuous ultrasound on tumor growth in mice. Phys Ther. 1998; 78(3):271–277. [PubMed: 9520972]

114. DeLisa, JA., Gans, BM., Walsh, NE. Physical medicine and rehabilitation: principles and practice. Vol. 1. Lippincott Williams & Wilkins; 2005.

Table 1

Common Chemotherapy Agents and Side Effects

Drug Category	Common Generic Drugs (brand name)	Side effects
Alkylating Agents	• Cyclophosphamide • Ifosfamide • Melphalan • Busulfan • Thiotepa • Carmustine • Dacarbazine	• Congestive heart failure • Pericardial effusion • Shortness of breath • Dyspnea on exertion • Pulmonary fibrosis • Dizziness, confusion agitation • Joint pain • Anemia • Renal failure
Anthracyclines	• Danorubicin • Doxorubicin (Adriamycin) • Epirubicin • Bleomycin	• Cardiotoxicity • Left ventricular dysfunction • Congestive heart failure • Cardiomyopathy • Pulmonary fibrosis
Anti-Androgens	• Flutamide (Eulexin) • Nilutamide	• Muscle wasting • Osteoporosis • Erectile dysfunction
Antimetabolites	• 5-flurouracil • Capecitabine (Xeloda) • Gemcitabine • Fludarabine • Methotrexate	• Anemia • Shortness of breath • Skin rash/dermatitis
Aromatase Inhibitors	• Letrozole (Femara) • Anastrozole (Arimidex) • Exemestane (Aromasin)	• Joint arthralgias • Osteopenia/Osteoporosis • Hot flashes • Weight gain • Mood fluctuations
Cytoskeletal disruptors (Taxanes)	• Paclitaxel (Taxol) • Docetaxel (Taxotere) • Abraxane	• Peripheral neuropathy • Cytopenia • Acute myocardial infarction
Gonadotropin-releasing hormone agonist	• GnRH-A (Cetrorelix)	• Osteoporosis • Weight gain • Heart failure • Heart disease

Drug Category	Common Generic Drugs (brand name)	Side effects
Luteinizing hormone agonist	• Goserelin (Zoladex) • Leuprolide (Lupron) • Triptorelin (Trelstar)	• Bone pain • Sexual dysfunction • Anemia • Cognitive dysfunction
Kinase Inhibitors	• Erlotinib (Tarceva) • Lapatinib (Tykerb) • Imantinib (Gleevac) • Gefinitib (Iressa)	• Hypertension • Acute myocardial infarction • Stroke • DVT/PE * • Interstitial lung disease • Bradycardia
Monoclonal Antibodies	• Trastuzumab (Herceptin) • Alemtuzumab (Campath) • Bevacizumab (Avastin)	• Cytopenia • Pulmonary inflammation • Congestive heart failure • Hypertension • Reduced wound healing • Skin rash
Platinum-based agents	• Carboplatin • Cicplatin • Oxaliplatin	• Neurotoxicity • Ototoxicity • Rhabdomyolysis
Retiniods	• Tretinoin • Alitretinion	• Increased intracranial pressure • DVT/PE
Selective Estrogen Receptor Modifiers	• Tamoxifen (Nolvadex) • Raloxifene (Evista)	• Hot flashes • Weight gain • Cognitive and memory dysfunction • DVT/PE • Stroke
Topiosomerase Inhibitors	• Irinotecan (Camptosar) • Topotecan (Hycamtin)	• Cytopenia • Severe diarrhea and dehydration
Vinca Alkaloids	• Vincristine (Oncovin) • Vinblastine	• Peripheral neuropathy • Dyspnea • Hypertension • Angina • Acute myocardial infarction

* DVT=deep vein thrombosis; PE=pulmonary embolism

Table 2

General Rehabilitation Considerations in the Context of Hematological Compromise[13,16,19]

Blood Count	Rehabilitation Considerations
White Blood Cells	> 11.0 10^9/L: Symptom-based approach, monitor for fever < 4.0 10^9/L: Symptom-based approach, monitor for fever < 1.5 10^9/L (Neutropenia): Symptom-based approach, neutropenic precautions based on facility guidelines. • Mild < 1.5 10^9/L • Moderate 0.5 – 1.0 10^9/L • Severe < 0.5 10^9/L
Platelets	< 150,000 cells/uL (Thrombocytopenia): Symptom-based approach, monitor tolerance to activity. > 50,000 cells/uL: Progressive exercise as tolerated, aerobic and resistive with monitoring for symptoms associated with bleeding. >30,000 cells/uL: Active range of motion exercises, moderate exercise, aquatic therapy based on immune status. > 20,000 cells/uL: Light exercise, walking, activities of daily living without strenuous effort;Assess fall risk and implement safety plan for falls prevention < 20,000 cells/uL: Understand transfusion status or plan of care, walking, light activities of daily living, symptom monitoring, precaution for falls.
Hemoglobin	Reference Values Male: 14 – 17.4 g/dL Female: 12 – 16 g/dL < 11 g/dL (anemia): Establish baseline vital signs; may be tachycardic or present with orthostatic hypertension; symptom-based approach to intervention, monitoring self-perceived exertion < 8 g/dL (severe anemia): Close monitoring of symptoms and vital signs with intervention; transfusion may or may not be indicated based on individual presentation; short periods of intervention, symptom-limited; education for energy conservation

Table 3

Mirels Criteria

Score	Site of lesion	Size of lesion	Nature of lesion	Pain
1	Upper limb	< 1/3 of cortex	Blastic	Mild
2	Lower limb	1/3–2/3 of cortex	Mixed	Moderate
3	Trochanteric region	> 2/3 of cortex	Lytic	Functional

Table 4

General Safety Measures with Bone Metastasis

No manual muscle testing in affected limb
No progressive resistive exercises in affected limb
Offloading affected limb with assisted device
Avoid excessive spinal flexion, extension and rotation. Clarify need for bracing.
Monitor for increasing functional pain

Table 5

Modality Indications, Precautions and Contraindications for Cancer Survivors

Modality	Indication	Precaution	Contraindication
Heat	• Pain relief • Muscle relaxation • Tissue extensibility	• Impaired lymphatic function • Scar tissue • Open wounds or skin fragility	• Unmanaged tumor/active disease • Peripheral vascular disease (PVD) • Severely impaired sensation • Irradiated tissue
Ultrasound	• Tissue extensibility • Inflammation management	• Impaired sensation • Open wounds or skin fragility	• Individuals with cancer or with a history of cancer
Cryotherapy	• Pain relief • Acute management of inflammation • Hair loss management	• Impaired sensation • Open wounds or skin fragility	• Ischemic tissue • PVD • Raynaud's syndrome
Transcutaneous electrical nerve stimulation (TENS)	• Sensory pain management • Scar desensitization	• Insensate tissue	• Unmanaged tumor/active disease • Over pacemaker • Open wounds
Needle Electromyography (EMG)	• Measures muscle response to nerve stimulation	• Thrombocytopenia	• None
Functional Electrical Stimulation (FES)	• Restoration of muscle firing when nerve conduction is intact (e.g. ambulation, limb function, swallowing, pelvic floor retraining)	• Poor skin condition or indurated tissue	• Unmanaged tumor/active disease
Low Level Light Laser	• Oral mucositis • Scar tissue extensibility • Lymphedema	• Open wounds or skin fragility	• Acute radiation dermatitis • Unmanaged tumor/active disease
Manual Therapy	• Pain relief • Tissue extensibility • Joint mobility • Soft tissue and radiation fibrosis management • Lymphatic stimulation	• Impaired sensation • Dysvascular tissue • Open wounds or skin fragility	• Acute radiation dermatitis • Unmanaged tumor/active disease • Bone fragility due to metastasis or osteoporosis
Spinal Manipulation	• Spinal mobility and alignment • Pain relief	• Open wounds or skin fragility	• Bone fragility due to metastasis or osteoporosis • Radiculopathy, spinal stenosis, myelopathy • Spinal cord compromise from tumor or lesion

Table 6

Oncologic emergencies

Condition	Presenting Symptoms	Rehabilitation Implications
Structural or Mechanically Induced Oncologic Emergencies		
Spinal Cord Compression (SCC)	• Localized back pain, primarily in thoracic region. • Thoracic pain escalating with lying supine, at night, with increased thoracic pressure during sneezing, coughing, or straining. • Muscle weakness below the area of spinal involvement.	Worsening pain in a recumbent position helps to differentiate SCC from other forms of mechanical back pain. Pain is the most frequent presenting symptom. Identification of SCC prior to onset of motor or sensory loss improve functional mobility and mortality outcomes. Patients with SCC are at risk for urinary tract infections, VTE, decubitus ulcers, and pneumonia. Pain assessment should be routine in rehabilitation interactions with concomitant assessment of muscle strength and sensory changes.
Malignant pericardial effusion	• Due to primary pericardial tumor (rare) or metastatic pericardial disease associated with lung, breast, esophageal, lymphoma, leukemia, and melanoma. • Pericardial effusion results in increased intrapericardial pressure, reduced cardiac output and cardiac tamponade. • Dyspnea, cyanosis, engorged neck veins, orthopnea, congested cough, fatigue, palpitations, and a drop in systolic blood pressure of > 10mm Hg during inspiration. • Hypotensive, tachycardic, narrow pulse pressure, diaphoretic.	Frequent assessment of heart rate, hemodynamic status and respiratory status, including oximetry levels should be carried out during treatment. Assessment of skin color and temperature, capillary refill and peripheral pulses should be tracked. Awareness of mental status changes, confusion, or seizures is necessary due to reduced cerebral blood flow. Following a cardiac tamponade episode, patients should have medical clearance before re-engaging in rehabilitation care. Rehabilitation is indicated to provide strengthening and reconditioning activities, pulmonary hygiene, and postural positioning.
Superior Vena Cava Syndrome	• Swelling in the upper thorax, face, neck. Jugular vein distention. In early stages edema is worse in the morning and improves throughout the day. • Dyspnea, dry cough. • Tachycardia, hypotension, cyanosis, cough, tachypnea, dyspnea. • Central nervous system symptoms; confusion, headache and vision changes.	Onset is typically slow and progressive. Symptom recognition and observance of change over time will support differential diagnosis. Avoid valsalva maneuvers with activity and exercise. Heart rate response to activity may be impaired. Use Rate of Perceived Exertion (RPE) scale as a more sensitive self-reported measure during activity.
Metabolic Oncologic		
Emergencies Hypercalcemia	• Presentation may be vague and symptoms diffuse. • Impact on nervous tissue and muscle tissue result in constipation, lethargy, fatigue, bone pain, abdominal pain, polyuria, muscle weakness, confusion, delirium.	Diagnostic testing includes serum ionized calcium levels. The rate of increase of calcium level is more important than the absolute serum calcium in correlating with symptoms. In severe conditions individuals are relatively unresponsive and rehabilitation may not be indicated. In mild to moderate conditions, weight-bearing activities are recommended along with general aerobic conditioning. Consider assistive devices for safety with ambulation. Assess and ascertain mental status changes and impact on safety judgement.

Condition	Presenting Symptoms	Rehabilitation Implications
Tumor Lysis Syndrome	• Symptoms may include nausea, vomiting, weakness, fatigue, lethargy, and arthralgia. • Typical onset is during acute 6 to 72 hours post chemotherapy delivery.	Awareness of sudden changes in patient's status including weakness, muscle cramping, dysrhythmias, dyspnea, central nervous system changes, irregular heart rhythms. In intensive care settings, early progressive mobility and rehabilitative interventions improve recovery and maintain functional status after discharge.
Hematologic Emergencies		
Neutropenic Fever	• Greatest risk is with ANC below 500 c/mm^3 • Trend of change in ANC count overtime is more important than absolute value. • Presence of a fever > 101.3° F or > 100.4 ° F for more than 1 hour. • Typical symptoms of infection such as redness, swelling and puss exudate from wounds are frequently absent.	Rehabilitation is not contraindicated. Considerations for protective wear including gowns, gloves, masks, and reducing risk of transmission of infectious agents by handwashing, keeping equipment clean, reducing exposure to raw foods and live plants.
Venothrombolic Events	• DVT present with swelling in the extremity, redness and extreme tenderness. More commonly occur in the lower extremity but may also occur in the arms. • Pulmonary emboli present with dyspnea, tachycardia, crackles, hemoptysis, chest pain, tachypnea, and anxiety. • Diagnostic imaging includes Doppler ultrasound for suspected DVT and chest CT, ventilation perfusion scan and pulmonary angiography for suspected PE.	Support protocols for VTE prophylaxis including mechanical compression devices including compression hosiery and pneumatic applications. Ambulation is encouraged to reduce risk for VTE development in high risk populations. Awareness of pharmacologic interventions that alter platelet activity and clotting.