**Acute Myelogenous Leukemia**

 Acute myelogenous leukemia (AML) is a rapidly progressing cancer involving the uncontrolled accumulation of myeloblasts (immature white blood cells) in the bone marrow, which results in the crowding out of healthy white blood cells, red blood cells and platelets.20 Signs of AML include fever, shortness of breath, bruising or bleeding, weakness or feeling tired, and weight loss or loss of appetite.20 Acute myelogenous leukemia is the most common acute leukemia in adulthood.13 In 2012, it was estimated that 13,780 individuals (7350 men and 6430 women) in the United States would be diagnosed with AML.21Based on our case study information, the 22-year old patient, Ms. F. was diagnosed with AML in 2005 when she was 17 years old. From 2005 to 2009, only six percent of individuals diagnosed with AML were under age 20.21While outcomes have improved over the last 30 years,unfortunately, the majority of patients who are diagnosed with AML and achieve remission, will relapse and require further treatment.26 In the case of Ms. F., who has experienced relapse, she will seek curative therapy with a bone marrow transplant (BMT) and in preparation, has been referred to physical therapy (PT) for an exercise program to address proximal muscle weakness and general conditioning.

**Factors Affecting Evaluation and Exercise Prescription**

 With respect to PT evaluation and exercise prescription, the patient’s cancer diagnosis, past medical history, and cancer treatment should be considered. As a result of AML and its treatment, Ms. F. is at high risk for cancer related fatigue (CRF).11 The evaluation should include measures of CRF, and initially, the exercise prescription should be tailored to Ms. F.’s current level of function and tolerance. The evaluation should also capture factors related to Ms. F.’s past medical history of lobectomy and adrenal insufficiency, which may include fatigue, weakness and joint pain, and her past medical history of anxiety/depression. Exercise should be graded, and Ms. F.’s response to exercise should be monitored closely. Ms. F was treated with chemotherapy after initial AML diagnosis and more recently after AML relapse. The effects of chemotherapy may include fatigue, pain, cardiovascular, pulmonary, neurological and endocrine changes, and impaired immune and gastrointestinal function and may persist for years.25 Ms. F. recently received three chemotherapy drugs that may affect her response to evaluation and exercise prescription. Cytarabine and Idarubicin, drugs known to cause myelosuppression, may increase her risk of infections, and Bortezomib may cause fatigue, peripheral neuropathy, orthostatic hypotension, arthralgia and dyspnea.7 Again, exercises should be progressed in a graded manner and responses to exercise should be monitored closely. While on the topic of medication, Ms. F. is currently taking Remeron, an antidepressant; Nexium, to reduce stomach acid; Zofran, for nausea and vomiting; and Fluconazole, an antifungal antibiotic to treat weakened immune systems.7 These drugs are unlikely to cause problems with exercise, and drug adherence is likely to help Ms. F. better tolerate exercise.7

 To plan the evaluation, I would refer to the Guide to Physical Therapist Practice and Practice Pattern 6B: Impaired Aerobic Capacity/Endurance Associated With Deconditioning and the International Classification of Functioning Disability and Health’s domains of body function and structure, activity, and participation.1,30 With specific focus on Ms. F.’s proximal muscle weakness and fatigue affecting her ability to carry her one year old daughter, perform housework and walk long distances, I would consider several tests and measures for the initial evaluation that could also be used over time to evaluate for change in response to exercise.

 The evaluation would include a detailed subjective history, a general systems review including cardiopulmonary (blood pressure, heart rate, oxygen saturation, and respiratory rate) and musculoskeletal status (AROM and manual muscle and strength testing with hand held dynamometry), followed by more specific tests and measures to assess aerobic capacity, fatigue, and general functional and health status.1,10 Ms. F is having trouble walking long distances without becoming fatigued; therefore, the Six Minute Walk Test could be administered as a measure of submaximal aerobic capacity.10 The test is feasible to administer and involves having the patient walk as far as possible back and forth along a 30-meter hallway in six minutes while the therapist counts laps to determine distance. Ms. F has risk factors and complaints related to CRF; therefore, the Brief Fatigue Inventory (BFI), a valid and reliable measure of CRF could provide information on fatigue severity and impact on function.17,10 Ms. F. is clearly having trouble performing daily activities like going to school and work, carrying her child, and performing housework. To assess her functional status, the Karnofsky Performance Status Scale is another easy to administer measure that is reliable and valid for patients with cancer.10,19 Last, to provide a clearer picture of Ms. F.’s overall health status, the EQ-5D should be considered. The EQ-5D is a valid and reliable health status measure for patients with cancer and includes domains of mobility, self-care, usual activities, pain/discomfort, and anxiety/depression.8,23 I think these tests and measures would target Ms. F.’s impairments, limitations and restrictions and provide a starting point to develop and initiate an exercise program and over time, evaluate for change in response to the exercise program.

**Exercise Interventions and Benefits of Exercise**

 In North America, up to 70 percent of cancer survivors do not meet physical activity guidelines and therefore, are not active enough to achieve potential health benefits.18 Patients with variety of hematopoietic cancers (including AML) have been reported to have respiratory and skeletal muscle weakness and reduced exercise capacity.**27** By identifying patients at risk for progressive weakness and initiating rehabilitation prior to cancer treatment, morbidity post-treatment may be reduced.27 In a systematic review, Knols et al. indicated that exercise is safe and feasible for cancer survivors during and after treatment and may reduce cancer and treatment related symptoms and improve physical and psychosocial function.12Specific to hematological cancers, like AML, Liu et al. highlighted the need for more rigorous studies to determine the effectiveness of exercise interventions but suggested that exercise interventions are feasible and may improve physical fitness.**14**

 Battaglini et al. studied the effects of an aerobic and strengthening exercise program in patients with leukemia. The exercise program started while participants were in the hospital receiving chemotherapy and continued for two weeks after patients were discharged home but prior to the next round of treatment. Using a pre-test post-test design, the researchers reported significant decreases in fatigue and depression scores and significant improvements in cardiorespiratory endurance and maintenance of muscular endurance.2 In the first study of its kind, Wiskemann et al. examined the effects of an aerobic and strengthening exercise program in patients with a variety of cancers (the majority with AML) pre, during and post hematopoietic stem cell transplantation (HCST).28 Except during the participants’ hospitalization for HSCT, the exercise program was performed independently, but adherence was monitored and participants had access to the exercise therapist via telephone. The researchers reported that patients who participated in the exercise program experienced reduced cancer related fatigue and improvements in physical capacity, functioning, anger/ hostility, pain, and global distress.28 In one of the few studies examining the effects of exercise specifically in patients with AML, Chang et al. reported that hospital patients with AML who participated in three-week walking program while receiving chemotherapy had significantly greater increases in 12-minute walking distance and lower levels of fatigue, symptom distress, anxiety, and depressive status compared to the control group who did not participate in the walking program.5

The American Cancer Society recommends that cancer survivors avoid inactivity and aim to perform 150 minutes of moderate intensity (50-75 percent of maximum heart rate) or 75 minutes of vigorous intensity (> 75 percent of maximal hart rate) aerobic exercise per week and strengthening exercises targeted at major muscle groups at least two days per week.24Under ideal circumstances without insurance limitations, I would recommend that Ms. F. participate in outpatient PT two days per week for eight to 12 weeks prior to her BMT. Outpatient PT would consist of 30-40 minutes of aerobic exercise (cycling, elliptical machine, rowing, treadmill walking, walking indoors on a track or outdoors) and 20-30 minutes of strengthening exercises targeting all major muscle groups but with a special focus on the shoulder, core and hip/pelvic girdle (resistance bands, free weights, machines, pulleys, body weight, task specific functional strengthening like lifting and carrying loads, and transitioning sit-stand and up and down steps). On non-therapy days, Ms. F. should attempt to achieve three to five days of aerobic exercise. She may need to start out with intervals of 10 minutes of aerobic exercise two to three times a day and gradually increase her duration to tolerate one bout of 30 minutes. To ensure adequate aerobic intensity, Ms. F. would need to be instructed in techniques to monitor her heart rate or use the Borg Rating of Perceived Exertion.22 Eventually, Ms. F. should transition to a home aerobic and strengthening exercise program and as tolerated (taking into consideration immune function), participate in community based structured group exercise programs.

**Potential Barriers to Participation in Exercise**

 While the benefits of exercise for cancer survivors have been highlighted, the majority of cancer survivors do not meet physical activity recommendations;29 therefore, it is important to identify and overcome barriers to exercise. Of 9,105 cancer survivors who participated in a survey on lifestyle behaviors, the majority of participants did not meet physical activity recommendations.3 However, those who did meet the PA recommendations reported significantly higher health related quality of life.3Among breast cancer survivors, time has been reported to be a barrier to exercise. Even though Ms. F. has a different type of cancer, she is a young single mother and before her relapse, she attended community college and worked; therefore, time may be a perceived or real barrier.**16** In a qualitative study of barriers to exercise among patients with various types of cancer, patients reportedCRF as the main barrier to exercise.4Other barriers included lack of confidence, lack of motivation, physical deconditioning, cost and lack of exercise facilities tailored to patients with cancer.4 Patients with cancer undergoing treatment have also reported barriers to physical activity that include: the side effects of treatment, perceived lack of capability, lack of interest, and beliefs about the negative effects of physical activity on their condition.9 Thus far, the barriers described have been from the patient’s perspective, but physical therapists have also reported barriers to prescribing exercise for patients with cancer. In a study examining barriers to exercise in patients with CRF, physical therapistsreported that lack of guidelines, the advising of rest, poor exercise compliance, limited exercise resources and time, and lack of PT referral limited exercise as a management strategy.6

**Ways to Address Barriers to Participation in Exercise**

 After identifying barriers to exercise for patients with cancer, the next step is to work towards overcoming barriers. Blaney et al. not only looked at barriers to exercise but also facilitators to exercise.**4** The following facilitators to exercise were identified by patients with cancer: programs should be overseen by specially trained health care professionals, programs should take place in a hospital setting, programs should be tailored to patient’s individual needs and progressed gradually, and programs should be include patients with various types of cancer.4As a means to encourage participation in exercise, physical therapists have a responsibility to educate physicians, other health care providers, and the general public about the benefits of exercise, pre, during and post cancer treatment. Behavioral change strategies may also increase cancer survivors’ participation in exercise.18 Finally, in addition to providing direct services in an outpatient clinic or in the home envrionment, physical therapists can educate patients about community-based programs that offer exercise program for cancer survivors like the partnership between the Livestrong Foundation and YMCAs.15 Livestrong at the YMCA is 12-week group exercise program for cancer survivors aimed at increasing strength, flexibility, and endurance, preventing unwanted weight changes, building self-esteem, and helping participants develop an individual fitness program they can practice on their own and make part of their lives.**15** If a patient is hesitant to exercise in a group environment or has compromised immune function, physical therapists can assist patients in developing home exercise programs. On a final note, Ms. F. has the potential to achieve remission and get well after her BMT, and exercise during and post BMT should not be assumed to be contra-indicated.25 If Ms. F. has knowledge of the importance of exercise and feels confident in her ability to exercise, there is greater potential she will make exercise a part of her life and experience its physical and psychosocial benefits.

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