Topics in Geriatric Rehabilitation
Vol. 26, No. 2, pp. 120–127

Aquatic Exercise as a Management Tool for Breast Cancer–Related Lymphedema

Cheryl Ambroza, PT, CLT; Paula Richley Geigle, PT, PhD

Clinical management in the aftermath of breast cancer mainly focuses on screening for cancer recurrence. Issues such as lymphedema and the related cosmetic changes, decreased functional use, and altered self-image often receive less attention than is warranted. Women report, however, that breast cancer–related lymphedema (BCRL) negatively impacts quality of life, and their ability to advance successfully beyond the breast cancer experience. On the basis of clinical experience and early clinical data, practitioners indicate that moderate aerobic exercise involving trunk and extremity muscle contraction actually assists in BCRL volume control. Aquatic exercise utilizes hydrostatic pressure to reduce residual arm volumes. In addition to the constant hydrostatic pressure, buoyancy allows women to move more freely than on land, creating more muscle pump activity to mobilize lymph fluid. Aquatic exercise provides women with one activity to assist in BCRL management. **Key words:** *aquatic therapy*, *breast cancer*, *lymphedema*

OVERVIEW AND STATISTICS

Breast cancer is one of the most common cancers to occur in the United States. It is estimated that there will be nearly 200 000 new cases of breast cancer diagnosed this year.[1] Currently 2.5 million breast cancer survivors live in the United States.[1] Age and gender play a large role in the risk of developing breast cancer with women the majority diagnosed, and breast cancer occurrence in men at less than 1%. One in 8 women will be diagnosed with cancer of the breast during their lifetime with the highest frequency in women older than 50 years.[2] Just 5% of all breast cancers occur in women younger than 40 years.[3] Seventy percent to 80% of women diagnosed with breast cancer are without family history of this disease.[3]

Author Affiliations: *St Joseph's Medical Center, Towson, Maryland (Ms Ambroza); and School of Medicine, University of Maryland, Baltimore (Dr Geigle).*

Corresponding Author: *Cheryl Ambroza, PT, CLT, St Joseph's Medical Center, 7601 Osler Dr, Towson, MD 21204 (cherylambroza@msn.com).*

CANCER TREATMENTS

Common cancer treatments include surgery, radiation therapy, and chemotherapy. Surgery removes the cancerous tissue, which is used for confirming diagnosis and determining a plan of care. Depending on the presentation of the tumor, a lumpectomy (removing only the tumor) or a mastectomy (all or a portion of the breast and sometimes other tissue) may be performed. Some surgical procedures also excise lymph nodes. The sentinel lymph node, or the first node visualized, is recognized as the first site of metastases and is often biopsied to determine whether cancer has spread outside the breast. If cancer is identified in the sentinel node, often an axillary lymph node dissection will follow. Surgical side effects vary depending on the extent of surgery and patient's overall health.

Radiation therapy is treatment with high-energy rays or particles that destroy cancer cells.[4] The goals of radiation include elimination of cancer cells, shrinking a tumor, and minimizing tumor return. Two types of radiation are external-beam radiation and internal

radiation. External beam is the most common in treating breast cancer. The radiation may be directed to the breast, chest wall, axillary lymph nodes, and clavicular region, depending on the location, size, and proliferation of cancer. Side effects of external-beam radiation include, but are not limited to, redness, swelling, burns, fibrosis, and scarring of the lymphatic system. Radiation to the axillary lymph nodes can also cause lymphedema.[4] One type of radiation, internal or brachytherapy, is a radioactive implant placed in the breast tissue.

Chemotherapy treatment uses drugs to kill the cancerous cells. It may be given intravenously or orally. It is administered by a medical oncologist over the course of several months in cycles with a recovery period between doses. Hair loss, fatigue, anemia, and loss of appetite are a few of the side effects of chemotherapy. Other cancer treatments include targeted therapy, immunotherapy, hormone therapy, bone marrow, and stem cell transplantation.

BREAST CANCER–RELATED LYMPHEDEMA

A less-known, yet common adverse effect of cancer treatment is lymphedema. Lymphedema is the accumulation of protein-rich fluid in the body.[5] Breast cancer–related lymphedema (BCRL) is an impairment of the lymphatic system that commonly occurs following cancer-related treatment. Surgical removal of lymph nodes or radiation to lymph nodes or lymphatic vessels can disrupt the lymphatic system, making it less efficient, and perhaps lead to lymphedema development.

The lymphatic system is an accessory route to the vascular system that is responsible for producing, removing, and filtering excess fluid in the body. Lymph fluid consists of water, blood cells, cellular particle, proteins, and fatty acids. The lymphatic vessels also transport waste products including germs, toxins, cancer cells, and bacteria, whose cellular particles are often too large to be reabsorbed into the venous system. These compounds are carried through the lymphatics to the lymph nodes where they are filtered and returned to the bloodstream.

Figure 1 shows how lymphatic vessels in the arm and chest drain to the axillary lymph nodes. The vessels then converge with those from the neck to form larger vessels called ducts. From here, the lymph is returned to the bloodstream through large veins just under the collarbone.[5]

Understanding the physiology of the lymphatic system can clarify why the system is affected in the case of BCRL. The amount of fluid the lymphatic system is able to transport in one unit of time is known as lymph time volume.[6] Lymphatic load (LL) is the amount of lymph volume actually carried. Transport capacity (TC) is the amount of fluid transported by the lymphatic system at its maximum lymph time volume.

Lymphatic system insufficiencies occur when the TC drops below the LL. Breast cancer–related treatments such as lymph node removal or trauma to the lymph nodes or vessels from radiation cause a disruption to the lymph system. This damage decreases the system's TC, causing a mechanical insufficiency. The TC in the damaged vessels is permanent. At this point, one is considered to be in a latent stage of lymphedema or a subclinical stage. In many cases, the body accommodates and is able to clear the excess LL by draining the lymph fluid to other adjacent healthy vessels and nodes in the supraclavicular, infraclavicular, contralateral, interpectoral, and intramammary regions. If not, lymphedema develops.

Lymphedema occurs when the system is no longer able to keep up with the LL and the protein-rich fluid collects in the tissues of the affected area. If left untreated, it can severely impact one's quality of life, causing severe disfigurement to the chest, breast, arm, or hand, discomfort, and disability (Fig 2). Persistent swelling and the buildup of stagnant protein eventually lead to fibrosis and provide an excellent medium for complications such as cellulitis and lymphangitis.[7]

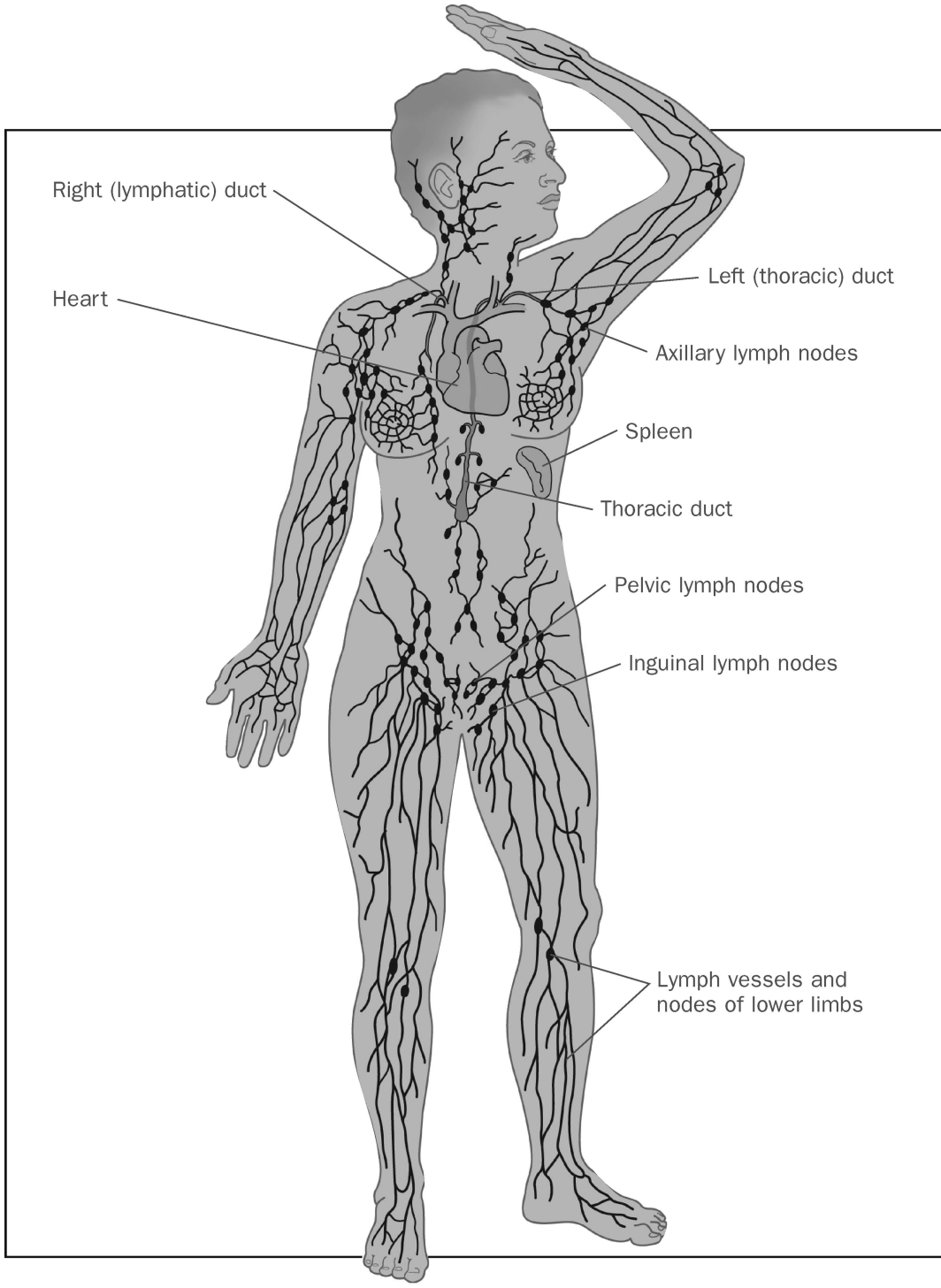

Figure 1. The lymph system. Reprinted with permission from American Cancer Society.[5(p4)] Illustration by Fran Milner on page 4, *Lymphedema - Understanding and Managing Lymphedema after Cancer Treatment*, Published by American Cancer Society, Health Promotions, 1599 Clifton Road NE, Atlanta, GA 30329, Copyright 2006.

Figure 2. Arm and hand lymphedema.

Lymphedema is graded on the basis of severity and is classified into 4 stages. In stage 0, or subclinical stage, the body is able to sufficiently manage the LL, despite a lowered TC. Stage 1, or reversible stage, presents with swelling of the body part without fibrosis. Pitting may be present. With proper management, the lymphedema can easily return to its latent state. Stage 2 is characterized as fibrosis or hardening of the tissue. Lymphedema is considered irreversible at this stage. Proper management is essential to prevent frequent infections from occurring. In stage 3, also known as lymphostatic elephantiasis, severe progression of swelling and tissue changes occur. Infections, open wounds, and skin/nail issues present in this stage.

Incidence of BCRL varies widely and appears related to surgery extent, radiation, and overall health. Occurrence following axillary lymph node dissection with tangent beam radiation ranges from 20% to 38%.[8] This increases to 50%–80% if radiation is given also to the supraclavicular and axillary lymph node beds.[8] The prevalence is lower with sentinel node biopsy combined with tangent beam radiation and is documented at 5% to 7%.[8] Radiation to the sternoclavicular region, immobility, obesity, and weight gain after treatment are also known risk factors for developing lymphedema. The onset of lymphedema can occur immediately after surgery, following cancer-related treatment such as radiation, or years after treatment. It has even been reported to develop 30 years after treatment.[5]

No cure exists for lymphedema; therefore, proper treatment and self-management are essential. Therapy goals should consist of reducing the swelling as close to the stage of latency as possible and maintaining that reduction. Current treatments include elevation, compression garments, pneumatic compression pumps, and complete decongestive therapy (CDT).[7] CDT is the standard of care for patients with lymphedema and is the recommended treatment by National Lymphatic Network.[9]

The 4 components to CDT are manual lymph drainage (MLD), compression therapy, decongestive exercises, and skin and nail care. CDT is broken down into 2 phases. Phase I, the intensive phase, is performed with a certified lymphedema therapist with a focus on reducing the swelling and patient education in self-management. Phase II, the improvement or self-management phase, aims to preserve and improve the success achieved in Phase I.[6] MLD is a gentle manual treatment that improves lymphatic activity and reroutes the lymph flow around blocked areas into more centrally located healthy lymph vessels.[6]

Compression therapy in Phase I CDT consists of the application of short-stretch bandages and various padding. These bandages preserve the reduction achieved from MLD and provide a pump-like action when the muscle contracts against the pressure from the bandage during activity of the extremity. In Phase II CDT, compression garments are prescribed by a certified garment fitter. Depending on the severity of the lymphedema, the fitter determines the size, knit of fabric (circular or flat-knit), and compression class of the garment.

Decongestive exercises, the third component to CDT, work to improve lymph

circulation. They are performed with the short-stretch bandages or compression garments on to enable the muscles to act as an internal pumping mechanism. The muscular contraction presses against the compression bandages or garments, helping to push the lymph fluid through the vessels.

EXERCISE AND BREAST CANCER

Exercise reduces the risk of cancer recurrence and death among cancer survivors,[10] increases physical functioning among cancer survivors,[11,12] and facilitates positive physiologic and psychological benefits in cancer survivors during and after treatment.[11–15] In addition, evidence suggests that exercise enhances quality of life in breast cancer survivors.[16–18] Exercise or custom-dosed activity is a protective element for the fatigue and weight gain associated with chemotherapy.[19] In addition, exercise and weight control combined may increase recurrence-free survival for hormone-driven malignancies.[20] However, survivors are not currently provided with customized information regarding exercise. The women who do receive general exercise information report anxiety regarding potentially injuring themselves with exercise or uncertainty in maintaining an exercise regime.[21]

BREAST CANCER–RELATED LYMPHEDEMA AND AQUATIC EXERCISE

Exercise is an emerging, important aspect of BCRL management, prevention and treatment.[22,23] In August 2009, the *New England Journal of Medicine* published an unprecedented study reporting that strength training exercises did not increase lymphedema symptoms in women after breast cancer treatment but actually reduced lymphedema presentation occurrence. Schmitz et al[22] reported lymphedema symptoms and incidence of exacerbations dropped significantly for individuals following a steady, progressive resistance training routine.

Another exercise option for BCRL management is aquatic exercise. Clinically, aquatic intervention is therapeutic for general lymphedema,[24,25] and evidence is emerging supporting the benefits of aquatic exercise for BCRL symptom management.[26–29] Hydrodynamic principles facilitate a safe exercise venue for women with BCRL. The 2 hydrodynamic principles critical to BCRL management are buoyancy and hydrostatic pressure. Buoyancy is dependent on positioning in the water, equipment selection, and technique application to facilitate active assisted or resisted movement. Buoyancy support is offered to the upper extremity and to the individual's balance. This support is a critical element for individuals uncertain about their ability to complete exercise without injury. This resultant movement augmented by the water environment assists in increased lymph flow via muscle pump activity.[24] Hydrostatic pressure provides a consistent compression gradient that also assists in returning lymph fluid into the vascular system.

Aquatic exercise evidence

Jamieson and Box, early investigators of aquatic exercise's impact upon women with BCRL, independently report decreases in volume and in arm tightness.[26,27] A pilot study measured the impact of one aquatic exercise session upon BCRL volumes of 5 women at three 1-hour intervals post–aquatic exercise.[28] The results indicate a reduction trend even with one aquatic session, and more important no adverse effects. The participants also reported decreased arm tightness or a "softening" of the arm. Recent research indicates existence of subclinical swelling (no change measured by tape measure or water displacement methods) that may relate to the participants' positive statements regarding extremity feeling.[8] More investigation using impedance measurement technology may assist in understanding tissue changes occurring with BCRL.

Tidhar and Katz-Leurer[29] reported aquatic exercise to be both safe and effective in reducing BCRL volumes. Geigle and Ambroza[30]

Table 1. Aquatic exercise program considerations for individuals with breast cancer–related lymphedema

Thermoneutral water temperature, 87°F to 90°F
Ambient air temperature, <85°F
Ambient air humidity <60%
Water depth completely covering clavicles
Diaphragmatic breathing during exercise routine to assist with lymph fluid clearance
Exercise continuously for 40 to 45 min
Full-body warm-up exercise for 5 to 10 min
Precaution: no open skin areas in aquatic environment. Cover with bio-occlusive dressing or wait until skin lesion is healed.

recently completed a single-blind, cross-over study of 12 women with stage I and II BCRL engaged in a community-based aquatic exercise program 2 times a week. Eight women reduced volumes, two demonstrated little or no volume change, and two showed slightly, non-clinically significant increased BCRL volumes. Interesting to note is bilateral volume reduction occurred in the women demonstrating volume decrease. Baylor University is currently enrolling a randomized trial of 100 individuals with BCRL into an aquatic exercise program.[31] Outcome variables include body mass index, bilateral arm circumference, and quality-of-life information.

Figure 3. Participant with water level at clavicle height.

Aquatic exercise logistics

For individuals with BCRL, specific considerations need to be addressed within any aquatic exercise program: water and ambient air temperatures; water depth; exercise scope; and skin integrity (Table 1). For obvious reasons, no randomized trial data exist regarding the perfect temperature for aquatic exercise. However, clinical experience indicates that water temperature greater than 90°F will increase the swelling for women with BCRL. Physiologically peripheral vasodilation increases with warmer water temperature decreasing the vascular return. Aquatic exercise with regard to volume increases is particularly difficult to titrate as warmer temperatures are offset by hydrostatic pressure. Ambient air temperature and humidity are 2 other features to consider when selecting a BCRL aquatic exercise site. Ambient air temperature greater than 85°F and humidity greater than 60% negatively influence BCRL volumes.[32]

Figure 4. Therapist and Client.

Table 2. Recommended exercise protocol for individuals with breast cancer–related lymphedema

Water depth must cover the clavicles for all activities
Water temperature < 90°F
Diaphragmatic breathing for entire exercise period
30 to 40 min of continuous exercise is goal

Activity	Frequency/ Reps/Sets	Duration, min	Potential equipment	Comments
Warm-up: Water walking	1 set: forward, backward, sideward	7–10 min	No ↑ surface area to start, slowly ↑ to include paddles for UEs and wrap cuffs for LEs	Core stability focus, open chest expansion in all planes
LE muscle group				
Cardio				
UE muscle group				
Cardio				
Functional activities				
Cool-down				

Abbreviations: LE, lower extremity; UE, upper extremity.

Water depth must adequately cover the clavicles to optimize lymphatic flow into the water shed and major vessels (Figs 3 and 4).

Although clavicle water depth appears relatively straightforward, it is clinically difficult to continuously maintain and requires integration of the following factors: initial and ongoing client education about the importance of water depth; pool depth potential assessment; modification of exercise positioning to best achieve clavicle coverage; and acclimation training for women uncomfortable with this water depth.

Several other critical features to consider before initiating aquatic exercise for women with BCRL are the importance of diaphragmatic breathing throughout exercise, full-body warm-up and cool-down, and routine skin inspections. Diaphragmatic breathing assists with lymphatic flow via mechanical pressure on the major lymph vessels. It is important to instruct women in "belly" breathing before starting aquatic exercise. Tactile cueing is often needed to facilitate diaphragmatic breathing. Typical for any exercise program, a full-body warm-up and cool-down are necessary. Water walking maintaining core stability is one typical warm-up and cool-down activity. The full-body warm-up followed by large muscle group activities facilitates opening of major lymph vessels and increased lymph flow (Table 2).

CONCLUSION

The evidence supporting aquatic exercise as one means to manage BCRL is emerging; however, aquatic exercise is not indicated for all women presenting with BCRL. A thorough clinical assessment is needed to determine the best program of lymphedema management. A benefit-risk analysis is needed before adding aquatic exercise into each woman's exercise menu options. In addition, personal choice of exercise venue and treatment options must be considered. Empowering individuals to positively impact their own health outcomes is a secondary benefit of aquatic exercise. Additional research addressing frequency and exercise intensity is needed to best prescribe efficient and safe BCRL programs.

REFERENCES

1. http://www.cancer. org/docroot/CRI/content/CRI_2_2_1X_How_many_people_get_ breast_cancer_5.asp. Accessed November 2, 2009.
2. http://seer.cancer.gov/csr/1975_2006/results_merged/sect_04breast.pdf. Accessed November 2, 2009.
3. American Cancer Society. *Breast Cancer Facts and Figures 2009–2010.* Atlanta, GA: American Cancer Society; 2009.
4. American Cancer Society. Radiation therapy. http//www.cancer.org. Published 2009.
5. American Cancer Society. *Lymphedema, Understanding and Managing Lymphedema After Cancer Treatment*. Atlanta, GA: Health Promotions; 2006.
6. Zuther J. *Lymphedema Management: The Comprehensive Guide for Practitioners*. New York, NY: Thieme Medical Publishers Inc; 2005.
7. Petrek JA, Pressman PI, Smith RA. Lymphedema: current issues in research and management. *CA Cancer J Clin*. 2000;50(5):292–307.
8. Cheville A. *Western Regional Networking and Educational Seminar for Lymphedema Therapists*. Baltimore, MD; 2009.
9. Stout N. Early diagnosis and treatment intervention for lymphedema—the new standard of care. *Cancer.* 2008;112:2809–2819.
10. Warburton DE, Nicol CW, Bredin SS. Health benefits of physical activity: the evidence. *CMAJ.* 2006;174(6):801–809.
11. Ingram C, Visovsky C. Exercise intervention to modify physiologic risk factors in cancer survivors. *Semin Oncol Nurs.* 2007;23(4):275–284.
12. Stevinson C, Lawlor DA, Fox KR. Exercise interventions for cancer patients: systematic review of controlled trials. *Cancer Causes Control.* 2004;15(10):1035–1056.
13. Schmitz KH, Holtzman J, Courneya KS, Masse LC, Duval S, Kane R. Controlled physical activity trials in cancer survivors: a systematic review and meta-analysis. *Cancer Epidemiol Biomarkers Prev.* 2005;14(7):1588–1595.
14. Galvao DA, Newton RU. Review of exercise intervention studies in cancer patients. *J Clin Oncol.* 2005;23(4):899–909.
15. Knols R, Aaronson NK, Uebelhart D, Fransen J, Aufdemkampe G. Physical exercise in cancer patients during and after medical treatment: a systematic review of randomized and controlled clinical trials. *J Clin Oncol.* 2005;23(16):3830–3842.
16. Valenti M, Porzio G, Aielli F, et al. Physical exercise and quality of life in breast cancer survivors. *Int J Med Sci.* 2008;5(1):24–28.
17. 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. *CMAJ.* 2006;175(1):34–41.
18. Milne HM, Wallman KE, Gordon S, Courneya KS. Effects of a combined aerobic and resistance exercise program in breast cancer survivors: a randomized controlled trial. *Breast Cancer Res Treat.* 2008;108(2):279–288.
19. Holmes MD, Chen WY, Feskanich D, Kroenke CH, Colditz GA. Physical activity and survival after breast cancer diagnosis. *JAMA*. 2005;293:2479–2486.
20. Irwin ML, Smith A, McTiernan A, et al. Influence of pre- and post-diagnosis physical activity on mortality in breast cancer survivors: the health eating activity and lifestyle study. *J Clin Oncol*. 2008;26(24):3958–3964.
21. Geigle PR, Robinson A, Purnell K, Baquet C, Shiraz MI. *Attitude, Beliefs and Opinions of Cancer Survivors Regarding Exercise*. Washington, DC: American Institute of Cancer Research; 2009.
22. Schmitz K, Ahmed R, Troxel A, et al. Weight lifting in women with breast-cancer-related lymphedema. *N Engl J Med.* 2009;361:664–673.
23. Mosely A, Pillar. Exercise for limb lymphoedema: evidence that it is beneficial. *J Lymphoedema*. 2008;3(1):51–56.
24. Havas E, Parviainen T, Vuorela J, Nikula T, Vekko V. Lymph flow dynamics in exercising human skeletal muscle as detected by scintography. *J Physiol*. 1997;504(Pt 1):233–239.
25. Tidhar D, Drouin J, Shimony A. Aqua lymphatic therapy in managing lower extremity lymphedema. *Support Oncol*. 2007:5(4);179–184.
26. Jamison LJ. Aquatic therapy for the patient with lymphedema. *J Aquat Phys Ther*. 2005;13:9–12.
27. Box R, Marnes T, Robertson V. Aquatic physiotherapy and breast cancer related lymphoedema. Paper presented at: 5th Australasian Lymphology Association Conference Proceedings; 2004:47–49.
28. Geigle PR. Lymphedema and aquatics with measurement by perometer (LAMP). Platform presentation: Combined Sections Meeting of American Physical Therapy Association; February 2006; San Diego, CA.
29. Tidhar D, Katz-Leurer M. Aqua lymphatic therapy in women who suffer from breast cancer treatment-related lymphedema: a randomized controlled study. *Support Care Cancer.* 2009;5(4):179–183.
30. Geigle PR, Ambroza C. *Role of Aquatic Exercise in Breast Cancer Related Lymphedema Management*. Washington, DC: American institute of Cancer Research, November 2009; and Combined Sections Meeting of American Physical Therapy Association; February 2010; San Diego, CA.
31. http://clinicaltrials.gov/ct2/show/NCT00498771. Accessed November 2, 2009.
32. American College of Sports Medicine. *ACSM Resource Manual for Guidelines for Exercise Testing and Prescription*. 6th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2010:531–579.