Bioimpedance devices for detecting lymphedema

Coverage policy

The use of bioimpedance devices for detecting lymphedema is investigational/not clinically proven and, therefore, not medically necessary.

Limitations

No limitations were identified during the writing of this policy.

Alternative covered services

Various radiographic, imaging, and other methods of detecting lymphedema.

Background

Lymphedema is a swelling in the interstitial space due to accumulation of protein-rich fluid resulting from congenital or acquired damage to the lymphatic system. There are three stages of the disease, from 0 (the least severe) to 3 (the most severe) (International Society of Lymphology, 2016).

Primary lymphedema refers to congenital cases of the disease that manifest before age two; lymphedema praecox, which occurs at puberty; and lymphedema tarda, which occurs after age 35. The more common secondary lymphedema refers to cases acquired from disruption to the lymphatic system, from disease, trauma,
surgery, or radiation (Oremus, 2010). Primary lymphedema is a result of improper lymphatic development not linked to injury, trauma, illness, or disease (Morgan, 2008). Globally, filarial larvae from a mosquito bite that develop into worms that damage the lymphatic system is the most common etiology of secondary lymphedema. In the U.S., malignancies and related treatments (radiation, surgery) are the most common causes of secondary lymphedema.

Lymphedema is common in post-treatment cancer patients, especially breast cancer. A trial of 936 women with breast cancer who underwent sentinel lymph node biopsy found 5 percent had upper extremity secondary lymphedema. In those who also underwent axillary lymph node dissection, the incidence climbed to 16 percent (McLaughlin, 2008). The rate of upper extremity lymphedema after mastectomy was estimated to be 24 to 49 percent (Warren, 2007). Incidence of upper extremity lymphedema in breast cancer patients five years after diagnosis has been estimated at 40 percent (Armer, 2010; Norman, 2009). Of 664 auxiliary node dissection patients with and without radiation therapy, 30 and 19 percent developed lymphedema (Miller, 2014). Five to 49 percent of women treated for cervical, endometrial, and vulvar malignancies are diagnosed with lymphedema (Rockson, 2008).

Lymphedema is usually diagnosed through history and physical examination; in some cases, computed tomography, magnetic resonance imaging, and lymphoscintigraphy are used (Simonian, 2008). Severity of cases is classified by the difference in circumference between affected and unaffected arms, with larger numbers being more severe. Typically, one to two assessments of circumference are made before, during, and after the patient’s treatment.

Treatments for lymphedema include non-surgical interventions, including compression techniques, decongestive therapy, manual lymphatic drainage, exercise, laser treatment, ultrasound, and aquatherapy. Physicians, massage therapists, and nurses can administer treatments. Surgery may also be performed when needed (Oremus, 2010). Surveillance programs can include circumferential arm measures, perometry, bioimpedance, exercise programs, prophylactic/early intervention compression garments, and referral for complete decongestive therapy (Ostby, 2014).

Bioimpedance, an abbreviation for bioelectrical impedance spectroscopy, is a means of diagnosing lymphedema up to a frequency level of 30 kHz. Above that level, the technique is not reliable (Gaw, 2011). The test uses resistance to electrical current in comparing composition of fluid compartments to help diagnose lymphedema. Treatments are administered in a clinical setting, but have been demonstrated to produce accurate results when the patient self-administers at home (Ridner, 2014). Patients lie supine when the test is administered.

Findings

To date, no professional society guidelines have been issued on use of bioimpedance after cancer treatment. In November 2016, recommendations for techniques, protocols, and detection were issued by three radiation oncologists from Ohio, Michigan, and Virginia, who summarize data supporting use of the procedure for recently-treated breast cancer patients. Authors identify higher-risk patients as those who underwent mastectomy, auxiliary lymph node dissection, sentinel node biopsy (over six nodes sampled), regional nodal irradiation, or taxene based chemotherapy (Shah, 2016). A report of the American College of Radiology on upper extremity swelling did not mention bioimpedance (Dill, 2014).

A comprehensive literature review concluded that bioimpedance spectroscopy is an accurate diagnostic tool for pre-existent lymphedema, but has not been validated for early detection (Seward, 2016). A systematic review found that bioimpedance was highly accurate in measuring lymphedema in the lower extremities (intrarater correlation coefficient .89), at but not in higher extremities, in which coefficients for water volumetry, tape measurement, and perometry were .98 to .99 (Hidding, 2016).
Several analyses have compared bioimpedance with perometry arm measurement, with mixed results. In a report to the Agency for Health Research and Quality, correlation coefficients for bioimpedance were between 0.61 and 0.99, lower than methods like perometer and tape measure of the arm (International Society of Lymphology, 2009). A study to predict development of lymphedema in 964 breast cancer patients who underwent axillary node clearance found arm volume measurement remains the gold standard (Bundred, 2015).

Other studies found bioimpedance to be an accurate means of identifying women with lymphedema, compared to arm measurement (Smoot, 2011). One found it to produce inter-limb ratios similar to perometry for women without lymphedema, but higher ratios for women with the disorder (Czerniec 2011). Bioimpedance was similar to perometry in its ability to predict water volumes in arms of women with and without lymphedema (Ward, 2009).

Various studies determined that bioimpedance was less effective in identifying or predicting lymphedema, compared to other methods:

**Arm Circumference Measurement.** A study of 73 patients found that compared to upper and lower arm circumference, extracellular fluid was correlated, but bioimpedance was only correlated with arm circumference below the elbow (Kim, 2011).

**Ultrasound.** Reports determined bioimpedance failed to accurately predict compressibility from ultrasound (Choi, 2014), and identified lymphedema in 31.6 percent of cases, much less than the 90.3 percent figure with circumferential measurement (Blaney, 2015). An analysis found that compressibility in the arms of breast-cancer related lymphedema determined by ultrasound was not as accurate when bioimpedance or circumferential measurement was used (Choi, 2014).

**Tonometry.** Although bioimpedance of changes in post-operative breast fluid levels and tonometry of changes in tissue resistance to compression were both found to be reliable, ranges of covariance for tonometry (1.29 to 3.25 percent) were higher than bioimpedance (0.20 to 0.86) (Moseley, 2008).

**Tissue Dielectric Constant.** In 100 women surgically treated for breast cancer tested for lymphedema, bioimpedance spectroscopy had lower sensitivity (42.1 vs. 65.8 percent), and similar specificity (93.5 vs. 83.9 percent) compared to tissue dielectric constant. Affected to contralateral arm ratios for upper arm (1.12 vs. 1.56) and forearm (1.12 vs. 1.28) were lower for bioimpedance (Lahtinen, 2015).

**Volume Displacement.** After (median) follow up of 18.2 months of 186 breast cancer patients, the sensitivity and specificity of bioimpedance compared with volume displacement were 75 and 93 percent, considered a poor correlation. Volume displacement was considered by the authors as the gold standard for measuring breast cancer-related lymphedema (Barrio, 2015).

An analysis of cost savings for a managed care company estimated that $315,711, or 3 cents per member per month, was realized by using bioimpedance on 627 women with breast cancer. Most savings resulted from fewer infections or hospitalizations (Bilir, 2012).

**References**

On January 16, 2020, we searched PubMed and the databases of the Cochrane Library, the U.K. National Health Services Centre for Reviews and Dissemination, the Agency for Healthcare Research and Quality, and the Centers for Medicare & Medicaid Services. Search terms were “bioimpedance,” “breast cancer,” and “lymphedema.” We included the best available evidence according to established evidence hierarchies (typically systematic reviews, meta-analyses, and full economic analyses, where available) and professional guidelines based on such evidence and clinical expertise.


### Policy updates

5/2017: initial review date and clinical policy effective date: 6/2017

6/2018: Policy references updated

2/2019: Policy references updated

1/2020: Policy references updated