NATIONAL LYMPHEDEMA NETWORK

NLN

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The NLN Mission Statement

The mission of the NLN is to create awareness of lymphedema through education and to promote and support the availability of quality medical treatment for all individuals at risk for or affected by lymphedema.

The NLN is dedicated to:

- *promoting research into the causes, prevention and treatment of lymphedema;*
- *securing adequate insurance coverage for medically necessary, safe and effective treatment;*
- *expanding the number and geographical distribution of lymphedema treatment facilities and certified therapists.*

To achieve these goals, the NLN disseminates information about lymphedema to health care professionals so they can appropriately counsel their patients on its avoidance, and prescribe safe, effective treatment for those affected by this condition. The NLN also provides this information to the general public.

Measurement Techniques In Assessment Of Lymphedema

By Jane M. Armer, RN, PhD, and Sheila H. Ridner, RN, PhD, MSHA, MSN, ACNP-C

The measurement of lymphedema-related swelling and lymphatic function is quickly becoming an area of great interest to patients, clinicians and researchers. Currently, a clinically accepted "gold standard" for objective measurement of swelling associated with lymphedema does not exist. However, there are a number of existing methods being used to measure affected limbs. These include: (1) water displacement, (2) limb girth via tape measurements, (3) infrared laser perometry, and (4) bioelectrical impedance (BIA). Unfortunately, these measurement methods are not as precise when used for truncal, breast, genital and head/neck lymphedema. Thus, assessment using patient symptom reports and professional observation when swelling occurs in these areas is necessary. Symptom report is also useful in the validation and early detection of swelling of the extremities in conjunction with objective measures. This article will discuss in-depth issues related to measurement and the leading methods used to estimate limb volume (LV).

Methods of Assessing Limb Volume

Water Displacement

For many years, the bench science method for measurement of LV has been water displacement.[11,13] Although it has been regarded as the sensitive and accurate "gold standard" for volume measurement in the laboratory setting, water displacement is seldom used clinically because it is cumbersome and messy. Water displacement is usually applied to a certain distal part of the limb and does not provide data about localization of the edema or the shape of the extremity.[13,20]

This measurement method requires removal of any clothing covering the limb and then placement of the limb in a cylinder of water. The amount of water displaced (moved out of the cylinder) by the limb is measured by weight or volume and used to estimate LV. A standard deviation of 25 ml for repeated measures of the arm is reported by Swedborg.[13,19] Although fairly accurate and inexpensive, this method requires privacy and cannot be easily done in most outpatient facilities or home environments. Finally, water displacement is contraindicated in patients with open skin lesions. Therefore, limbs with wounds cannot be assessed with this method. End-of-life patients may be too frail, weak and fatigued to extend the limb into the water displacement volumeter and maintain this position until overflow dripping stops.

Circumferential Measurement of Limb Volume

Because of the problems associated with water displacement, limb girth is usually measured in centimeters with a non-flexible tape to determine circumference of the limb at selected anatomic locations when fitting the limb for a compression garment and obtaining measurements to enter into one of several formulae (such as that for a truncated cone) to calculate LV. Patients must remove all limb coverings and, while in a standardized position, extend limbs while measurement increments are marked on their skin or on a strip of adhesive tape attached to the skin. A specially designed non-stretch, flexible tape measure is recommended in assessing circumferences to ensure consistent tension over soft tissue muscle and bony prominences. The tape measure, which is routinely calibrated in metric units (0.1 cm divisions), is placed around the limb at intervals of 4 to 10 centimeters from wrist to axilla, depending on the selected protocol.

Often, both limbs are measured for comparison of circumferences at similar anatomic

Continued on page 2

In This Issue

PRESIDENT'S MESSAGE 4
7TH NLN INT'L CONFERENCE 5
MEASUREMENT OF LE (INT'L) 7
CS: AXILLARY WEB SYNDROME 9
2006 MIDYEAR LE UPDATE 10
RESOURCE GUIDE (4-page pull-out) ... 19
SUPPORT GROUPS 20
NEWS & NOTES 21
QUESTION CORNER 23
RESEARCH PERSPECTIVES 25
EDUCATION CORNER 28
BECOME AN NLN SUPPORTER 31

locations to compare differences in girth. Periodically, total LV is calculated for comparison over time. This method, when used to calculate LV, is comparable, but not identical in results, to water displacement.[11] Studies report correlations with water displacement ranging from 0.70 to 0.98.[13,20]

While bilateral or serial circumferences at various points of a body part are commonly used to quantify lymphedema,[12] several problems exist.[8] The circumferential method is time-consuming and requires considerable experience.

Although this is the most commonly used type of LV measurement in clinical settings, measurement error potentially may mask lymphedema occurrence or progression, or falsely imply lymphedema.[2] For example, individuals measuring limbs with a tape measure may hold the tape very tightly or loosely around the limb, causing variation in circumferences applied in the formula to calculate LV. It may be very difficult to use the technique with accuracy in individuals with large, loose skin folds or in those with arthritis who cannot extend their limbs. Although it is portable and inexpensive, it is a time-intensive method and may be plagued by intra- and inter-rater reliability issues.

Limits for acceptable difference between repeated circumferential measurements of the normal adult arm, forearm and wrist are 0.2 cm,[4] a standard that is rarely met in the clinical setting. Armer reports the estimated standard deviation of intra- and inter-rater measurements over a multi-year research study to be consistently in the 0.10 cm–0.35 cm range.[1]

Volume calculations assume a circular circumference, which is seldom the case. Because of its irregular shape, circumference of the hand is an inaccurate way of determining volume. There are also severe limitations with this method when skin damage exists. Handling of the extremity and contact with equipment raise hygienic concerns.[13] Thus, limbs with wounds are difficult to measure with circumferences.

Infrared Perometry

The Perometer 400T/350S (Juzo®, Cuyahoga Falls, OH) is an optoelectronic volumetry (OEV) device developed to meet the need for a quick, hygienic, and accurate method of LV calculation. It works similarly to computer-assisted tomography, but uses infrared light instead of X-rays.[13] Transections are measured every 3 mm and summed to the volume by a computer.[4] In addition, volume and transection of any part of the limb can be measured, the shape of the limb or limb segment can be displayed, and accurate calculations of change in volume can be made in seconds, using PeroPlus™® computer software (Juzo®, 2002).

Assessment is performed on limbs in a horizontal position or vertical position, depending upon the model of the perometer. The perometer maps a three-dimensional graph of the affected and non-affected extremities using numerous rectilinear light beams. The perometer is interfaced with a computer for data analysis and storage. A three-dimensional image of the limb is generated from the data and LV is calculated using a modification of the disc method.[9,20] The data are used to calculate the LV and limb shape is displayed in seconds. Clothing must be removed from the limb before measurement and careful attention must be paid to body position during the scan. Consistency in positions used when conducting multiple measurements is essential for accurate comparisons over time. The size and non-portable nature of the most widely used model requires patients to come into the clinic for limb measurement. Recently, a portable model has entered the market. Perometers can be used to fit compression garments and to determine LV. Because the frame does not touch the skin, measurements can be carried out on limbs with sensitive or broken skin. It may be difficult to accurately measure individuals who cannot maintain a stable position.

Procedures for perometry are documented by the European research teams of Tierney, et al.[20] and Stanton et al.,[18] and modified in work by Armer.[2] The Perometer 400T/350S is reported to have a standard deviation with repeated measures of 8.9 ml, less than 0.5% of the arm volume.[13,20] Test-retest with perometry, water displacement, and circumferences are reported by Armer (2005) and colleagues,[2] demonstrating perometry to be equally or more reliable than circumferences, as compared to water displacement.

Bioelectrical Impedance

Bioelectrical Impedance devices such as the IMP XCA (ImpediMed, Queensland, Australia), are being used in research settings in the United States and in clinical settings outside the United States to estimate extra cellular volume and assess presence of lymphedema. Most of these devices use a single-frequency low voltage electric current to determine extra cellular fluid (lymph).[6] Individuals with pacemakers and metal implants cannot be measured using BIA. Clothing does not have to be removed from the limb(s). Lightly adhesive electrodes are placed on each hand, each wrist and one foot. The procedure takes less than one minute and is painless. The devices are portable, allowing measurements to be done in clinics and community settings.

It is recommended that individuals lie down while being measured with BIA, although it is also possible for individuals to sit with the arm extended in front of the body and resting on a hard foam surface during measurement. As with infrared perometry, consistency in positions used when conducting multiple measurements is essential for accurate comparisons over time. BIA technology has been shown to be more sensitive, reliable and valid than circumferential tape measurement of the limb.[5,7,15,16,21]

Symptom Assessment

Self-reported symptoms of heaviness and swelling are reported to correspond with 2 cm or greater changes in limb girth among women treated for breast cancer.[3] Patients with lymphedema may also experience subjective symptom changes at less than 150 ml LV change.[3] Interviews using a structured symptom assessment tool, Lymphedema and Breast Cancer Questionnaire (LBCQ), developed by Armer and colleagues to guide elicitation of symptoms, have proven useful in validating lymphedema occurrence.[3]

LBCQ reliability was evaluated using Kuder-Richardson-20 and the test-retest method. Kuder-Richardson-20 revealed an acceptable internal consistency ($r = .785$) for all 19 items. Test-retest reliability was evaluated using a sample of healthy women without breast cancer or lymphedema ($n = 35$) with a 2-hour test-retest interval. Findings revealed a high degree of reliability ($r = .98$).[3]

Validity was confirmed through application of the self-report symptom tool in two samples to: (1) differentiate healthy women and women with known breast cancer lymphedema; and (2) predict limb swelling in a sample of breast cancer survivors with yet undetermined lymphedema.[3] Self-report of swelling and heaviness was associated with 2 cm or greater circumferential differences between limbs among those treated for breast cancer ($c = .952$).[3]

Findings Applying Four Definitions of Lymphedema

Armer and Stewart[1] report findings from analysis of data from a study with breast cancer survivors in which four definitions of lymphedema were applied: 2 cm circumference difference (by tape measure), 200 ml LV difference (by perometry), 10% LV change (by perometry), and self-report of heaviness and swelling (by interview). In the absence of a "gold standard" for lymphedema diagnosis, researchers continue to pursue results from these four definitions. From this study, it appears that the definition of 10% LV change would correspond to a more conservative definition of lymphedema, as fewer apparent cases of lymphedema are detected. On the other extreme, it appears that the definition of 2 cm difference corresponds to a more liberal definition of lymphedema, as more apparent cases of lymphedema are detected.

Again, it is emphasized that in the absence of a "gold standard," the terms "conservative" and "liberal" are used only in a relative sense. These findings document the importance of baseline anthropometric and symptom data and monitoring of changes over time.[1] They also reveal differences and similarities among the four diagnostic criteria applied to assess lymphedema occurrence.

Discussion

Accurate measurement of LV and/or lymphatic function is necessary in order to diagnose lymphedema and monitor the progress of treatment. While circumferential measurement is the most commonly used method in clinical practice, other methods are gaining popularity in research settings and may soon find their way into clinical settings. When choosing measurement methods, it is necessary to determine the reason for the measurement (e.g. garment fitting, LV assessment, lymphatic function), while also considering equipment cost and patient/therapist convenience. Water displacement and BIA are useful to determine volume, but not helpful when fitting garments. Circumferential measurements and infrared perometry can be used for both volume assessment and fitting garments. Water displacement and circumferential measures are inexpensive. BIA devices are expensive, but much less so than infrared perometry. Circumferential measurement and BIA devices are portable and not messy. Only recently, a portable perometer has been produced. Perometry and BIA produce rapid results and can be used with broken skin.

Multiple measurements over time using a single method and protocol, or assessment by more than one method will be more informative than a single measurement at a single point in time. Measurements at baseline prior to risk-inducing procedures are most helpful in assessing changes over time and detecting early changes associated with emerging lymphedema. Development of standardized protocols that apply valid and reliable measurement methods at standard time points will greatly advance our knowledge in the field and assist patients in acquiring the care they need.

Editor's Note: Although this article focuses on the application of measurement techniques for the upper extremity, the measurement tools described in this document are applicable (with certain modifications to the technique) to lower extremity swelling. Further research is required for truncal, breast, and head/neck lymphedema measures.

Disclaimer: The mention of the brand names does not constitute an endorsement by the NLN; the brand names are noted solely for informational purposes.

Continued on page 27, column 3

2006 Mid Year...

Continued from page 12

care of their lymphedema.

I already have heard from one Medicare "beneficiary" who, after many years of receiving compression garments for his lymphedema, was notified that he no longer will receive compression garments for treatment of his lymphedema, based on the recent code change.

We must write to our Congressional representatives protesting this change of coding which has no basis, either in Medicare law or medicine, which was not opened to medical or legal discussion, and which potentially will result in an increase in Medicare costs to treat cellulitis resulting from under-treatment of lymphedema. A National Coverage Decision on the subject of lymphedema treatment is long overdue. Also ask them whether they have considered sponsoring the "Lymphedema Diagnosis and Treatment Cost Saving Bill," which has been proposed widely in Washington over the last four years by this writer. ❒

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President's Message...

Continued from page 4

Conference in November, will address this topic during the Saturday luncheon and we hope many can personally witness his lecture.

Last, but not least, I would like to thank Nicole Gergich, PT, for covering the well-read Question Corner. She systematically reviews the frequently asked questions from our many patients.

Attention NY State residents! Please refer to the Legislative Corner *(pg 11)*. This is a crucial time for you to contact your representatives and state senators and support these important bills.

It surely is exciting to see the tremendous progress and the increased number of professionals becoming involved in this fascinating and complex field. Please spread the word about the Conference among your colleagues. Make sure to register today, as the popular Instructional Sessions are filling up quickly. Also, please review the message from our Editorial Committee in the News & Notes section. We greatly welcome your feedback and active participation in *LymphLink*. In the meantime, enjoy the summer and I look forward to seeing many of you in Nashville. ❒

Measurement Techniques...

Continued from page 3

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A complete list of references as referred to herein numerically is available upon request through NLN office, 510-208-3200, and will be included as part of the Reprint. Members can download Reprints from the NLN website. ❒