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Diagnosis and Treatment of Lymphedema Following Breast Cancer: A Population-based Study

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Abstract

Objective—To examine factors associated with variations in diagnosis and rehabilitation treatments received by women with self-reported lymphedema secondary to breast cancer care.

Design—Population-based, prospective study.

Setting—California, Florida, Illinois, New York.

Participants—Elderly (65+) women identified from Medicare claims as having had an incident breast cancer surgery in 2003.

Interventions—N.A.

Main Outcome Measures—Self-reported incidence of lymphedema symptoms, formal lymphedema diagnosis; treatments for lymphedema.

Results—Of the 450 breast cancer survivors with lymphedema who participated in the study, 290 (64.4%) were formally diagnosed with the condition by a physician. An additional 160 (35.6%) reported symptoms consistent with lymphedema (arm swelling on the side of surgery that is absent on the contralateral arm) but were not formally diagnosed. Of those reporting as being diagnosed by a physician, 39 (13.4%) received the comprehensive decongestive therapy (CDT) that included multiple components of treatment (manual lymphatic drainage (MLD), bandaging with short stretch bandages, using compression sleeves, skin care and remedial exercises), 24 (8.3%) received MLD only, 162 (55.9%) used bandages, compression garments or a pneumatic pump only, 8 (2.8%) relied solely on skin care or exercise to relieve symptoms and 65 (22.4%) received no treatment at all. Multivariate regressions revealed that race (African American), lower income, and lower levels of social support increased a woman's probability of having undiagnosed lymphedema. Even when formally diagnosed, African American women were more likely to receive no treatment or to be treated with bandages/compression only, rather than to receive the multi-modality, comprehensive decongestive therapy.

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Conclusions—Lymphedema is a disabling chronic condition related to breast cancer treatment. Our results suggest that a substantial proportion of those reporting symptoms were not formally diagnosed with the condition, thereby reducing their opportunity for treatment. The variation in rehabilitation treatments received by women who were formally diagnosis with the condition by a physician suggests that lymphedema might not have been optimally addressed in many cases despite availability of effective interventions.

Keywords

Rehabilitation; complete decongestive therapy; lymphedema care; breast cancer

Introduction

Lymphedema is a chronic debilitating condition associated with the treatment of breast cancer. It arises from the interstitial accumulation of protein rich fluid that would normally drain via the lymphatic system back to the venous circulation. Chronic swelling leads to soft tissue fibrosis, adipose tissue hypertrophy, and increases patients' risk for cellulitis that can further damage the lymphatic capillaries. Patients with chronic lymphedema are also at risk of developing lymphangiosarcoma – a rare malignant tumor arising from the lymphatic system. Although the reported incidence of lymphedema in breast cancer survivors varies depending on the clinical definition, lymphedema may occur many years following the initial cancer treatment[1–5] often leading to emotional distress and reduced quality of life.[6–9]

The goals of rehabilitation treatment of lymphedema secondary to breast cancer are to prevent the progression of the disease, reduce and maintain the size of the limb, alleviate the discomfort arising from excessive fluid and protein accumulation, prevent recurrent episodes of cellulitis, and educate patients on self-management of the condition. Despite numerous modalities available, individually none offer unequivocal benefits for lymphedema control. In their consensus statements, both the International Society of Lymphology (2009) and the National Lymphedema Network (2011) suggest that the Complete Decongestive Therapy (CDT) be considered the "optimal" treatment of peripheral lymphedema[10–11]. The CDT treatment, which takes place in two phases, consists of manual lymphatic drainage (MLD) with subsequent application of compression bandages, remedial active exercises, meticulous skin care, and patient education on self- management of lymphedema. Ultimately, patients are fitted with a compression garment. Phase 1 of CDT usually takes place in the clinic setting or patient's home and is performed by a health care professional (physical or occupational therapist, n urse) trained in lymphedema treatment. In Phase 2, the maintenance phase, patients and family continue to manage lymphedema independently with daily MLD, use compression bandages overnight and compression garments during the day, exercise regularly as well as care for the skin integrity. Self-management of lymphedema requires patients' continuous compliance with the treatment recommendations in order to keep the condition under control and prevent further complications. Individual treatment components are often selected based on the severity of lymphedema, comorbidities, patients' lifestyle, and social situation in order to ensure compliance with recommendations. While randomized, long-term controlled studies examining the effectiveness of different components of Complete Decongestive Therapy are limited,[12–14] the position statement of the National Lymphedema Network recommends that "every patient with lymphedema should have access to the established effective treatment for this condition."

The sparse literature evaluating lymphedema tends to be retrospective in nature, limited to a single institution, or include a relatively small number of patients.[3,4,15,16] Among the prospective studies,[1, 13,17–21] only few included information on lymphedema treatments.[13,14,19,20] In addition, differences in patient populations, lymphedema measurement methods, information on breast cancer treatment, and length of follow up time make it difficult to compare findings across these studies.

The purpose of this study was to examine the characteristics of women reporting lymphedema symptoms among a large and diverse sample of breast cancer survivors followed prospectively over a 48-month period following incident breast cancer surgery and to examine variations in rehabilitation treatment received by women who reported being diagnosed with lymphedema by a health care provider.

Methods

Data Sources

Data for this study are drawn from a large, population-based, longitudinal telephone survey of community-dwelling elderly women with incident breast cancer in 2003. Details of the survey can be found in Nattinger et al.[22] Conducted in four geographic and racially diverse states — California, Florida, Illinois and New York, the survey was designed to gather information on treatments and outcomes of breast cancer care among elderly Medicare beneficiaries. The initial wave of the survey yielded 3,083 completed interviews, with an overall participation rate of 70%.[22] The second and third waves, at a median time of 36 and 48 months after initial breast cancer surgery, had participation rates exceeding 96%. For the purpose of this analysis, the sample consists of 450 breast cancer survivors who reported having developed lymphedema at any wave of data collection.

Variable Definitions

Survey items related to incidence and treatment of lymphedema were asked consistently in all three waves. Patients were asked if in the last month they noticed any hand or arm swelling on the side of breast cancer surgery that they didn’t have on the other side. Positive responses were followed with more specific questions regarding onset of edema, symptoms of cellulitis in the affected arm, and whether specific treatments were recommended (and, if so, received). Scientific studies validating such self-reported measures of lymphedema suggest a high correlation between patients self-reported symptoms and objective measurement methods.[23,24] Women reporting symptoms of lymphedema were further classified into two groups: 1) “formally diagnosed” by a physician if they answered “yes” to the question: “Since your breast cancer surgery, has a doctor ever told you that you have lymphedema or arm edema?” or 2) “symptoms only” if they reported lymphedema symptoms as described above but indicated that they were not told by a doctor or other health care provider that they had lymphedema.

In all waves, a list of common lymphedema treatments provided the basis for the treatment questions. Specifically, we assessed prescription, frequency and intensity of use of manual lymph drainage (MLD), short stretch bandages, pneumatic pumps, compression garments/ sleeves, therapeutic exercise, and lymphedema-specific skin care based on patients’ reports.

Information on age, state of residence, and dual enrollment in both Medicare and Medicaid programs (a proxy for poverty status) was derived from Medicare enrollment files. The presence and number of comorbid conditions was characterized by examining individual’s inpatient, outpatient and Carrier claims for the period between incident breast surgery and survey interview using the methodology described in Klabunde.[25] Most other information came from the patient interviews. Women were classified according to their reported race/ ethnicity as White non-Hispanic, Black/African American non- Hispanic, Hispanic, or other race/ethnicity. Marital status categories were married/living with a partner, widowed, separated/divorced, and never married. Educational level was captured by years of formal education and categorized as less than high school, high school graduate, and some college.

Body mass index was calculated based on self-reported height and weight. Respondents were also asked to estimate their annual household income in the year preceding the survey. Income was then classified in categories as $15,000 or less, $15,001–$30,000, $30,001–$45,000, and greater than $45,000. Social support was assessed using the Medical Outcomes Study Social Support Scale, a validated measure of patients' perceptions of help and support available to them in various aspects of life.[26,27] We focus specifically on women's emotional and informational support questions (e.g. "someone to give you information to help you understand a situation", "someone to turn to for suggestions about how to deal with a personal problem"), calculated based on their scoring at the lowest quartile of that subscale for the cohort's distribution. Finally, binary indicators for survey waves (wave 2 and wave 3; reference period= wave 1) were included in all analyses to examine temporal trends in incidence of symptoms/formal diagnosis of the lymphedema and type of treatment received.

Statistical Analysis

The dependent variables examined in this study were (i) the probability of experiencing symptoms-only lymphedema, as opposed to having the condition "formally diagnosed" by a physician according to self-reported data and (ii) the type of self-reported rehabilitation treatment received by women formally diagnosed with lymphedema. A standard multivariate logistic regression was used to examine the independent effects of socio-demographic and economic characteristics on the likelihood of experiencing lymphedema symptoms without a formal diagnosis (relative to having a formal diagnosis by a physician) while a four-category multinomial logistic model was used to examine factors associated with the type of rehabilitation treatment received: CDT, MLD, bandages/compression, no treatment. Point estimates from the models are reported as odds ratios (OR) or relative risk ratios (RRR) along with the corresponding p-value and 95% confidence interval (CI). All statistical analyses were performed using STATA 11.0 statistical software (College Station, TX).

Results

Sample Characteristics

A total of 450 women reported having lymphedema during the 48-month post incident breast cancer surgery. Table 1 shows the summary characteristics of the sample overall and by lymphedema diagnosis (symptoms only versus formally diagnosed by a physician).

Among this cohort of elderly Medicare beneficiaries with lymphedema secondary to breast cancer, a third of patients were less than 70 years of age. The vast majority (89.3%) were white, nearly half were either married (46.7%) or widowed (38.9%) and had a college degree (53.1%). Despite high levels of education, only 16.7% had annual incomes above $45,000, one out of every five women were at or below $15,000 and 5.6% were dually enrolled in Medicare and Medicaid, the public program for low income Americans. Two-thirds of them developed lymphedema in the first 30 months post-surgery, with an additional 16.4% and 16.9% of women developing the condition by 36- and 48- months, respectively. Although the overall sample of breast cancer patients was relatively evenly split across the 4 states, nearly two-thirds (65.5%) of all women with lymphedema resided in Florida or California.

Despite the majority (290 or 64.4%) of breast cancer survivors who reported symptoms of lymphedema indicated that they had been diagnosed with the condition by a physician, 160 women (35.6%) reported symptoms of lymphedema on the side of breast cancer surgery that they didn't have on the other side that were not diagnosed by health care providers. Summary statistics by diagnosed status reveal differences across groups by age, race, marital status, income and dual enrollment. Most notably, compared to women who reported being formally diagnosed by a physician, women with symptoms-only tended to be older, Black/ African American, unmarried and have lower annual incomes. The groups also differed with respect to time to developing lymphedema since breast cancer surgery. Among the 300 women developing lymphedema in the first 30 months post-incident breast cancer surgery, 223 (or 74.3%) were formally diagnosed while the remaining 77 (25.7%) had symptoms only. Among those developing the condition after 30 months post surgery, the proportion with “symptoms only” increased to 52.7% and 57.9%, respectively, for lymphedema incident between 30–36 months and 37–48 months post breast cancer surgery. In fact, over one-quarter of all cases of undiagnosed symptom only lymphedema occurred after 3 years from the initial breast cancer surgery.

The lowest panel of Table 1 describes lymphedema treatment prescribed to women in our sample. Among women formally diagnosed, nearly one in five (19.7%) received no rehabilitation interventions for the condition. Overall, 13.5% patients in the formally diagnosed group received the constellation of treatments encompassed by CDT; 55.8% were treated either with compression bandages, compression garments, or both; 8.3% reported receiving lymphatic massage only, and 2.8% received other treatments, most notably, skin care and exercises.

Factors Associated with a Formal Diagnosis of Lymphedema

Table 2 presents odds ratios (OR), p-values and 95% confidence intervals (CI) for the multivariate regression examining factors associated with having symptoms only and no formal diagnosis of lymphedema among all women with the condition. Black/African American women were significantly more likely to suffer from symptoms -only lymphedema than breast cancer survivors of other races or ethnicities (OR=2.7; 95% CI: 0.81–0.98). Compared to women with higher levels of social support, those ranking in the lowest quartile of the scale were also more likely to have undiagnosed lymphedema (OR=1.7; 95%CI=1.03–1.47).

Household income was a significant predictor of a formal diagnosis, with women with lower incomes being more likely to experience lymphedema symptoms that went without a formal diagnosis by a health care provider (OR=0.89; 95% CI=0.82–0.98). Once income was controlled for, Medicaid enrollment was not correlated with the probability of undiagnosed lymphedema. Being unmarried, on the other hand, did not increase a woman’s likelihood of undiagnosed lymphedema relative to her married counterparts. Similarly, obesity was not significantly associated with formal diagnosis.

Late onset lymphedema, proxied by survey wave in which women first reported symptoms or a formal diagnosis of the condition, was the main factor associated with the likelihood of symptoms-only lymphedema not diagnosed by a health care provider. Women reporting incident lymphedema between 30–36 months post breast cancer surgery were 3.6 times (95% CI= 2.04–6.22) more likely to have the condition go unnoticed and not addressed relative to those developing the condition earlier after the initial cancer treatment. For those developing lymphedema between 36 to 48 months post-incident breast cancer, the odds of undiagnosed lymphedema increased to 4.4 (95%CI= 2.54–7.69).

To put the results into perspective, we used our multivariate model to compute the probability that a woman with certain characteristics (e.g., Black/African American, late onset of lymphedema) would report having symptoms but *not* being formally diagnosed with lymphedema by a physician. For African American women, the adjusted probability of having symptoms only (and no “formal” diagnosis) was 56.6%. This probability decreased 21.3 points to 35.3% among women of other races. This difference represent the *independent* effect of race on the probability of undiagnosed lymphedema, after controlling for age, income, BMI and other confounding variables described above. Differences were also marked for late onset lymphedema. Patients developing lymphedema 36–48 months post breast cancer had a 38.8% adjusted probability of experiencing undiagnosed lymphedema, compared to 26.2% among those with earlier onset (within 2 years since breast cancer surgery).

Lymphedema Treatments among Women Formally Diagnosed

Table 3 presents descriptive information on the subset of breast cancer survivors who were formally diagnosed with lymphedema by type of prescribed lymphedema treatment. For the purpose of comparison, lymphedema patients receiving treatment including bandages with or without compression garments, were grouped as a single category as the most prevalent mode of lymphedema treatment. The rest of patients that reported receiving the treatment were grouped as following: (1) patients that received all components of Complete Decongestive Therapy (CDT) (is available in the specialized setting and performed by providers trained in the technique); (2) women that reported receiving Manual Lymphatic Drainage only; (3) patients that reported receiving other treatment components (exercise, skin care).

Findings from the multinomial logistic regression examining factors associated with receipt of (i) manual lymphatic drainage only, (ii) bandages and/or compression garments, or (iii) no treatment relative to the complete decongestive therapy (CDT) - indicate that, among those reporting being formally diagnosed with lymphedema, Black/African American breast cancer survivors were significantly more likely to go untreated (RRR=4.3; p<.001) or be prescribed bandages/compression only (RRR=17.1; p<.001) than to receive CDT. Somewhat surprising, higher educational achievement was not correlated with the likelihood of being treated with the CDT. The only additional factor predictive of treatment type in multivariate regressions was onset of lymphedema symptoms. Specifically, those developing the condition in later waves were more likely to receive no rehabilitation treatment at all (RRR= 7.5; p=.07 for wave 2 and RRR=10.8; p<.01 for wave 3, respectively) relative to CDT. Women diagnosed with lymphedema in wave 2 were also more likely to receive bandages/ compression garments rather than CDT (RRR=8.3; p=.04).

Discussion

In a recent NIH conference on Symptom Management in Cancer,[28] experts acknowledged that, while research has produced important new insights into the causes and cures of cancer, efforts to manage the symptoms of the disease and its treatment have not kept pace. In this study, we sought to advance our understanding of variations in use of lymphedema-related services and to identify gaps in service delivery with the ultimate goal of improving quality of life among breast cancer survivors living with lymphedema.

We found a strong gradient on undiagnosed lymphedema based on onset of the condition, with the odds of having symptoms only lymphedema with no formal diagnosis by a provider increasing three to four-fold among women with late onset lymphedema compared to patients in whom the condition had developed earlier following breast cancer surgery (<30 months). Evidence suggests that, when diagnosed early, lymphedema can be controlled more effectively, preventing worsening of the condition,[11,29–31] making these findings particularly relevant for quality improvement interventions. In fact, the volume of edema at the time of diagnosis is the single best predictor of successful treatment,[32–33] underscoring the importance of early diagnosis. These findings also bring into question the awareness of providers to the possibility of late onset lymphedema. Although two-thirds of the sample reported experiencing lymphedema symptoms by the first 30 months after incident breast cancer surgery, patients remained at risk for a much longer time, with lymphedema developing later after completion of cancer treatment in 33.3% of cases. These findings are consistent with results from several studies reporting that lymphedema in breast cancer survivors may occur many years following the initial cancer treatment.[1, 4, 5, 32–34] Armer et al., for example, report high frequency of lymphedema occurrence up to 60 months after the initial breast cancer treatment based on objective measures. Lymphedema with arm volume increase of 2cm by circumferential measurements (mild lymphedema) is reported in that study as the most frequently seen new onset lymphedema.[34]

Our data also suggest that, among women who were formally diagnosed by a provider with the condition, over 20% received none of the components of recommended effective interventions, raising concerns about accessibility and quality of follow up breast cancer care. Our findings also highlight important racial and socioeconomic disparities in the probability of formal diagnosis of lymphedema. The finding of significantly higher likelihood of undiagnosed lymphedema among African American breast cancer survivors is especially concerning given evidence of increased risk of lymphedema among African American women.[21,37] In addition, patients with lower income and limited social support were also at higher risk for undiagnosed lymphedema, a relevant finding considering that all women in our sample were insured by Medicare and many had supplemental insurance coverage, factors that might have influenced access to quality specialized medical care.

A number of factors have been associated with higher risk of developing lymphedema in patients treated for breast cancer. Number of lymph nodes resected is one such key risk factor for lymphedema.[17,35,37] Yen et al reports a substantially increased risk in patients with more than five lymph nodes resected based on contemporary prospective population-based study. Radiation therapy also increases the risk of lymphedema in patients who underwent axillary node dissection in combination with axillary radiation therapy.[38,39] Recent advancements in breast cancer treatment introduced effective and less invasive techniques, including sentinel lymph node dissection and newer radiation therapies that are often limited to the breast and chest wall. Recent studies found no association between these newer radiation therapy techniques and lymphedema.[18,35,37] Finally, there is also evidence that being obese at the time of diagnosis is associated with increased lymphedema risk in women undergoing breast cancer treatment.[18,21,32,36–38] Awareness of these risk factors might improve providers' ability to detect lymphedema and to address it accordingly with specialized individualized interventions depending on the extension of lymphedema. In the cases of mild lymphedema, the importance of patients' education on monitoring and surveillance of the condition is crucial in order to prevent further worsening of edema and incidence of related complications. Although such patients may not require the extensive CDT treatment, formal assessment by a specialized lymphedema provider would likely yield important benefits in terms of prevention of secondary complications.

Several important limitations of our study are worth mentioning. The first is our reliance on self-reports of lymphedema symptoms and diagnosis, albeit based on structured interviews and a validated screening tool for lymphedema. Evidence suggests, however, that patient self-reported symptoms on lymphedema correlate well with other measurement methods.[23,24] Ridner and colleagues have shown a high predictive ability ($c = 0.919$) between objective measures of swelling and self-report of arm swelling and heaviness.[24] Furthermore, several studies have demonstrated that self-reported measures of arm swelling and other symptoms such as those used here are consistently and negatively associated with breast cancer-specific quality of life measures, further validating their usefulness.[17,18,26] The second, and related, limitation is the lack of a measure of severity of lymphedema symptoms in our patient population, knowledge of which would have helped us further understand the "appropriateness" of the variability of treatments applied. It is also plausible, albeit unlikely, that a proportion of women in our sample had clinical symptoms of lymphedema but failed to report any symptoms of the condition.

Conclusions

Our results revealed that over one-quarter of all breast cancer survivors reporting symptoms consistent with lymphedema had not been formally diagnosed with the condition by a physician. Lymphedema treatments vary significantly among those diagnosed with the condition by a physician with only a small minority receiving the complete CDT therapy and nearly one in five receiving no interventions at all for the condition. Our results also highlight that lymphedema may occur many years following initial breast cancer treatment, and that time since initial breast cancer surgery reduces the likelihood that the condition will be formally diagnosed by a physician. These findings emphasize the importance of patient and provider education on the life-long risk and recognition of the signs/symptoms of lymphedema and the importance of early referral to a lymphedema expert for evaluation and treatment.

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References

1. Norman SA, Localio AR, Potashnik SL, et al. Lymphedema in breast cancer survivors: incidence, degree, time course, treatment, and symptoms. J Clin Oncol. 2009 Jan 20; 27(3):390–397. [PubMed: 19064976]
2. Clark B, Sitzia J, Harlow W. Incidence and risk of arm oedema following treatment for breast cancer: a three-year follow-up study. QJM. 2005 May; 98(5):343–348. [PubMed: 15820971]
3. Coen JJ, Taghian AG, Kachnic LA, Assaad SI, Powell SN. Risk of lymphedema after regional nodal irradiation with breast conservation therapy. Int J Radiat Oncol Biol Phys. 2003 Apr 1; 55(5):1209–1215. [PubMed: 12654429]
4. Geller BM, Vacek PM, O'rien P, Secker-Walker RH. Factors associated with arm swelling after breast cancer surgery. J Womens Health (Larchmt). 2003 Nov; 12(9):921–930. [PubMed: 14670172]
5. Petrek JA, Senie RT, Peters M, et al. Lymphedema in a cohort of breast carcinoma survivors 20 years after diagnosis. Cancer. 2001; 92:1368. [PubMed: 11745212]
6. Ridner SH. The psycho-social impact of lymphedema. Lymphat Res Biol. 2009; 7(2):109–112. [PubMed: 19534633]
7. Ahmed RL, Prizment A, Lazovich D, Schmitz KH, Folsom AR. Lymphedema and quality of life in breast cancer survivors: the Iowa Women's Health Study. J Clin Oncol. 2008 Dec 10; 26(35):5689–5696. Epub 2008 Nov 10. [PubMed: 19001331]
8. Shih YC, Xu Y, Cormier JN, et al. Incidence, treatment costs, and complications of lymphedema after breast cancer among women of working age: a 2-year follow-up study. J Clin Oncol. 2009 Apr 20; 27(12):2007–2014. [PubMed: 19289624]
9. Kwan W, Jackson J, Weir LM, Dingee C, McGregor G, Olivotto IA. Chronic arm morbidity after curative breast cancer treatment: prevalence and impact on quality of life. J Clin Oncol. 2002; 20:4242–4248. [PubMed: 12377968]
10. The diagnosis and treatment of peripheral lymphedema. 2009 Concensus Document of the International Society of Lymphology. International Society of Lymphology. Lymphology. 2009 Jun; 42(2):51–60. [PubMed: 19725269]
11. The diagnosis and treatment of lymphedema. Position statement of the National Lymphedema Network. Updated February 1011. National Lymphedema Network website (http://www.lymphnet.org/ScreeningandMeasurementforEarlyDetectionofBreastCancerRelatedLymphedema).

12. Lasinski BB, McKillip Thrift K, Squire D, et al. A systematic review of the evidence for complete decongestive therapy in the treatment of lymphedema from 2004 to 2011. PM R. 2012 Aug; 4(8): 580–601. [PubMed: 22920313]
13. McNeely ML, Magee DJ, Lees AW, Bagnall KM, Haykowsky M, Hanson J. The addition of manual lymph drainage to compression therapy for breast cancer related lymphedema: a randomized controlled tri. Breast Cancer Res Treat. 2004 Jul; 86(2):95–106. [PubMed: 15319562]
14. Williams AF, Vadgama A, Franks PJ, Mortimer PS. A randomized controlled crossover study of manual lymphatic drainage therapy in women with breast cancer-related lymphoedema. Eur J Cancer Care (Engl). 2002 Dec; 11(4):254–261. [PubMed: 12492462]
15. Petrek JA, Heelan MC. Incidence of breast carcinoma-related lymphedema. Cancer. 1998 Dec 15; 83(12 Suppl American):2776–2781. [PubMed: 9874397]
16. Armer J, Fu MR, Wainstock JM, Zagar E, Jacobs LK. Lymphedema following breast cancer treatment, including sentinel lymph node biopsy. Lymphology. 2004 Jun; 37(2):73–91. [PubMed: 15328760]
17. Engel J, Kerr J, Schlesinger-Raab A, Sauer H, Hölzel D. Axilla surgery severely affects quality of life: results of a 5-year prospective study in breast cancer patients. Breast Cancer Res Treat. 2003 May; 79(1):47–57. [PubMed: 12779081]
18. Paskett ED, Naughton MJ, McCoy TP, Case LD, Abbott JM. The epidemiology of arm and hand swelling in premenopausal breast cancer survivors. Cancer Epidemiol Biomarkers Prev. 2007 Apr; 16(4):775–782. [PubMed: 17416770]
19. Hamner JB, Fleming MD. Lymphedema therapy reduces the volume of edema and pain in patients with breast cancer. Ann Surg Oncol. 2007 Jun; 14(6):1904–1908. Epub 2007 Mar 8. [PubMed: 17342565]
20. Karadibak D, Yavuzsen T, Saydam S. Prospective trial of intensive decongestive physiotherapy for upper extremity lymphedema. J Surg Oncol. 2008 Jun 1; 97(7):572–577. [PubMed: 18459131]
21. Kwan ML, Darbinian J, Schmitz KH, et al. Risk factors for lymphedema in a prospective breast cancer survivorship study: the Pathways Study. Arch Surg. 2010 Nov; 145(11):1055–1063. [PubMed: 21079093]
22. Nattinger A, Pezzin LE, Sparapani RA, Neuner JM, King TK, Laud PW. “Heightened Attention to Medical Privacy: Challenges for Unbiased Sample Recruitment and a Possible Solution”. American Journal of Epidemiology. 2010; 172(6):637–644. [PubMed: 20660123]
23. Tewari N, Gill PG, Bochner MA, Kollias J. Comparison of volume displacement versus circumferential arm measurements for lymphoedema: implications for the SNAC trial. ANZ J Surg. 2008 Oct; 78(10):889–893. [PubMed: 18959643]
24. Ridner SH, Montgomery LD, Hepworth JT, Stewart BR, Armer JM. Comparison of upper limb volume measurement techniques and arm symptoms between healthy volunteers and individuals with known lymphedema. Lymphology. 2007 Mar; 40(1):35–46. [PubMed: 17539463]
25. Klabunde CN, Legler JM, Warren JL, Baldwin LM, Schrag D. A refined comorbidity measurement algorithm for claims-based studies of breast, prostate, colorectal, and lung cancer patients. Ann Epidemiol. 2007; 17(8):584–590. [PubMed: 17531502]
26. RAND Health. Medical Outcomes Study: Social Support Survey. Available from URL: http://www.rand.org./health/surveys_tools/mos/mos_socialsupport.html.
27. Sherbourne CD, Stewart AL. The MOS social support survey. Soc Sci Med. 1991; 32(6):705–714. [PubMed: 2035047]
28. Patrick DL, Ferketich SL, Frame PS, Harris JJ, Hendricks CB, Levin B, et al. National Institutes of Health State-of-the-Science Conference Statement: Symptom management in cancer, July 15–17, 2002. Journal of the National Cancer Institute. Monographs. (32):9.
29. Stout Gergich NL, Pfalzer LA, McGarvey C, Springer B, Gerber LH, Soballe P. Preoperative assessment enables the early diagnosis and successful treatment of lymphedema. Cancer. 2008 Jun 15; 112(12):2809–2819. [PubMed: 18428212]
30. Shih YC, Xu Y, Cormier JN, et al. Incidence, treatment costs, and complications of lymphedema after breast cancer among women of working age: a 2-year follow-up study. J Clin Oncol. 2009 Apr 20; 27(12):2007–2014. [PubMed: 19289624]

31. Vignes S, Porcher R, Arrault M, Dupuy A. Long-term management of breast cancer-related lymphedema after intensive decongestive physiotherapy. Breast Cancer Res Treat. 2007 Mar; 101(3):285–290. [PubMed: 16826318]
32. Johansson K, Branje E. Arm lymphoedema in a cohort of breast cancer survivors 10 years after diagnosis. Acta Oncol. 2010; 49(2):166–173. [PubMed: 20100154]
33. Ramos SM, O'Donell LS, Knight G. Edema volume, not timing, is the key to success in lymphedema treatment. Am J Surg. 1999 Oct; 178(4):311–315. [PubMed: 10587190]
34. Armer JM, Stewart BR. Post-breast cancer lymphedema: incidence increases from 12 to 30 to 60 months. Lymphology. 2010 Sep; 43(3):118–127. [PubMed: 21226414]
35. Yen TW, Fan X, Sparapani R, Laud PW, Walker AP, Nattinger AB. A contemporary, population-based study of lymphedema risk factors in older women with breast cancer. Ann Surg Oncol. 2009; 16(4):979–988. [PubMed: 19194754]
36. Mandelblatt JS, Edge SB, Meropol NJ, et al. Predictors of long-term outcomes in older breast cancer survivors: perceptions versus patterns of care. J Clin Oncol. 2003; 21:855–863. [PubMed: 12610185]
37. Meeske KA, Sullivan-Halley J, Smith AW, et al. Risk factors for arm lymphedema following breast cancer diagnosis in Black women and White women. Breast Cancer Res Treat. 2009 Jan; 113(2):383–391. [PubMed: 18297429]
38. Erickson V, Pearson M, Ganz P, Adams J, Kahn K. Arm edema in breast cancer patients. JNCI. 2001 Jan; 93(2):96–111. [PubMed: 11208879]
39. Kiel KD, Rademacker AW. Early-stage breast cancer: arm edema after wide excision and breast irradiation. Radiology. 1996; 198:279–283. [PubMed: 8539394]

Table 1

Sample Characteristics, Overall and by Lymphedema Diagnosis Status

	Overall N=450	**Formally Diagnosed N=290**	**Symptoms Only N=160**	**p-value**
Age Group (%)				
65–69	34.7	36.9	30.6	.18
70–74	34.4	33.1	36.9	
75–79	21.6	21.7	21.3	
80+	9.3	8.3	11.3	
Race (%)				
Caucasian	89.3	90.3	87.5	.04
Black	4.2	2.8	6.9	
Hispanic	3.6	3.8	3.1	
Other race/ethnicity	2.9	3.1	2.5	
Education (%)				
Less than High School	7.3	6.6	8.8	.61
High School	38.4	39.3	36.9	
Some College	53.1	53.8	51.9	
Marital Status (%)				
Married	46.7	48.3	43.8	.27
Single	2.4	2.1	3.1	
Divorced	10.9	9.7	13.1	
Widowed	38.9	39.7	37.5	
Income (mean/ std dev)	28,279(28,728)	31,042(31,989)	23,272(20,770)	
Income Categories (%)				
Less than $15,000	20.9	18.3	25.6	.06
$15,000–$29,999	30.7	31.7	28.8	
$30,000–$44,999	15.8	16.2	15.0	
$45,000+	16.7	19.0	12.5	
Missing Income Information	16.0	14.8	18.1	
Low Social Support (%)	0.25	0.21	0.34	<.001
Dually Enrolled in Medicare & Medicaid (%)	5.6	4.5	7.5	.18
BMI (mean/std dev)	27.8(5.2)	27.9(5.4)	27.7(4.9)	.88
Obese (BMI>30) (%)	0.32	0.29	0.34	.27
Months to incident lymphedema after breast cancer surgery (%)				
< 30	66.7	76.9	48.1	.02
≈ 30–36	16.4	12.1	24.4	
≈ 36–48	16.9	11.0	27.5	

	Overall N=450	Formally Diagnosed N=290	Symptoms Only N=160	p-value
State of Residence (%)				
CA	27.3	27.9	26.3	.18
NY	16.0	15.5	16.9	
IL	18.4	20.7	14.4	
FL	38.2	35.9	42.5	
Lymphedema Treatment (%)				
No treatment	41.3	19.7	80.6	
Complete Decongestive Therapy	8.7	13.5	0	
Manual Lymphatic Drainage	5.3	8.3	0	
Bandages	23.5	36.5	0	
Compression only	12.4	19.3	0	
Other (exercise, skin treatment)	8.7	2.8	19.4	

Note: P-value based on two-sided t- (continuous variable) and F-test statistics (categorical variables).

Table 2

Factors Associated with Undiagnosed, Symptoms-only Lymphedema

	Odds Ratio	P-value	95% CI
Age	1.00	.94	.96–1.04
Race: Black/African American	**2.69**	**.06**	.81–.98
Education: High school or greater	0.63	.22	0.29–1.33
Marital status: Unmarried	0.93	.77	0.59–1.48
Income	**0.89**	**.01**	0.82–0.98
Low Social Support	**1.67**	**.03**	1.03–2.70
BMI	0.87	.61	0.52–1.47
Time Since Breast Cancer Surgery			
Wave 1: ≈ 30 mos post-surgery	Reference		
Wave 2: ≈ 36 mos post-surgery	**3.57**	**.00**	2.04–6.22
Wave 3: ≈ 48 mos post-surgery	**4.42**	**.00**	2.54–7.69
State of Residence			
CA	Reference		
NY	1.18	.63	0.60–2.30
IL	0.75	.39	0.39–1.44
FL	1.47	.15	0.87–2.49

Note: Sample size for this analysis is 450 breast cancer survivors who developed lymphedema any time in the first 48 months post breast cancer surgery. In addition to the variables shown in the table, the regression equation included binary variables for missing BMI (for women not reporting height or weight), missing income (for women not reporting household income), and a constant term.

Table 3

Distribution of Breast Cancer Respondents Formally Diagnosed with Lymphedema, by Prescribed Lymphedema Treatment

	Complete Decongestive Therapy N=39	**Bandages and/or Compression Only N=162**	**Manual Lymphatic Drainage Only N=24**	**No treatment[a] N=65**
Distribution (%)				
Age Group (%)				
65–69	28.2	38.3	29.2	41.5
70–74	59.0	30.2	33.3	24.6
75–79	10.3	22.2	33.3	23.1
80+	2.6	9.3	4.2	10.8
Race (%)				
Caucasian	92.3	87.7	100	92.3
Black	0	4.3 b	0	1.5 b
Hispanic	5.1	4.3	0	3.1
Other race/ethnicity	2.6	3.7	0	3.1
Education (%)				
Less than High School	7.7	6.8	0	7.7
High School	33.3	43.2	33.3	35.4
Some College	56.4	50.0	66.7	56.9
Marital status (%)				
Married	51.3	52.5	37.5	40.0
Single	5.1	2.5	0	0
Divorced	15.4	6.8	12.5	12.3
Widowed	28.2	37.7	50.0	47.7
Income/10,000 (mean/ std dev)	3.4(4.4)	3.0(3.1)	3.0(2.3)	3.2(2.8)
Income Categories (%)	20.5	19.8	8.3	16.9
Less than $15,000	23.1	30.9	45.8	33.8
$15,000–$29,999	12.8	16.0	16.7	18.5
$30,000–$44,999	23.1	17.9	16.7	20.0
$45,000+	20.5	15.4	12.5	10.8
Missing Income Information				
Dually Enrolled in Medicare & Medicaid (%)	0	6.2	4.2	3.1
Social Support (mean/std dev)	75.9(21.0)	73.2(26.6)	74.7(24.4)	77.5(21.2)
Body Mass Index (mean/std dev)	29.0(5.6)	27.8(5.2)	25.2(4.8)	28.4(5.9)
Survey Wave at Diagnosis (%)				

	Complete Decongestive Therapy N=39	**Bandages and/or Compression Only N=162**	**Manual Lymphatic Drainage Only N=24**	**No treatment[a] N=65**
Wave 1: ≈ 30 mos post-surgery	92.3	78.4	83.3	61.5
Wave 2: ≈ 36 mos post-surgery	2.6	15.4[b]	12.5	9.2[b]
Wave 3: ≈ 48 mos post-surgery	5.1	6.2	4.2	29.2[b]
State (%)				
CA	25.6	25.9	29.2	33.8
NY	17.9	14.8	12.5	16.9
IL	17.9	27.2	12.5	9.2
FL	38.5	32.1	45.8	40.0

[a] Includes 8 patients whose treatment consisted of skin treatment or exercise only.

[b] Indicates variables found to be statistically significant based on the multinomial logistic regression (reference category=CDT). Specifically, Black/African American breast cancer survivors were significantly more likely to go untreated (RRR=4.3; p<.001) or to be prescribed bandages/compression only (RRR=17.1; p<.001) than to receive CDT. Women developing lymphedema in wave 2 were more likely to receive no rehabilitation treatment at all (RRR= 7.5; p=.07) or to be treated with bandages/compression garments only (RRR=8.3; p=.04) rather than receiving CDT. Women developing lymphedema in wave 3 were also more likely to go untreated (RRR=10.8; p<.01) than to receive CDT.