Breast Cancer–Related Lymphedema: Comparing Direct Costs of a Prospective Surveillance Model and a Traditional Model of Care

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Secondary prevention involves monitoring and screening to prevent negative sequelae from chronic diseases such as cancer. Breast cancer treatment sequelae, such as lymphedema, may occur early or late and often negatively affect function. Secondary prevention through prospective physical therapy surveillance aids in early identification and treatment of breast cancer–related lymphedema (BCRL). Early intervention may reduce the need for intensive rehabilitation and may be cost saving. This perspective article compares a prospective surveillance model with a traditional model of impairment-based care and examines direct treatment costs associated with each program. Intervention and supply costs were estimated based on the Medicare 2009 physician fee schedule for 2 groups: (1) a prospective surveillance model group (PSM group) and (2) a traditional model group (TM group). The PSM group comprised all women with breast cancer who were receiving interval prospective surveillance, assuming that one third would develop early-stage BCRL. The prospective surveillance model includes the cost of screening all women plus the cost of intervention for early-stage BCRL. The TM group comprised women referred for BCRL treatment using a traditional model of referral based on late-stage lymphedema. The traditional model cost includes the direct cost of treating patients with advanced-stage lymphedema. The cost to manage early-stage BCRL per patient per year using a prospective surveillance model is $636.19. The cost to manage late-stage BCRL per patient per year using a traditional model is $3,124.92. The prospective surveillance model is emerging as the standard of care in breast cancer treatment and is a potential cost-saving mechanism for BCRL treatment. Further analysis of indirect costs and utility is necessary to assess cost-effectiveness. A shift in the paradigm of physical therapy toward a prospective surveillance model is warranted.

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New models of care are emerging that promote rehabilitation as a component of secondary prevention for chronic disease.[1–6] *Secondary prevention* is defined as prospective monitoring and screening, often in the absence of impairment, to prevent common chronic disease–related sequelae.[7] Through interval monitoring and screening, early identification of disease-related impairments becomes possible, prompting early intervention. Therefore, a prospective surveillance model enables health care providers to meet the pending needs of patients when disease morbidity is less severe, potentiating improved functional outcomes and even cost savings. Emerging data demonstrate the efficacy of rehabilitation-based secondary prevention models to prevent sequelae from chronic diseases such as diabetes, heart disease, obesity, and cancer.[8–11]

Secondary prevention for cancer treatment–related morbidity is an important consideration in physical therapist practice. Numerous functional impairments result from common cancer treatments and can be prevented or alleviated with rehabilitation interventions.[12–14] Breast cancer treatment typically includes chemotherapy, radiation therapy, and surgery, all known to instigate acute and late functional morbidity.[15–18] Every person undergoing breast cancer treatment has a lifelong risk for a variety of treatment-related physical impairments, including pain, loss of upper-extremity strength and range of motion (ROM), fatigue, lymphedema, and others.[15,19–21] Prospective monitoring of patients after breast cancer treatment enables early intervention when these common impairments are less severe.[22]

Lymphedema Defined

Lymphedema is a swelling condition, resulting from lymphatic ablation during breast cancer treatment, that affects approximately one third of women during and after treatment.[23–30] The condition is lifelong, chronic, and associated with a significant direct and indirect cost burden in advanced stages.[31] Findings demonstrate that breast cancer–related lymphedema (BCRL) may be reversed and the progression prevented using a secondary prevention model that utilizes preoperative assessment and ongoing interval surveillance.[32–34] Prospective surveillance, conducted through at least the first postoperative year, enables identification and treatment of lymphedema at the earliest onset when it can be managed conservatively as opposed to managing advanced-stage, chronic lymphedema, which entails more intensive and costly care.

Due to the extended treatment period for breast cancer and the prolonged latency period when lymphedema may present, ongoing prospective interval surveillance is an optimal approach to enable early detection and intervention.[33–35] This model, however, is not the standard of care. Instead, a traditional impairment-based rehabilitation model is typically followed. The traditional model relies on a clinically apparent, visible swelling to be present in the limb and for a health care provider (or patient) to recognize this swelling as advanced-stage lymphedema and to seek care. This approach often results in missed or delayed diagnoses and a protracted time line for the patient to receive necessary treatment.[36] A primary reason for this reactive approach is our current health care delivery and reimbursement systems, which recognize and pay only for procedures provided to patients with chronic illness after impairment diagnosis.[37] We believe the paradigm of rehabilitation must shift toward secondary prevention, including monitoring and screening, to accommodate the needs of patients with chronic diseases known to cause functional disability.[8]

Direct costs associated with managing advanced-stage lymphedema include health care provider visits for extended periods of intensive therapy, ongoing lifetime medical follow-up visits, and costly durable medical goods, including compression garments and bandages. Indirect costs such as hospitalizations for infections, antibiotics, lost time at work, and lost or diminished quality of life also are substantial.[31,38] A prospective surveillance model may prevent the progression of lymphedema to a chronic stage, thereby reducing this cost burden.[32,33]

Analyses of direct and indirect cost data and of cost-benefit and cost-effectiveness studies of prospective surveillance for lymphedema management are lacking. The purpose of this article is to present the construct of a prospective surveillance model and provide an estimation of the direct treatment costs associated with a prospective surveillance model of care compared with the direct treatment costs of a traditional model for managing BCRL.

Methods and Assumptions

This cost analysis was undertaken from an institutional perspective. Average retail costs were considered for durable medical equipment. Administrative data-costing methods for treatment interventions and resource utilization were ingredient based, where quantities of equipment and services rendered by the provider were multiplied by their respective prices to derive a total cost.[39,40] Incidence data were used to approximate newly diagnosed cases.[30,33,41–44] Only direct treatment costs associated with intervention were analyzed.

Due to disparate incidence reports associated with diagnosed cases of

BCRL, a sensitivity analysis was conducted using Microsoft Excel (Microsoft Corporation, Redmond, Washington) Goal Seek and what-if analysis functions for the incidence rate variable associated with each model. Goal Seek threshold values were based on the cost of the alternate model base case cost (established at an incidence rate of 33.5/100). The analysis also evaluated the cost impact of an estimated rate of disease progression that may occur as a part of the natural history of early lymphedema. Estimated progression rates from early-stage to advanced-stage lymphedema were calculated in a 1:1 rate of progression using what-if analysis functions in Excel.

Definition of Terms

For the purposes of this article, we have chosen to use the following terminology and definitions:

Direct treatment costs: The cost of a treatment visit with a physical therapist and the cost of durable medical equipment associated with condition treatment and management. Costs such as patient co-pay and other out-of-pocket expenses as well as indirect costs are not considered.

Early-stage lymphedema: Lymphedema that is diagnosed at stage 0 or stage I. The condition may or may not be clinically apparent and is amenable to conservative treatment.[32,45]

Advanced-stage lymphedema: Lymphedema that is diagnosed at stage II or higher. The condition is visible, palpable, and requires skilled intervention for treatment. It also is chronic and requires ongoing care. There may or may not be associated functional morbidity.[32,45,46]

Prospective Model of Care

The prospective surveillance model incorporates examination of physical and functional domains into the medical model currently used for breast cancer care. The prospective surveillance model utilizes physical therapists who are experts in movement dysfunction to provide preoperative examination, education, ongoing clinical monitoring, early identification, and intervention for lymphedema.

A preoperative assessment visit involves examination, education, and advice for return to activity postoperatively. This baseline examination establishes upper-limb ROM, muscle strength, limb volume, anthropometric measures (eg, body mass index), functional status, and level of physical activity. Education is provided for a postoperative plan of care including exercises for ROM and strength restoration, advice on returning to activities during and after treatment, and how to monitor for signs and symptoms of early adverse effects of treatment such as pain, joint immobility, weakness, and lymphedema.

Regular follow-up visits for routine surveillance are conducted at 3-month intervals postoperatively to repeat baseline tests and measures, identify changes indicative of impaired body structure and function, and provide ongoing education and monitoring for potential early and late adverse effects of treatment. If an impairment is detected, the therapist will implement a plan of care to alleviate and mitigate the conditions.

In an earlier study, we demonstrated successful management of BCRL using a conservative compression intervention in the context of a prospective surveillance model.[32] This approach utilized only minimal physical therapy and durable medical equipment resources for early-stage lymphedema management and has been shown to be clinically effective.[34,44,47] We make the assumption in this proposed cost model that in the context of a prospective surveillance model, lymphedema will be detected at its earliest onset and conservatively managed according to the outlined protocol for care. The prospective surveillance model matches incidence rates for BCRL and represents a cross-section of survivors of breast cancer who are diagnosed with early-stage lymphedema over a 1-year period. Table 1 outlines the prospective surveillance model protocol.

Traditional Model of Care

Advanced-stage lymphedema requires intensive decongestive therapy for adequate management. The gold standard for lymphedema treatment is decongestive therapy requiring daily intervention followed by ongoing lifetime maintenance of the condition.[45,48–50] Complete decongestive therapy (CDT) requires daily, one-on-one skilled therapy with a specialized provider over the course of 4 to 6 weeks.[48,51] Complete decongestive therapy also requires complex materials for limb volume decongestion, including short-stretch compression bandages, various types of padding, and other materials to bandage the limb.[28,52] Upon optimal limb decongestion, compression garments are applied daily to prevent reaccumulation of fluid in the limb.[53] Compression garments are replaced at 6- to 9-month intervals to ensure effectiveness and are optimally prescribed in multiplicity for ease of wear and care. Patients typically require various styles of garments such as a sleeve and hand compression piece for the upper limb.

Lymphedema is a progressive condition if not treated, and delayed diagnosis often results in a more advanced, clinically apparent condition.[54,55] A traditional model of care requires the physician to be aware of conditions such as lymphedema and to make an accurate and timely diagnosis as well as an appropriate referral to therapy. Current medical provider awareness is poor, often

Table 1.
Intervention Protocols With Cost Outline for Skilled Therapy and Durable Medical Equipment Costs With a 1-Year Timeline

Services and Supplies	Prospective Surveillance Model	Cost	Traditional Model	Cost
Skilled therapy	• All patients are seen for baseline (preoperative) and 1-, 3-, 6-, 9-, and 12-month postsurgery visits (6 visits) • Initial visit: coded as an evaluation (97001–1 visit) • Follow-up: coded as re-evaluation (97002–5 visits) Prospective surveillance model cost If lymphedema is diagnosed: • If greater than 3%–5% volume increase, a ready-made sleeve and gauntlet are issued for daily wear for 4 weeks • Patient returns in 4 weeks for follow-up (97002–1 visit) • If volume is reduced, continue surveillance schedule • Continue modified garment use • Replace garments in 6–9 months • If volume is not reduced, initiate decongestive therapy	 $69.29 $185.75 $255.04 $37.15	If lymphedema is diagnosed: • Patient is referred by the medical provider for therapy • Initial visit: coded as an evaluation (97001–1 visit) • Decongestive therapy: 5 visits/week for 2 weeks then 3 visits/week for 1 week[a] • Each visit is 1 hour in duration and requires one-to-one care (4 units of 97140 each visit for 13 visits) • At the completion of therapy, patient receives custom-made compression garments (sleeve and gauntlet) • One additional visit is undertaken 6 months later for renewal of garments (97002–1 visit)	 $69.29 $1,388.48 $37.15
Compression bandage supplies	None required	$0	2 sets of bandages	$230.00
Compression garment supplies	4 ready-made arm sleeves 4 ready-made hand gauntlets	$344.00	4 custom-made arm sleeves 4 custom-made hand gloves	$1,400.00
Prospective surveillance model cost		$636.19	Traditional model cost	$3,124.92

[a] Average length of therapy frequency and duration.

resulting in diagnosis and referral for treatment only when lymphedema has reached an advanced stage.[56] The traditional model also depends on the patient seeking medical attention when the signs and symptoms of lymphedema are present. The combination of these factors may lead to delayed diagnosis.

The current practice standard for managing BCRL with CDT does not differentiate between early-stage and advanced-stage lymphedema. Therefore, patients diagnosed with lymphedema receive standard CDT, with the duration of therapy varying based on severity. The interventions are typically not adjusted in their application; therefore, mild and severe cases are managed with the same CDT protocol.

In the following cost representation, we assumed that the traditional model for managing BCRL requires CDT intervention as described previously.[45,49–51] The traditional method matches the incidence rates for BCRL and represents a cross-sectional perspective of survivors of breast cancer who are diagnosed with lymphedema over a 1-year period after surgery. The clinical protocol for the traditional model is outlined in Table 1.

Based on these models of care, direct treatment cost assumptions were made for 2 groups of survivors of breast cancer. The cost data provided herein relied on assumptions made about the population of survivors of breast cancer, the epidemiology of BCRL, evidence-based care for lymphedema, and treatment procedural costs based on the 2009 Medicare physician fee schedule.[39,57] Only direct treatment costs were considered for patient care visits and materials prudent to manage lymphedema. No indirect costs were measured. Table 1 provides a comparison of each intervention protocol along with the cost at each point of intervention.

PSM group. We assumed that all women treated for breast cancer will be followed according to the prospective surveillance model for 1 year and that one third of the women, based on average incidence data, will develop lymphedema. We further assumed that by using the prospective surveillance model, lymphedema will be identified at an early stage and managed conservatively. In the base case cost model, we assumed that none of these women will progress to advanced-stage lymphedema in the first year and, therefore, that none will require decongestive therapy. We then extrapolated, using what-if analyses, on how lymphedema progression would theoretically change the cost of care if progression occurred.

Table 2.
Medicare 2009 Fee Schedule for *Common Procedural Terminology* (CPT) Codes Used With Lymphedema Management

CPT Code	Descriptor	Fee	Unit Assumptions
97001	Physical therapist evaluation	$69.29	1 unit/session
97002	Physical therapist re-evaluation	$37.15	1 unit/30 days, with exceptions for altered status
97140	Manual therapy techniques	$25.74	1 unit/15 minutes

TM group. We assumed that a traditional model of physician follow-up will identify women with lymphedema at the same average incidence rate (ie, one third of women over a 1-year period). We assumed that the physician will refer these women for therapy and that CDT will be delivered.

Using the 2009 Medicare physician fee schedule,[57] we outlined costs for the prospective surveillance model and the traditional model based on the above assumptions using *Current Procedural Terminology* (CPT) codes specific to physical therapy care for BCRL. These fees are listed in Table 2. *Current Procedural Terminology* codes are well defined to capture the examination and procedural interventions conducted by the physical therapist.[58] In the absence of cost points associated with Medicare Healthcare Common Procedural Coding System (HCPCS) codes for durable medical equipment related to lymphedema, we relied on cost data averaged from 3 United States–based materials distributors to determine costs for materials based on a typical lymphedema arm bandage kit and standard-of-care compression garments for the arm and hand.* In advanced-stage lymphedema, compression garments should be custom made to ensure optimal fit and to adequately manage the chronic nature of the condition.[59] Custom-made garment cost estimates were averaged from 3 world-wide garment manufacturers.† Estimated materials costs are identified in Table 3.

Findings

Table 1 compares the cost breakdown based on CPT billing codes for the prospective surveillance model and for the traditional model for BCRL intervention. The table depicts the associated direct treatment costs per unit of skilled care combined with the durable medical equipment costs based on the respective protocol. Our direct treatment cost assumptions yielded the following cost per patient per year for each group (Tab. 1). The direct treatment cost of managing one patient with BCRL per year using a prospective surveillance model whereby lymphedema is detected and treated conservatively at an early stage is $636.19. The cost of treating one patient with advanced lymphedema per year using a traditional model is $3,124.92.

Figure 1 outlines a calculation of costs per 100 patients, considering the above incidence rates assumptions. The cost of a prospective surveillance model for 1 year is $38,272.83. This calculation includes the cost of surveillance for 100 women (as shown in Tab. 1, the direct treatment cost of conducting only the prospective surveillance model program based on the protocol for care is $255.04 per patient per year). We added to that the cost of intervention for early-stage BCRL treatment for 33.5 of those women. The cost of treating the same number of women with advanced BCRL using the traditional model of care is $104,684.82. The traditional model does not include any surveillance monitoring in the protocol for care.

A sensitivity analysis was conducted for varied incidence rates associated with each protocol to adjust for disparity of reported incidence of BCRL in the literature and enable comparison between models at various rates. Disease incidence reports specific to BCRL range from 10% to 48%.[26,30,54,60] Using varied incidence rates, the prospective surveillance model cost ranges from $29,315.50 to $43,799.20, and the traditional model cost ranges from $32,811.66 to $149,996.16 (Fig. 2). Comparing these models with consideration for varied incidence rates, we found that treating more than 12.5 patients per year with the traditional model would exceed the base case cost of the prospective surveillance model (based on an incidence rate of 33.5/100). Conversely, treating all 100 patients with the prospective surveillance model and anticipating that all patients would develop BCRL remains below the base case cost for

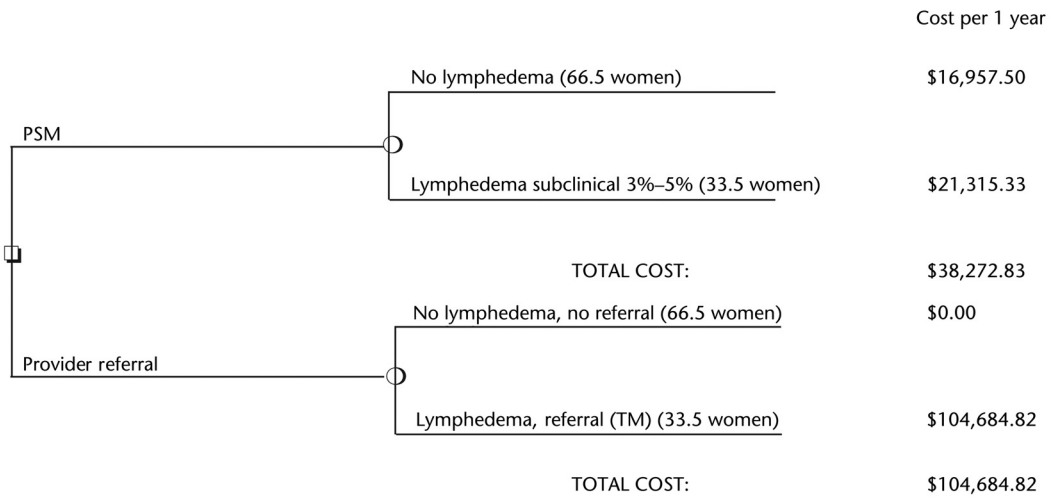
Table 3.
Direct Cost Assumptions for Durable Medical Materials to Manage Lymphedema

Material	Cost
Bandages/set[a]	$115.00
Ready-made sleeve[b]	$54.00 each
Ready-made gauntlet[b]	$32.00 each
Custom-made sleeve[c]	$145.00 each
Custom-made gauntlet[c]	$205.00 each

[a] Average cost based on information from 3 materials distributors in the United States.
[b] Average cost based on information from 3 garment distributors in the United States.
[c] Average cost based on information from 3 custom-made garment manufacturers worldwide.

* Lymphedema arm bandaging kit and ready-made garment estimates: www.northamericanrehab.com, www.bandagesplus.com, and www.lymphedemaproducts.com.

† Custom-made garment estimates: BSN Medical Inc (Charlotte, North Carolina), Juzo USA Inc (Cuyahoga Falls, Ohio), and Medi USA (Whitsett, North Carolina).



Intervention	Cost
Prospective monitoring all patients and treating with early intervention protocol (PSM)	$38,272.83
Impairment-based intervention (TM)	$104,684.82

Figure 1.
Decision tree for prospective surveillance model (PSM) versus the traditional model (TM) with direct cost data per 100 women with breast cancer.

the traditional method (based on an incidence rate of 33.5/100). However, the traditional method at the lowest cost estimate of treating 10/100 patients per year is less costly than the prospective surveillance model base case cost model. The rate of 10/100, however, is a very low estimate of diagnosed cases.

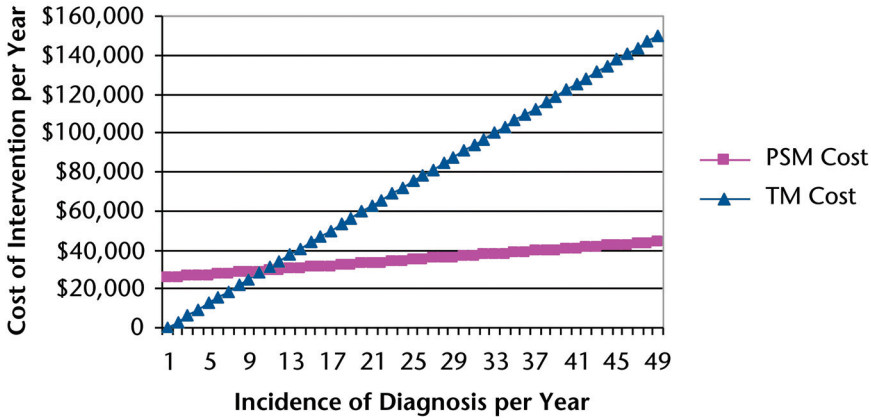


Figure 2.
Sensitivity analysis comparing varied incidence rates of lymphedema in the prospective surveillance model (PSM) and the traditional model (TM).

We then used a what-if analysis to examine how progression of early-stage lymphedema to advanced-stage lymphedema would affect our assumptions. We advanced cases from early to advanced stage in a 1:1 ratio. This analysis demonstrated that 27/100 patients or 80.5% of the anticipated 33.5/100 cases diagnosed through the prospective surveillance model would have to progress to advanced-stage lymphedema for the cost to eclipse the base case cost of the traditional model based on our assumptions. Table 4 reflects the direct cost shift associated with progressing patients from the prospective surveillance model to the traditional model.

Discussion

Prospective surveillance is clinically effective for early identification and

Table 4.
Direct Treatment Cost Associated With Progression of Early-Stage Lymphedema in the Prospective Surveillance Model

% Progression From Early Stage	Early-Stage Cases	Late-Stage Cases	Cost
0	33.5	0	$38,272.53
10	30.5	3	$45,735.95
20	26.5	7	$55,687.19
30	23.5	10	$63,150.63
40	20.5	13	$70,614.05
50	16.5	17	$80,565.30
60	13.5	20	$88,028.72
70	10.5	23	$95,492.16
80	6.5	27	$105,443.39[a]
90	3.5	30	$112,906.83
100	0	33.5	$120,370.25

[a] Threshold where cost associated with early-stage progression eclipses cost of the traditional model.

treatment of impairments commonly encountered after breast cancer treatment including BCRL.[32,34,47,61,62] Gordon et al[63] investigated the cost-effectiveness of prospective rehabilitation support services for women with breast cancer. Although not specific to BCRL, aspects of their model for intervention include lymphedema education and management. Their findings suggest that prospective interval assessment involving patient education and home-based exercise is the most cost-effective method to facilitate optimal rehabilitation outcomes.[63] These authors further suggested in a subsequent cost analysis that the economic impact of breast cancer treatment sequelae is substantial and has a continued impact on women with breast cancer who have survived longer than 18 months following treatment.[64] Earlier work by Chirikos and colleagues[65] suggested that functional impairments persist even 5 years after the completion of breast cancer treatment and negatively affect a woman's ability to work and complete daily activities, contributing to negative economic consequences. These findings suggest that ongoing, prospective surveillance should be incorporated during and after treatment to potentially mitigate or prevent treatment-related sequelae and reduce the economic burden encountered after breast cancer treatment.

The current standard of care for lymphedema treatment does not delineate the intensity of intervention among different levels of disease severity. Upon diagnosis of lymphedema, all patients are treated with the same CDT intervention. Emerging research in prospective surveillance demonstrates that more conservative treatment is clinically effective in early stages of lymphedema and does not require the components of an intense CDT program. Conservative treatment, however, has been shown to be effective only in early-stage lymphedema. Utilization of a prospective surveillance model for identification of early-stage BCRL may negate or greatly reduce the need for decongestive therapy and resource utilization by diminishing the severity of the condition.[32,33] We speculate that a prospective surveillance model also may be a means to decrease overall direct health care costs compared with a traditional model of care. However, to adequately assess cost from a societal perspective, efforts are needed to quantify additional cost-sensitive variables such as time lost from work and daily activities, quality of life, and potential disability.[39,66,67] A cost-effectiveness analysis is beyond the scope of this article; however, cost-effectiveness analysis should be pursued as a future opportunity to compare models for feasibility. A cost-effectiveness analysis must use a societal perspective to have validity in representing all aspects of cost and utility for an intervention.[67,68] Our work does not consider indirect costs, nor do we extrapolate costs for other conditions commonly associated with lymphedema such as infection, cellulitis, and blood clots, which may require more intensive therapies such as antibiotics, tests and procedures, and even hospitalizations. Evidence shows that these comorbidities occur more frequently in patients with advanced-stage lymphedema, suggesting that a prospective model that prevents the progression of lymphedema may play a role in reducing these costly events.[69]

Lymphedema incidence rates vary widely in the literature. Some studies have looked retrospectively at an aggregate cohort over a period of many years to derive a disease state–specific incidence rate.[23,24] These analyses are inadequate to inform rates of onset over a set time period (ie, 1 year after treatment). In studies that do focus on estimates of disease onset over a set time period, many fail to substratify into mild versus moderate versus severe cases.[70] These limitations make estimates of incidence very difficult to specify.

We chose to estimate the incidence rate of lymphedema onset based on prospective studies and their reported incidence rates of lymphe-

dema from before surgery to 1 year postsurgery.[30,41–44] We determined the range of reported onset of lymphedema during this time to be 10% to 48% and examined changes in the direct costs at these various rates. As evidenced by the sensitivity analysis, the prospective surveillance model is less costly at nearly every level of incidence rate (Fig. 2). Only when the incidence rate of advanced-stage lymphedema is less than 12.5% does it becomes more expensive to utilize the prospective surveillance model. However, if the incidence of early-stage lymphedema falls concomitantly, the threshold for cost savings is lowered as well. The model demonstrates that unless the overall incidence rate for all lymphedema falls below 8%, the prospective surveillance model is always a less costly intervention.

We make the assumption that over the course of 1 year, none of the patients treated in the prospective surveillance model with the early conservative compression intervention will progress. This assumption is based on our previous research,[32] which demonstrated clinical efficacy for this model in early detection and management of mild lymphedema over a 1-year period. In that cohort, no patients diagnosed with early lymphedema and treated using the prospective surveillance model progressed to an advanced stage over the first year. Lymphedema, however, does present a risk of progression to an advanced stage. Long-term follow-up studies have yet to be conducted regarding the progression rate of early-stage lymphedema managed using the prospective surveillance model intervention.

Our analysis revealed that 80.5% (27 cases) of those patients assumed to be diagnosed with early-stage lymphedema using the prospective surveillance model would have to progress to advanced-stage lymphedema before the prospective surveillance model becomes as costly as the traditional model at base case estimate (Tab. 4). Bar Ad et al[54] demonstrated progression to severe lymphedema in up to 48% of patients diagnosed with mild lymphedema over a 5-year period. However, only 40% of those diagnosed with mild lymphedema in their retrospective cohort were referred for therapy intervention, and no data were provided regarding whether patients actually received therapy or the level of intervention. Their progression rate likely demonstrates the natural progression of lymphedema in the absence of treatment. Even if the progression rate to advanced-stage lymphedema does occur in the prospective surveillance model at a rate of 48%, our model demonstrates that treating those advanced cases with decongestive therapy is still be less costly than the traditional model (Tab. 4).

The upfront cost of a prospective surveillance model for all patients diagnosed with breast cancer may be a barrier to implementation. Our current medical paradigm relies on an impairment-based approach to treating chronic disease with reimbursement levels based on procedural interventions tied to an impairment diagnosis. The cost burden associated with advanced-stage BCRL cannot continue to be overlooked, as models for conservative treatment are espoused as clinically effective. Currently, an estimated 5 million people in the United States are survivors of breast cancer and at risk of developing lymphedema during their lifetime.[71] Cost savings may not be immediately realized with a prospective surveillance model, thus deterring payers from accepting and implementing a model such as this. The assumptions compared in these 2 models demonstrate that the prospective surveillance model may indeed be defensible as a cost-savings measure and make a strong argument in favor of a shift in the paradigm of physical therapist practice toward a secondary preventive approach for patients with breast cancer.

Our estimated direct treatment costs are closely matched to the costs outlined by Shih et al[31] in their study of the cost burden of lymphedema. Our direct cost data, however, were derived from evidence-based guidelines for lymphedema management, either through prospective surveillance with early detection or through treatment of advanced-stage lymphedema with CDT.[45] We extrapolated clinical scenarios based on evidence and best practice guidelines and then used public reimbursement data to estimate direct costs. Shih et al used claims data to derive the cost of managing chronic lymphedema and factored in other contributory costs, including infection, prescription drug use, and other cancer- and non–cancer-related costs. Our cost estimate for the management of chronic lymphedema is greater than the cost offered by Shih and colleagues. However, we included the cost of compression bandaging supplies and specified the use of custom-made compression garments in our assumptions for care. Claims data likely demonstrate an underrepresentation of durable goods and supplies costs, as many third-party payers in the United States do not routinely reimburse for these materials.

We chose to extrapolate the direct treatment cost per patient to calculate the cost per 100 patients over a year. Although we based this extrapolation on historical data regarding the overall incidence of BCRL, these data should be considered as a generalized cost analysis suitable to compare the general concept of early conservative versus advanced inter-

vention for lymphedema.[39] Early intervention through the use of a prospective surveillance model may contribute to preventing new cases of BCRL through education and awareness.

The prospective surveillance model identifies costs only over a 1-year period and does not extrapolate data regarding additional future cases that may arise and affect the overall incidence beyond 1 year. It may be assumed that a percentage of patients treated with the prospective surveillance model may develop late-stage lymphedema. However, reports have shown that some patients resolve early-stage lymphedema completely, whereas others who progress to a more severe condition may eventually regress.[54,72] Therefore, ongoing interval surveillance will optimally continue during an extended period following treatment. This approach carries additional cost ramifications. Extrapolation of these scenarios over an extended period and through various disease states is better suited to sophisticated cost models such as Markov models.

Secondary prevention models as a new paradigm of physical therapy care must be explored in light of the potential cost savings that our comparison supports. Exploration into cost benefit analysis and cost-effectiveness comparison is beyond the scope of this article; however, we hope to lay the groundwork for the premise that a prospective surveillance model is a potentially cost-saving and emerging model of care for patients with BCRL. Crude cost data and extrapolation methods based on the assumptions we offered are a very basic method to identify and analyze direct treatment costs. The physical therapy literature has only recently begun exploring health care economics research.[63,64,73] Gordon et al[64] attempted to quantify cost burden, and only 2 studies quantified utility associated with BCRL.[74,75] Orr et al[74] conducted a cost-utility analysis with lymphedema noted as an aggregated comorbid diagnosis of their cohort of patients with breast cancer, and not stratified by intensity or severity, which is known to affect intensity of treatment intervention, patient perceptions, and quality of life. Cheville et al[75] quantified utility based on severity of disease, an important first step in supporting future work in conducting cost-benefit analysis and assessing the impact of treatment on quality-adjusted life years. The direct treatment cost data presented here and these construct models for the treatment of BCRL may be useful in future cost analysis studies based on the decision trees illustrated in Figure 1.

Limitations

Use of the Medicare fee schedule was a limitation in our analysis, as it may underestimate the true direct treatment costs associated with lymphedema. Public and private payers are not ubiquitous in their reimbursement structures, and geographical variance in payment trends also exists. Therefore, these raw data should be utilized with caution for actual cost comparison. The goal of this perspective article is to highlight the clinical efficacy of the prospective surveillance model and demonstrate the trend of direct treatment cost savings that this model potentiates.

We did not include indirect costs in the prospective surveillance model. Assessment of costs associated with lost time at work, productivity in the home, lost leisure time, and the cost impact of associated comorbidities should be assessed and are necessary if this work is to be extrapolated and used to compare the cost-effectiveness of these programs.[68]

Prevention and mitigation of late-stage lymphedema through use of the prospective surveillance model is promising. However, early data supporting such a program have followed patient cohorts only over a 1-year period. We recognize that not all patients diagnosed with early BCRL will remain free from progression of disease.[54] Lymphedema is a dynamic condition and is unpredictable regarding onset and disease progression. Episodic exacerbations of the condition from infection, other confounding conditions, and other external factors may occur, advancing the condition to a more severe stage.[76] Therefore, further cost modeling using sophisticated techniques such as Markov models may be useful in estimating how various levels of BCRL severity, required intensity of treatment, and cost to manage comorbid conditions closely associated with lymphedema will affect cost over an extended period of time.[77–79]

These models are based only on early identification and management of a single breast cancer treatment-related impairment: lymphedema. However, utilizing a physical therapist for the provision of care in a prospective surveillance model may contribute to improved functional outcomes with shoulder mobility, decreased fatigue, and improved quality of life overall.[35,62,80] The positive impact of prospective monitoring by a physical therapist may have an even broader impact on cost savings than illustrated in the models presented here.

Attention also must be given to the barriers that patients face in accessing medical care. Preventive models of care are promoted for many different chronic diseases; however, adherence rates vary significantly. Reducing barriers to care is an important factor contributing to the success of a prospective model of care.

Clinical Relevance

In 2011, the National Lymphedema Network issued a position statement on screening and measurement for early detection of breast cancer–related lymphedema.[81] This document highlights the prospective surveillance model as a preferred standard of care to enable early detection and management of lymphedema. Subsequently, the National Accreditation Program for Breast Centers, in its revised 2011 standards for accreditation document, recommended the National Lymphedema Network position be adopted among currently accredited centers and will implement this position as a standard for accreditation in the future.[82] The physical therapist is central to this approach and is the optimal health care provider to deliver cost-effective, clinically efficacious care in this population.

Conclusion

Prospective surveillance is a clinically effective model to identify and manage early-stage BCRL. However, data for direct and indirect costs of this novel approach are lacking. Our findings, utilizing only direct provider fees and durable medical costs, suggest that a prospective surveillance program potentially decreases direct treatment costs associated with managing BCRL. Further analysis of indirect costs and utility is necessary to assess the cost-effectiveness of this approach. A shift in the paradigm of examination and intervention by a physical therapist may be warranted in light of these emerging data. Physical therapists are ideally situated to provide secondary preventive interventions and treatment, using prospective surveillance, to those surviving breast cancer.

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