

# Developing a Lymphatic Surgery Program: A First-Year Review

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**Background:** Lymphedema is a chronic condition that carries a significant physical, psychosocial, and economic burden. The authors' program was established in 2017 with the aims of providing immediate lymphatic reconstruction in high-risk patients undergoing lymphadenectomy and performing delayed lymphatic reconstruction in patients with chronic lymphedema. The purpose of this study was to describe the authors' clinical experience in the first year.

**Methods:** A retrospective review of our clinical database was performed on all individuals presenting to the authors' institution for lymphatic surgery consideration. Patient demographics, clinical characteristics, and surgical management were reviewed.

**Results:** A total of 142 patients presented for lymphatic surgery evaluation. Patients had a mean age of 54.8 years and an average body mass index of 30.4 kg/m<sup>2</sup>. Patients with lymphedema were more likely to be referred from an outside facility compared to patients seeking immediate lymphatic reconstruction ( $p < 0.001$ ). For patients with lymphedema, the most common cause was breast cancer related. Thirty-two percent of all patients evaluated underwent a lymphatic procedure. Of these, 32 were immediate lymphatic reconstructions and 13 were delayed lymphatic reconstructions. In the authors' first year, 94 percent of eligible patients presenting for immediate lymphatic reconstruction underwent an intervention versus only 38 percent of eligible lymphedema patients presenting for delayed lymphatic reconstruction ( $p < 0.001$ ).

**Conclusions:** First-year review of our lymphatic surgery experience has demonstrated clinical need evidenced by the number of patients and high percentage of outside referrals. As a program develops, lymphatic surgeons should expect to perform more time-sensitive immediate lymphatic reconstructions, as evaluation of chronic lymphedema requires development of a robust team for workup and review. (*Plast. Reconstr. Surg.* 144: 975e, 2019.)

Conservative therapy for lymphedema has been championed as the cornerstone of treatment to prevent disease progression and improve symptoms. Early surgical procedures for lymphedema were invasive and entailed extensive soft-tissue excisions. These procedures often resulted in suboptimal outcomes, including

disfigurement, and a high complication rate.<sup>1,2</sup> Today, lymphatic surgery procedures such as debulking and microsurgical procedures are less morbid and have demonstrated decreases in limb volume, improved quality of life, and reduced infection rate.<sup>3-6</sup> In 2009, Boccardo et al. demonstrated the ability to perform a lymphovenous bypass at the time of lymphadenectomy for lymphedema prevention.<sup>7</sup> This procedure has demonstrated consistent promising results from multiple institutions in the past decade.<sup>8-11</sup>

Lymphatic surgery is increasingly being offered in select hospitals throughout the United States. However, there remains a paucity of information describing the implementation and early

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experiences of lymphatic surgery programs. Literature is focused on the development and experiences of surveillance programs for early detection of breast cancer–related lymphedema.<sup>12</sup> Others have analyzed patient diagnoses and referral patterns to a lymphedema clinic in the United States and a lymphatic surgery center in the United Kingdom.<sup>13,14</sup> These findings have highlighted not only the lack of experience in developing a comprehensive lymphedema program, but also the scarcity of programs dedicated to both the prevention and treatment of lymphedema.

We believe optimal management of lymphedema requires a core team with a multidisciplinary approach to coordinate the diagnostic workup, management, and surveillance of patients. Moreover, our team has previously advocated that all lymphatic surgical procedures be categorized as immediate versus delayed lymphatic reconstructions.<sup>15</sup> In this article, we describe our first-year experience after the creation of a lymphatic surgery program.

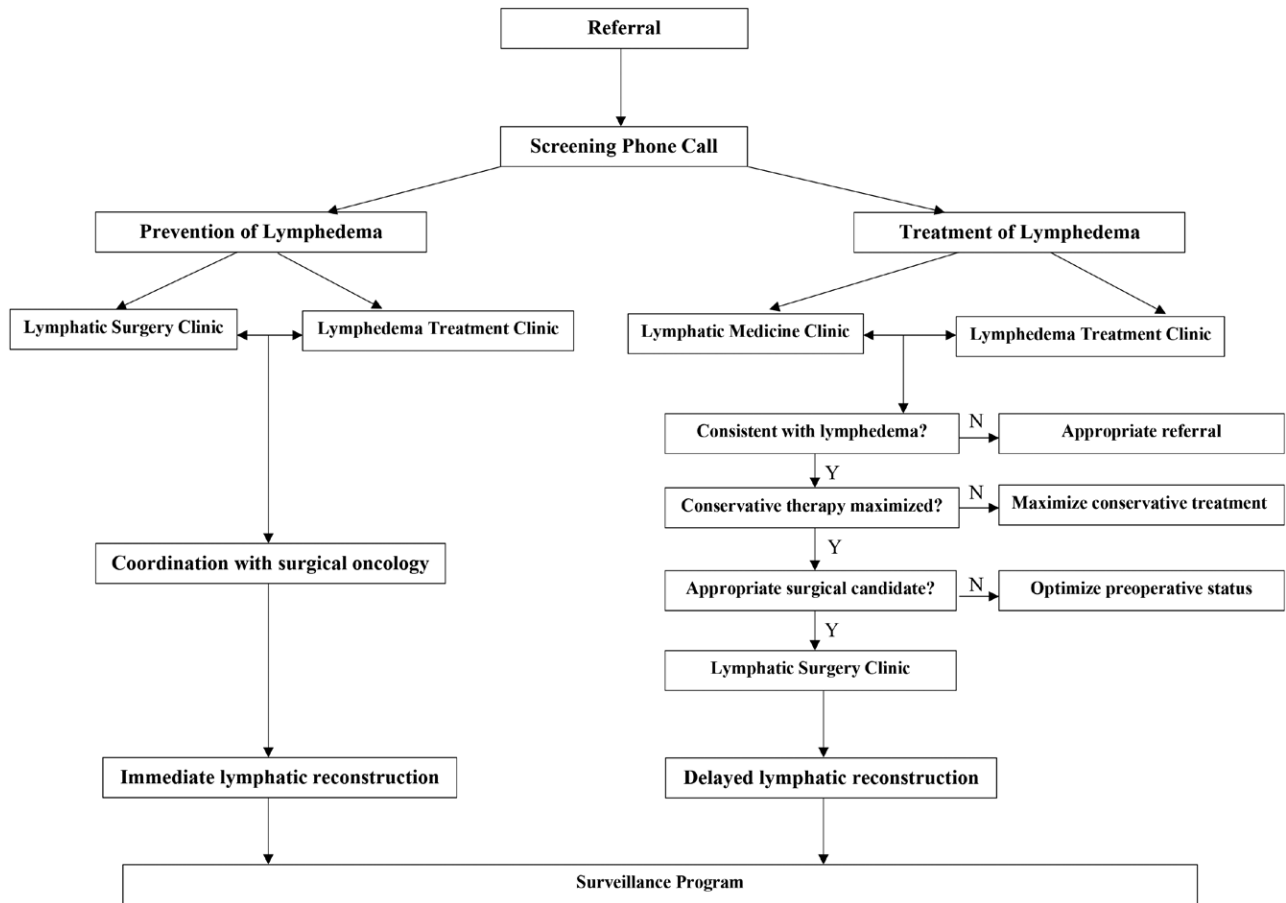
In 2016, we established a lymphatic surgery program at our institution. An electronic Research Electronic Data Capture (REDCap) database was established to monitor care delivery and facilitate future research.<sup>16</sup> Our program has three arms that constitute our “clinical triad”: lymphatic surgery (plastic surgeon with a focus on lymphedema care), lymphatic medicine (cardiologist with specialized training in vascular medicine and focus on lymphatic care), and the lymphatic treatment clinic (certified lymphedema therapists). In addition, our program is heavily supported by body and nuclear imaging. Our team meets bimonthly to discuss and formalize patient-specific care plans. Figure 1 illustrates our current clinical approach to patients who initially present for evaluation.

Lymphatic surgery evaluates all patients presenting for preventative procedures, or immediate lymphatic reconstruction. In contrast, lymphatic medicine first evaluates all patients presenting with chronic lymphedema who may be considering delayed lymphatic reconstruction. If a patient does not meet the three criteria described in Figure 1, surgical workup is deferred. Patients being considered for immediate or delayed reconstruction have baseline measurements obtained in the lymphatic treatment clinic. These include circumferential measurements, perometry, and bioimpedance spectroscopy (L-Dex U-400; ImpediMed, Carlsbad, Calif.). Patients are diagnosed with lymphedema if they have both clinical signs and symptoms consistent with lymphedema as determined by a certified lymphedema therapist

(e.g., heaviness) and at least one quantitative measurement consistent with lymphedema. For patients initially presenting for immediate lymphatic reconstruction, objective measurements consistent with lymphedema include a 10-point increase/decrease in L-Dex value from baseline; a 10 percent volume increase in the dominant, affected extremity; or a 7 percent volume increase in the nondominant affected extremity. In contrast, patients with lymphedema presenting for delayed lymphatic reconstruction must have existing volumetric findings as described above and/or abnormal bioimpedance values. International Society of Lymphology criteria are used in our center for clinical staging. Patient quality of life is assessed using the validated lymphedema quality-of-life instrument and 36-Item Short-Form Health Survey.<sup>17,18</sup>

Our surgical algorithm for all patients presenting for lymphatic reconstruction is depicted in Figure 2. Immediate lymphatic reconstruction is a lymphovenous bypass performed at the time of axillary lymph node dissection. Our specific surgical technique has already been described.<sup>19</sup> Immediate lymphatic reconstruction patients have a much more expedient workup that involves baseline measurements and a clinical examination before undergoing surgical intervention. Workup for those pursuing intervention for chronic lymphedema is more extensive. During initial delayed lymphatic surgical evaluation, patient care goals are elicited to create a personalized care plan. The determination of the patient’s lymphedema tissue composition through imaging guides the surgical workup. Fluid-dominant patients undergo physiologic procedures consisting of either lymphovenous bypass or vascularized lymph node transplantation, depending on the presence of existing lymphatic channels. Fat-dominant patients initially undergo a debulking procedure (e.g., power-assisted liposuction) followed by a staged physiologic procedure once their extremity volume has stabilized. All patients are evaluated postoperatively at prescribed time intervals.<sup>12</sup>

All surgical patients are followed postoperatively in both lymphatic surgery and lymphatic treatment clinics. Immediate lymphatic reconstruction patients are advised to undergo surveillance in the lymphatic treatment clinic by a certified lymphedema therapist postoperatively at 4 weeks, 3 months, and then every 3 months. Delayed reconstruction patients undergo variable follow-up depending on the procedure. Debulking patients are followed postoperatively at 2 weeks, 4 weeks, 3 months, and then every 3 months until



**Fig. 1.** Current patient flow at the Beth Israel Deaconess Medical Center lymphatic treatment center.

stabilization of limb volume has been established. Patients undergoing vascularized lymph node transplantation undergo no compression therapy for the first 3 weeks postoperatively. At this time, compression is then reinitiated in the lymphatic treatment clinic and maintained through the 3-month visit. Patients undergoing lymphovenous bypass initiate compression therapy in the recovery room. At the discretion of the therapist, weaning of compression is then initiated and tailored to the patient’s response as ascertained by symptoms and volume changes.

### PATIENTS AND METHODS

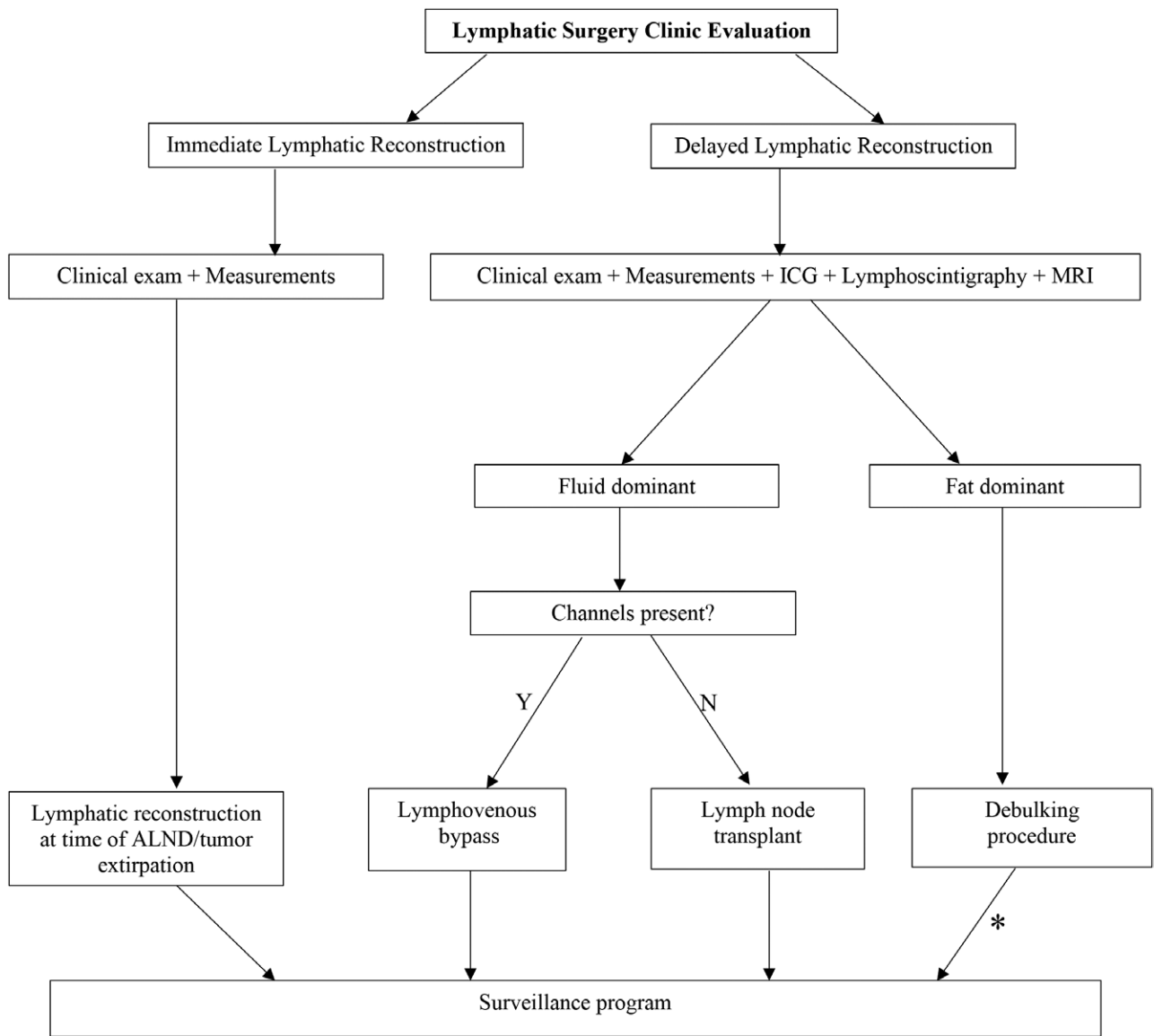
A retrospective review of our REDCap database was performed for all patients presenting for lymphatic surgery consultation at our institution during the 2017 calendar year. Patient demographics, clinical and surgical characteristics, treatment goals, and referral data were reviewed. Institutional review board approval was obtained. We used descriptive statistics to characterize our institutional cohort. We performed *t* tests or Wilcoxon

rank sum tests to compare continuous measures and chi-square tests for categorical measures across those seeking immediate lymphatic reconstruction to those seeking delayed reconstruction. When comparing more than two groups, we performed analysis of variance or the Kruskal-Wallis test for continuous measures. All analyses were conducted with R version 3.5 (R Development Core Team, 2018). All tests were two-tailed, and statistical significance was determined by a value of  $p < 0.05$ .

### RESULTS

#### Demographics

In the 2017 calendar year, 142 patients presented for lymphatic surgery evaluation (Table 1). The majority of patients were female (89 percent), Caucasian (84 percent), and identified as non-Hispanic (99 percent). The mean patient body mass index  $\pm$  SD was  $30.4 \pm 7$  kg/m<sup>2</sup>. Our patient population in the first year was composed largely of breast cancer patients presenting for



\*For patients undergoing an initial debulking procedure, a physiologic procedure (i.e. LVB or VLNT) may be considered once the extremity volume has stabilized (i.e. 1-2 years post-operatively)

**Fig. 2.** Surgical management algorithm. ICG, indocyanine green; MRI, magnetic resonance imaging; Y, yes; N, no, ALND, axillary lymph node dissection; LVB, lymphovenous bypass; VLNT, vascularized lymph node transplantation.

immediate or chronic lymphatic reconstruction (60 percent). There was a comparatively low number of patients (1 percent) seeking immediate lymphatic reconstruction for urogynecologic procedures. Approximately half of all patients seen (42 percent) were referred to our institution from an outside facility. The majority of outside referrals were patients seeking delayed reconstruction ( $p = 0.013$ ). In contrast, breast cancer patients seeking preventative surgery were more likely to be referred internally. The referral map (Fig. 3)

illustrates the geographic home residences of patients with respect to the location of our treating center.

### Patient Diagnoses

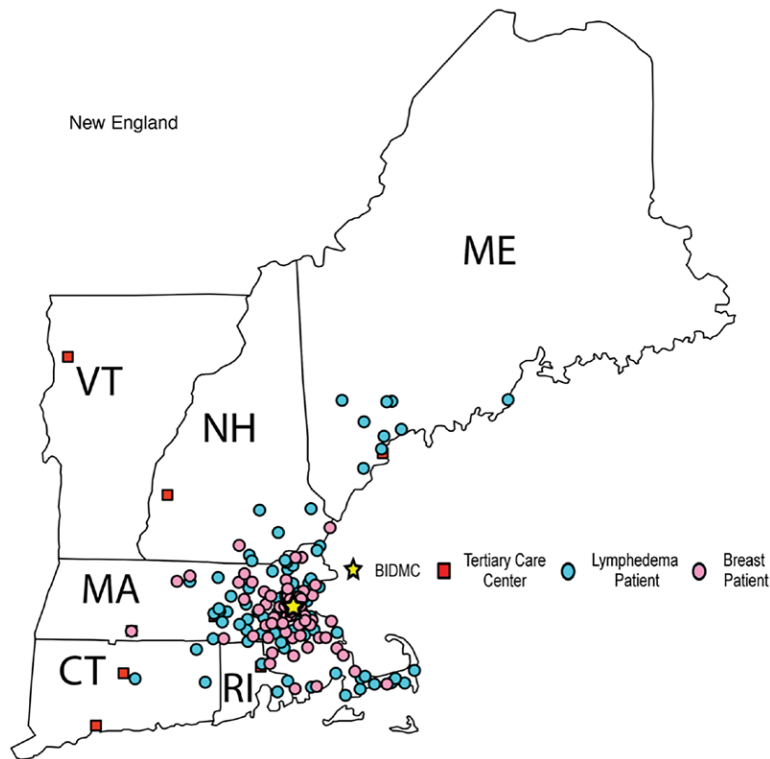
Lymphedema was diagnosed in 86 percent of patients presenting to our clinic (Table 2). Of these, primary disease (presumed congenital lymphedema) constituted only 7 percent of the cohort. The majority of patients had a secondary cause of lymphedema (81 percent), most commonly, breast

**Table 1. Demographics at Initial Evaluation**

	Breast Cancer			Cancer, Nonbreast		Noncancer	<i>p</i>
	Overall (%)	Immediate Lymphatic Reconstruction (%)	Delayed Lymphatic Reconstruction (%)	Immediate Lymphatic Reconstruction (%)	Delayed Lymphatic Reconstruction (%)	Delayed Lymphatic Reconstruction (%)	
No.	142	38	47	2	22	33	
Mean age ± SD, yr	54.8 ± 14	50.7 ± 12	60.8 ± 11	67.3 ± 22	58.7 ± 14	47.7 ± 14	0.16
Mean BMI ± SD, kg/m <sup>2</sup>	30.4 ± 7	27.9 ± 7	31.7 ± 7	26.1 ± 7	29.1 ± 8	32.9 ± 8	0.048
Sex							<0.001
Female	127 (89)	38 (100)	47 (100)	1 (50)	15 (68)	26 (79)	
Male	15 (11)	0 (0)	0 (0)	1 (50)	7 (32)	7 (21)	
Race							0.14
White	119 (84)	29 (76)	41 (87)	2 (100)	19 (86)	28 (85)	
Black	10 (7)	6 (16)	2 (4)	0 (0)	0 (0)	2 (6)	
Asian	6 (4)	3 (8)	3 (6)	0 (0)	0 (0)	0 (0)	
Other	3 (2)	0 (0)	1 (2)	0 (0)	1 (5)	1 (3)	
Unknown	4 (3)	0 (0)	0 (0)	0 (0)	2 (9)	2 (6)	
Ethnicity*							0.82
Hispanic	2 (1)	0 (0)	1 (2)	0 (0)	0 (0)	1 (3)	
Non-Hispanic	139 (99)	38 (100)	45 (96)	2 (100)	22 (100)	32 (97)	
Referred from an outside facility	60 (42)	8 (21)	24 (51)	0 (0)	12 (55)	16 (49)	0.013

BMI, body mass index.

\*One patient did not report their ethnicity.



**Fig. 3.** Comparative referral map. *BIDMC*, Beth Israel Deaconess Medical Center.

cancer. Only 14 percent of patients who presented to our clinic were not diagnosed with lymphedema. Nonlymphedema conditions included lipedema (6 percent), venous disease (3 percent), medication-related swelling (1 percent), and an unclear cause not consistent with lymphedema (4

percent). Patients with lymphedema of “unclear cause” had a clinical presentation and measurements consistent with a provisional diagnosis of lymphedema, although ultimately a specific cause could not be identified during subsequent evaluation and workup. Patients with a body mass index

**Table 2. Diagnosis of Patients with Presumed Lymphedema**

Characteristic	Value (%)
Primary	7 (7)
Secondary	81 (79)
Breast cancer	47 (58)
Cancer, nonbreast	22 (27)
Traumatic (trauma, other nononcologic surgery)	7 (9)
Obesity	2 (2)
Unclear cause	3 (4)
Nonlymphedema	14 (14)
Lipedema	6 (43)
Venous disease	3 (21)
Medication-related	1 (7)
Unclear cause	4 (29)

greater than 50 kg/m<sup>2</sup> were diagnosed with obesity-induced lymphedema of the lower extremities ( $n = 2$ ).<sup>20</sup> Patients presenting with presumed non-cancer-related lymphedema were less likely to be diagnosed with lymphedema compared to their cancer-related counterparts ( $p = 0.0047$ ). Specifically, 39.3 percent were determined to not meet the criteria for lymphedema.

### Clinical Characteristics

Lymphedema more commonly affected the upper extremity (55 percent) compared to the lower extremity (38 percent) in our cohort (Table 3). Nononcologic lymphedema patients were more likely to report a longer duration of lymphedema-related symptoms (15 years) compared to their cancer-related lymphedema counterparts ( $p = 0.0059$ ). In addition, patients with non-breast cancer-related lymphedema had a longer time interval from completion of oncologic treatment to development of lymphedema (1.5 years), which almost tripled that of breast cancer-related lymphedema (0.5 year). The three most common lymphedema-related symptoms across all groups included swelling (98 percent), tightness (81 percent), and heaviness (80 percent). Although no statistically significant differences across groups were observed, infection was reported in 23 percent of all patients. Patients spent 49 hours/week managing their disease. In each subgroup, patients reported spending up to 168 hours/week.

### Patient Goals

The most common primary treatment goal reported by chronic lymphedema patients across all subgroups was the desire to decrease symptoms (e.g., tightness and heaviness). Secondary and tertiary treatment goals varied across subgroups (Table 4).

### Surgical Considerations and Experience

The majority of all patients (61 percent) had a surgical workup initiated at the initial visit (Table 5). Patients presenting for immediate lymphatic reconstruction were more likely to undergo a surgical workup compared to those pursuing delayed reconstruction ( $p = 0.0037$ ). Surgical workup was initiated in only 49 of 102 patients (48 percent) presenting for delayed reconstruction. The most common reasons for patients to not undergo a surgical workup included poor surgical candidacy (47 percent), desire to pursue conservative therapy (47 percent), and a diagnosis not consistent with lymphedema (33 percent). A review of our operative experience demonstrates that immediate lymphatic reconstruction was the most commonly performed operation (Table 6). This procedure was completed in 94 percent of all immediate reconstruction patients who were eligible for the procedure after surgical workup. Patients evaluated for immediate lymphatic reconstruction who were considered ineligible had metastatic disease, were undergoing neoadjuvant chemotherapy, or ultimately did not proceed with lymphadenectomy. For chronic lymphedema patients, delayed lymphatic reconstruction was performed in 37 percent of eligible patients. Lymph node transplantation was the most common surgical procedure for patients undergoing delayed lymphatic reconstruction. Almost one-third (32 percent) of eligible patients evaluated were still actively undergoing surgical workup as of April of 2018. Patients who were ineligible for surgical intervention were diagnosed with another abnormality requiring treatment during workup or were required to postpone intervention to optimize operative status.

### Surgical Outcomes

#### Immediate Lymphatic Reconstruction

Of patients who underwent immediate lymphatic reconstruction ( $n = 32$ ), 19 had follow-up information within the first year. Of these, 18 had both preoperative and postoperative measurements. During the first year, only one patient was classified as having transient lymphedema. Thus, our lymphedema rate was 5.6 percent (one of 18). All patients were evaluated using bioimpedance spectroscopy, circumferential measurements (volumetry), and perometry performed by certified lymphedema therapists.

#### Delayed Lymphatic Reconstruction

For patients who underwent a debulking procedure, two patients had interventions to the

**Table 3. Patient-Specific Factors**

	Chronic Lymphedema				<i>p</i>
	Overall (%)	Breast Cancer-Related (%)	Cancer-Related, Nonbreast (%)	Noncancer (%)	
No.	88	37	22	19	
Location of lymphedema					<0.001
Upper extremity	48 (55)	43 (92)	3 (14)	2 (11)	
Lower extremity	33 (38)	0 (0)	18 (82)	15 (79)	
Other	7 (8)	4 (9)	1 (5)	2 (11)	
Duration of lymphedema symptoms, yr					0.0059
Median	4	4	3	15	
Range	0.29–30	0.33–17	0.29–21	0.29–30	
Time interval since last oncologic treatment and development of lymphedema, yr					0.24
Median	0.68	0.5	1.58	—	
Range	0–46	0–27	0–46	—	
Common lymphedema-related symptomatology reported					
Swelling	86 (98)	45 (96)	22 (100)	19 (100)	0.41
Tightness	71 (81)	35 (75)	19 (86)	17 (90)	0.28
Heaviness	70 (80)	36 (77)	17 (77)	17 (90)	0.48
Inability to fit into clothes	65 (74)	34 (72)	17 (77)	14 (74)	0.91
Aching	59 (67)	30 (64)	16 (73)	13 (68)	0.76
Numbness and tingling	56 (64)	31 (66)	15 (68)	10 (53)	0.52
Pain	53 (60)	28 (60)	13 (59)	12 (63)	0.96
Fatigue	44 (50)	21 (45)	13 (59)	10 (53)	0.52
History of LE-related infection	20 (23)	8 (17)	7 (32)	5 (26)	0.36
Ongoing therapy for lymphedema at time of intervention					
Compression wrapping/sleeve	78 (89)	41 (87)	22 (100)	15 (79)	0.10
Manual lymphatic drainage	68 (77)	41 (87)	15 (68)	12 (63)	0.054
Exercise	56 (64)	36 (77)	11 (50)	9 (47)	0.025
Pneumatic device	40 (46)	21 (45)	9 (41)	10 (53)	0.74
None	4 (5)	2 (4)	0 (0)	2 (11)	0.27
No. of hours of therapy patient requires per week					0.83
Median	49.0	43.0	73.5	80.0	
Range*	0–168	0–168	0–168	0–168	

LE, lymphedema.

\**n* = 57.

**Table 4. Chronic Lymphedema Patient Treatment Goals**

	Breast Cancer	Cancer, Nonbreast	Noncancer
Primary treatment goal	Decrease symptoms	Decrease symptoms	Decrease symptoms
Secondary treatment goals	Fit into clothing	Infection	Diagnosis/education
Tertiary treatment goals	Appearance	Fit into clothing	Decrease management

upper extremity and two to the lower extremity. The mean preoperative excess volume of the affected extremity was 2835 ml.<sup>21</sup> After debulking, a mean 91.6 percent reduction of excess volume was observed with a median 2 months' follow-up. A total of seven patients underwent vascularized lymph node transplantation using a gastroepiploic flap to the forearm for treatment of upper extremity breast cancer-related lymphedema. The mean preoperative excess volume of the affected extremity was 1020 ml. After transplantation, a mean 21 percent reduction of excess volume was observed with a median 3 months' follow-up. All

patients who underwent vascularized lymph node transplantation had significant improvement in lymphedema quality-of-life instrument scores, specifically, in the function and symptom domains (27 percent and 30 percent improvement, respectively). There was insufficient postoperative outcome information within the first year for patients who underwent lymphovenous bypass in the delayed setting.

## DISCUSSION

In this first-year review of a lymphatic surgery program, we made some notable observations.

**Table 5. Surgical Considerations**

	Overall	Breast Cancer		Cancer, Nonbreast		Noncancer
		Immediate Lymphatic Reconstruction (%)	Delayed Lymphatic Reconstruction (%)	Immediate Lymphatic Reconstruction (%)	Delayed Lymphatic Reconstruction (%)	
No.	142	36	47	2	22	33
Was surgical workup initiated for the patient at initial visit?						
Yes	87 (61)	37 (97)	29 (62)	1 (50)	11 (50)	9 (27)
No	55 (39)	1 (3)	18 (38)	1 (50)	11 (50)	24 (73)
If no, why was surgical workup not initiated?						
Patient does not have LE	18 (33)	0 (0)	5 (28)	0 (0)	0 (0)	13 (54)
Ineligible (metastatic disease)	2 (4)	1 (100)	0 (0)	1 (100)	0 (0)	0 (0)
Poor surgical candidate	24 (44)	0 (0)	10 (56)	0 (0)	3 (27)	11 (49)
Unrealistic expectations	2 (4)	0 (0)	1 (6)	0 (0)	1 (9)	0 (0)
Pursuing conservative treatment	26 (47)	0 (0)	7 (39)	0 (0)	8 (73)	11 (46)
History of noncompliance	2 (4)	0 (0)	2 (11)	0 (0)	0 (0)	0 (0)
Other	3 (6)	0 (0)	0 (0)	1 (100)	1 (9)	1 (4)

**Table 6. Procedures Performed**

Procedure	No.
Immediate lymphatic reconstructions	32
Delayed lymphatic reconstructions	13
Lymphovenous bypass	2
Lymph node transplantation	7
Excisional procedure (liposuction/debulking)	4

From a demographic perspective, we noted a predominance of breast cancer patients and referrals from outside institutions. Fourteen percent of all patients presenting to our program did not have lymphedema. The most common symptoms were heaviness, tightness, and swelling, with non-cancer-related lymphedema patients presenting with a significantly longer duration of symptoms at presentation. Patients with breast cancer-related lymphedema (i.e., lymphedema of the upper extremity) spend 43 hours per week managing their disease versus 73 hours per week for nonbreast cancer-related lymphedema, which primarily represents lower extremity involvement. Twenty-three percent of all patients present with a history of infections of the affected extremity. Immediate lymphatic reconstructions were significantly more common than delayed lymphatic reconstruction in our first year. There is a strong predominance of breast cancer patient referrals to the lymphatic program. This finding is not surprising, as lymphedema awareness is evident among breast surgeons as evidenced by the formation of the Lymphedema Panel and recommendations from the American Society of Breast Surgeons in 2017. However, this finding

underscores our own program's need to educate and bring lymphedema awareness to other specialties, including surgical oncology, urology, and gynecologic oncology. Postoperative lymphedema rates in these respective fields are estimated to range between 20 and 50 percent following lymph node dissection, which parallels the incidence in breast cancer.<sup>22</sup> Despite similar lymphedema incidence rates, the available literature and lymphedema research for the nonbreast cancer patient subgroup remains scant.<sup>22–25</sup> In initiating a lymphatic program, outreach efforts will naturally gravitate toward the breast service. Simultaneous engagement of surgical oncology, urology, and gynecology services would increase institutional awareness of immediate and delayed lymphatic reconstruction. We acknowledge that at our institution with an established breast reconstruction program, relationships with breast oncology services may have been easier to initiate. However, this does not undermine the broad need for persistent efforts to foster stronger relationships and increase internal referrals. The majority of patients evaluated at our lymphatic center for chronic lymphedema were referred from an outside institution. This statistic speaks directly to the current unmet need for these services. We note that many patients bypassed multiple other tertiary care hospitals to seek evaluation at our center. The senior author's (D.S.) 2017 geographic referral patterns for breast versus lymphatic reconstructions are displayed in Figure 3. Possible explanations for the wider geographic spread of patients presenting for lymphatic care may include a paucity of local lymphatic services or a dissatisfaction with



initial and/or local treatment. Outside hospital referrals, although often lucrative to a health care system, also require significant ancillary support to facilitate patient navigation (e.g., transfer of outside hospital records). We failed to recognize this programmatic need upfront and experienced an early lag in our ability to maneuver patients through the various clinical evaluation algorithms. The current data were recently used to obtain further ancillary support for our program. Lymphatic surgeons and program directors should consider this when designing programs moving forward.

Fourteen percent of all patients presenting to our center with chronic lymphedema were ultimately given an alternate diagnosis. The majority of these patients suffered from lower extremity edema. This finding underscores the importance of a multidisciplinary team. Early in the development of our lymphatic surgery program, we had yet to finalize the lymphatic medicine program. Therefore, the lymphatic surgery clinic was the initial clearinghouse for all lymphedema patients. After its development, the lymphatic medicine clinic evaluated all patients presenting for delayed lymphatic reconstruction to capture patients with causes not amenable to surgical intervention and aid in further evaluation and management of those with alternative causes (Fig. 1). We have found their evaluation most helpful in patients with lower extremity lymphedema given the increased rate of non-lymphedema-related diagnoses compared with upper extremity lymphedema. Today, since the advent of the lymphatic medicine clinic, the overwhelming majority of patients evaluated in our lymphatic surgery clinic are excellent surgical candidates.

In our study, the most common symptoms associated with lymphedema are swelling, tightness, and heaviness. We have used these findings to help surveil our high-risk cancer patients undergoing immediate lymphatic reconstruction. Specifically, our certified lymphedema therapists specifically ask about heaviness and tightness during routine surveillance visits. Infection of the ipsilateral extremity was reported in 23 percent of patients. Patients are prescribed a single dose of prophylactic antibiotics before any procedure that will penetrate the skin of the affected extremity. Of note, patients with non-cancer-related lymphedema presented with a duration of symptoms of 15 years versus only 3 to 4 years in the oncologic group. This finding further emphasizes the need for a multidisciplinary approach to ensure the proper diagnosis and rule out other

confounding factors. One of our findings was that breast cancer-related lymphedema patients spend an average of 43 hours per week managing their lymphedema versus 73 hours for other cancer patients (primarily with lower extremity lymphedema). Our team has found that quantifying the number of hours of care a patient provides toward lymphedema as a useful measure of the patient's level of compliance and simultaneous impact that the disease is having on their daily life. Moreover, this number is tracked as the patient is surveilled. From a surgical perspective, 28 percent of all patients evaluated ultimately underwent a lymphatic operation. Interestingly, 71 percent of the procedures performed our first year were immediate lymphatic reconstructions versus 29 percent delayed. We believe this finding is consistent with the realities of developing a multidisciplinary approach to the lymphedema patient. Specifically, immediate lymphatic reconstruction consultations are time-sensitive and require a less extensive workup than patients with chronic lymphedema. Establishing buy-in from multiple services to provide a coordinated approach to the lymphedema patient requires effort and time. Lymphatic surgeons can expect to perform more immediate reconstructions early in the development of their program until the multidisciplinary team is in place and working efficiently through institutional algorithms. Of note, only 56 percent of our immediate lymphatic reconstruction patients presented for appropriate surveillance. Patient surveillance requires persistent outreach efforts from the lymphedema treatment clinic to best monitor patient progress. Variability in patient adherence is likely multifactorial and includes perceived decreased need to attend if they are asymptomatic; prioritization of other oncologic, adjuvant appointments; and limited/varying insurance coverage. We have made changes to promote adherence, such as coordination with other oncologic appointments (i.e., adjuvant radiation) and more targeted direct outreach. These initial successes would not have been possible without staunch institutional support. Our institution made a commitment to the senior author (D.S.) to support the lymphatic program, including the purchase of a Mitaka MM51 operating microscope (Mitaka Kohki Co., Ltd., Mitaka, Tokyo, Japan), PDE Hamamatsu Imaging Device (Hamamatsu Photonics Co., Hamamatsu, Japan), perometer, and bioimpedance spectroscopy. From a billing perspective, if a patient is unable to obtain preapproval from their insurance carrier, both the surgeon and patient would be required

to navigate the appeals process, including peer-to-peer reviews with insurance medical directors. As we approach the end of our second year, we are beginning to meet directly with key insurance carriers to present our clinical data and approach with the aim of establishing a more concrete pathway to reimbursement. Our surgical results in the first year are promising and underscore the ability to achieve improved outcomes during a limited follow-up period. Patients undergoing immediate lymphatic reconstruction are at high-risk for postoperative lymphedema, with all patients undergoing axillary *lymph node* dissection and the large majority undergoing adjuvant regional lymph node radiation therapy. Our 1-year lymphedema rate of 5.1 percent, versus rates in historical controls of 28 to 38 percent,<sup>26–28</sup> was based on institutional criteria including multiple measurement modalities and patient-reported symptoms. Our approach to lymphedema diagnosis is conservative and sensitive, as any one positive measurement and symptoms would affirm the diagnosis. Furthermore, our debulking results (92 percent excess volume reduction) are promising and align with the current literature that demonstrates significant volumetric reductions with limited follow-up.<sup>5,21</sup> Early findings for patients undergoing vascularized lymph node transplantation demonstrate a more modest improvement in volume reduction (21 percent excess volume reduction). It has been this consistent observation that has evolved our treatment algorithm to initially debulk our fat-dominant patients before vascularized lymph node transplantation. The significant improvements in quality-of-life measures after vascularized lymph node transplantation is consistent with the available literature.<sup>29,30</sup> In addition, there were no incidences of postoperative donor-site lymphedema with use of the omentum as the donor site.<sup>31</sup>

The current study represents our work in developing a lymphatic surgery program in New England at a center with an already well-established program in breast reconstruction. We do believe, however, that many of our findings are generalizable. Mainly, lymphedema remains one of the most significant cancer survivorship issues in the United States, with a tremendous burden of disease. The number of centers nationwide providing coordinated care is limited. With increasing awareness of lymphedema and emerging advances in technology both in and out of the operating room, lymphatic care is becoming a field capturing the interest of many disciplines simultaneously. This article demonstrates the road map that we have put

forth at our institution to develop a lymphatic center, including our early successes and failures. We hope this will be a useful adjunct for any individual and team looking to pursue this worthy endeavor.

## CONCLUSIONS

Our first-year review demonstrates the tremendous demand for lymphatic surgery programs. Lymphatic surgeons will naturally find partners in breast care and would benefit greatly by also partnering with other surgical services including surgical oncology, urology, and gynecologic oncology. The multidisciplinary approach is critical to maximize patient evaluation and treatment. Lymphatic surgeons can expect to perform a higher volume of immediate lymphatic reconstructions early in program development as the multidisciplinary team is built to address the delayed lymphatic reconstruction patient.

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