

Single Center Retrospective Analysis of Cost and Payments for Lymphatic Surgery

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Background: Insurance coverage for microsurgical lymphatic surgery continues to be sporadic, as the procedures continue to be labeled investigational. The objective of this study was to examine the typical payment patterns of our clinical practice for microsurgical lymphatic procedures.

Methods: We performed a single center, single surgeon retrospective case review for all lymphovenous bypass and vascularized lymph node transfer cases performed from 2018 to 2020. We then queried the available financial data and calculated total charges, total paid by insurance, total variable cost (cost to the hospital), and the contribution margin (difference between the amount paid and variable cost). Descriptive statistics were then collected for each subgroup for analysis.

Results: Financial data were collected on 22 patients with 10 left-sided, 11 right-sided and one bilateral procedure performed. Seven procedures were done prophylactically, and 15 were done for existing lymphedema. An estimated 10 of 22 patients (45%) had Medicare, Medicaid, or Tricare, with the remaining having private insurance. We calculated an average cost of \$48,516.73, with average payment of \$10,818.68, average variable cost of \$5,567.10, for a contribution margin of +\$5251.58.

Conclusions: Lymphedema remains a common complication of surgery and a significant cost burden to patients and the healthcare system. Microsurgical procedures offer several advantages over medical therapy. In our practice, we were routinely reimbursed for both prophylactic and therapeutic procedures with positive contribution margins for the hospital and ratios similar to other surgeries. Despite the limitations of a small retrospective review, there is no similar published cost analysis data in the current literature. (*Plast Reconstr Surg Glob Open* 2021;9:e3630; doi: [10.1097/GOX.0000000000003630](https://doi.org/10.1097/GOX.0000000000003630); Published online 16 June 2021.)

INTRODUCTION

Lymphedema is a chronic disease, resulting in accumulation of interstitial fluid in soft tissue throughout the body. Lymphedema affects millions of Americans, and over 140 million patients worldwide.¹ Studies have documented 5%–7% of axillary sentinel lymph node biopsy patients will suffer from lymphedema, with varying rates depending on the length of follow-up and clinical definition.² Following mastectomy and level I+II axillary

dissection, 50% of patients may suffer from lymphedema in their lifetime.²

Historically, surgical treatments for lymphedema have included staged excision (the Modified Homan's procedure) and excision with subsequent skin grafting (the Charles procedure).³ Debulking procedures may further disrupt the remaining lymphatic channels in the affected limb and possibly create a bottle neck deformity.³ Liposuction has been utilized to assist with the edema and volume of a diseased limb. After liposuction, patients are committed to a lifelong use of elastic garments to maintain any benefit.³

Advances in microsurgical techniques have revolutionized the surgical approach to lymphedema. Lymphovenous bypass (LVB) and vascularized lymph node transfer (VLNT) were both developed to offer a more physiologic approach to treatment. In LVB, lymphatic channels at select sites along the affected limb are anastomosed to nearby superficial veins to divert outflow into the venous system.⁴ Lymphovenous bypass may be

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applied in a prophylactic (immediately following lymph node dissection) or delayed fashion.⁵ In VLNT, a pedicle of lymph nodes is harvested with both a feeding artery and vein as a free flap. The flap is then anastomosed directly to the diseased limb to facilitate lymphatic drainage into the systemic circulation.

There is a growing body of literature supporting both LVB and VLNT as safe, efficacious surgical treatments with substantial improvements in health and quality of life for patients, and with an impressive safety profile. Chang et al reported 100 cases of consecutive LVB with a mean volume decrease of 32% in 96% of the studied patients.⁴ Koide et al reported 75 cases of VLNT to the lower extremity with 100% flap success and a statistically significant decrease in rates of cellulitis and limb volume.⁶ Mardonado et al reported 100 cases of VLNT with a mean follow-up of 11 months and no reported secondary lymphedema of the harvest site, nor any reported flap loss.⁵ Moreover, in a systematic review of 32 total studies of the microsurgical treatment of lymphedema, all studies demonstrated an improvement in patient reported quality of life.⁷ Despite this evidence, these procedures are still considered experimental by many insurance companies and may remain uncovered.

There is a paucity of published research examining the actual payments and reimbursement for microsurgical lymphatic procedures. The objective of this study was to describe the patterns of charges and payments seen in the senior author's microsurgical lymphedema practice from 2018 to 2020. We examine both physician fees and hospital charges/costs to determine whether these interventions are being appropriately covered and reimbursed from both physician and hospital perspectives.

METHODS

Study Design

We performed a single center, single surgeon (KC) retrospective review of case logs from 2018 to 2020. We identified patients who underwent prophylactic and delayed LVB and VLNT procedures using hospital account record (HAR) codes. Patient demographic data, surgical data (laterality and type of procedure), indication for surgery, and type of insurance coverage were collected from electronic medical records. The financial department of Beaumont Hospital identified the following information for each HAR encounter: insurance payor information, total hospital charges, amount paid by insurance, total variable cost (the cost to the hospital directly attributable to performing the procedure), and contribution margin (the difference between amount paid and the cost). The contribution margin can be seen to represent the profit, or loss, the hospital incurred for that specific procedure. The total variable cost consists of the following specific components relating to surgery: anesthesia, cardiology, preoperative EKG, imaging, laboratory, medical and surgical supplies/devices, admission, operating room time/usage, other discharge services, intensive care unit (ICU) or surgical floor room stay, costs associated with hospital admission, and medication charges. Physician fees and payments were also collected

for each HAR. Descriptive statistics were calculated in Microsoft Excel. IRB approval for the study was granted by William Beaumont Hospital RO.

Treatment Approach

Referral and Work Up

Symptomatic patients were referred by the lymphedema treatment center after failing conservative decongestive therapy. In our algorithm, patients underwent magnetic resonance venography to rule out proximal venous obstruction and May-Thurner syndrome as appropriate, and nuclear imaging lymphoscintigraphy was performed to document both the severity and particular patterns of residual lymphatic drainage. In the office, the PDE Neo II (Mitaka, USA) was used for live indocyanine green lymphangiography, and the patient was graded in severity by the Cheng lymphedema grading system.⁸ Additional prophylactic referrals came through breast surgeons as a part of the reconstructive consult when axillary node dissection was anticipated.

Surgical Decision-making

Prophylactic operations, and patients diagnosed with Grade 1-2 lymphedema were offered LVB. Surgical technique in these patients involved injecting ICG and lymphazurin blue dye into digital webspaces, then injecting lymphazurin blue every 10–20 cm along the limb. A vein finder was used to mark visible superficial venous channels, which guided initial exploratory incisions. Incisions were made in a transverse fashion and microvascular exploration was undertaken to identify lymphatic channels (blue stained or green with SPY) and nearby veins (refilled with blood on strip test). Anastomosis was performed with 11-0 nylon suture under super-microsurgical magnification. Multiple LVAs were performed whenever possible.

Grades 3 and 4 lymphedema were offered LVB as well as VLNT. LVB proceeded as described above. For VLNT, the right supraclavicular lymph node basin (zone 5B) was selected as the preferred donor site, based on the transverse cervical artery and vein.^{9,10} This was connected to the radial or dorsalis pedis artery in an end-to-side or flow-through fashion depending on the vessel characteristics. A full-thickness skin graft was placed over the lymph node flap for skin coverage.

Postoperative Care/Follow-up

Patients were initially admitted to the ICU on a similar pathway to microvascular breast reconstruction patients; however, this practice was abandoned over time and instead patients were admitted to the surgical floor for overnight observation and were discharged on postoperative day 1 or 2. Patients were followed in the office every 3 months for clinical assessment and measurements.

RESULTS

Patient, Payor, and Procedure Characteristics

From 2018 to 2020, the financial data were available for 22 patients who underwent microsurgical lymphatic

procedures (Fig. 1). The average patient age was 55. The majority (95%) of procedures were for prophylaxis or treatment of upper extremity lymphedema secondary to breast cancer surgery, one patient underwent treatment for lower extremity edema. Among our cohort, 10 procedures were performed on the left extremity, 11 were on the right extremity, and one procedure was performed bilaterally. An estimated 32% (7/22) of procedures were performed prophylactically, and all prophylactic patients underwent LVB (Fig. 1). The rest (15/22 or 68%) of the procedures were for treatment of existing lymphedema. Of these patients, three received delayed VLNT alone, five received delayed LVB alone, and seven received both VLNT and LVB.

Within our cohort, 45% (10/22) had public insurance (Medicare, Medicaid, or Tricare), whereas 55% (12/22) had private insurance. Of the seven patients who underwent prophylactic surgery, one had public insurance and six had private insurance. Of the 15 patients who received

delayed surgery for existing lymphedema, nine had public insurance, and six had private insurance (Fig. 1).

The average hospital charges for each case were \$48,516.73, while the average total payment was \$10,818.68. The average direct variable cost was \$5,567.10. This resulted in an average contribution margin of +\$5,251.58. The payment-to-charge ratio averaged to 21.6% of total charges, ranging from 3% to 65%. Overnight ICU admission accounted for 10% of the total cost when present.

Hospital Charges, Payments, and Costs by Procedure and Payor (Fig. 2)

For patients undergoing prophylactic LVB, the average total charge for patients with private insurance was \$46,648.66, and the average total payment was \$6,297.10 with average reimbursement of 14.03%. The average direct variable cost for this group was \$4,823.50, resulting in an average contribution margin of +\$1,473.61 per procedure. The total charge for the patient with

		<i>Prophylactic</i>	<i>Delayed</i>			
		Prophylactic LVB	Delayed LVB	Delayed LNT	Delayed LNT & LVB	All patients
Demographics	Total Number	7	5	3	7	22
	Average Age	53.6	50.6	64.3	55.7	55.1
	Average OR Time (min)	321.43	234	330	420	334.09
Extremity	Upper	7	5	2	7	21
	Lower	0	0	1	0	1
Laterality	Left	4	1	2	3	10
	Right	3	4	1	3	11
	Bilateral	0	0	0	1	1
Payor Type	Private	6	2	0	4	12
	Public	1	3	3	3	10
Hospital Data	Hospital Charges	\$47,439.43	\$35,895.88	\$51,204.93	\$57,456.82	48,516.73
	Actual Payment	\$6,602.83	\$8,911.17	\$11,483.80	\$16,112.00	10,818.68
	Percent Charges Paid	14.3%	22.5%	22.0%	27.9%	21.6%
	Direct Variable Cost	\$4,685.00	\$3,921.44	\$6,487.83	\$7,230.09	5,567.10
	Contribution Margin	\$1,917.83	\$4,989.73	\$4,995.98	\$8,881.91	5,251.58
Surgeon Data	Surgeon Charges	\$5,087.71	\$7,609.20	\$10,675.00	\$17,800.71	10,467.73
	Actual Payment	\$1,870.06	\$3,397.24	\$3,429.76	\$5,740.46	3,661.32
	Percent Charges Paid	41.6%	39.4%	31.4%	37.8%	38.5%

Fig. 1. Demographic, cost, and payment data subcategorized into prophylactic and delayed surgery subsets.

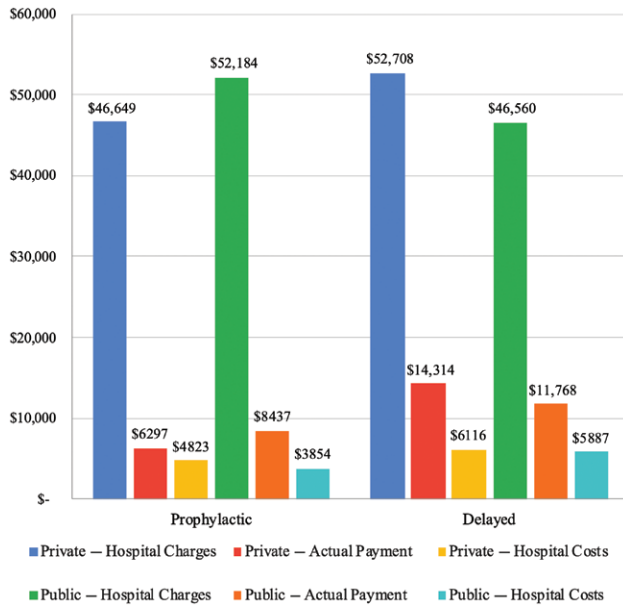


Fig. 2. Physician charges/payments by surgery and payor type.

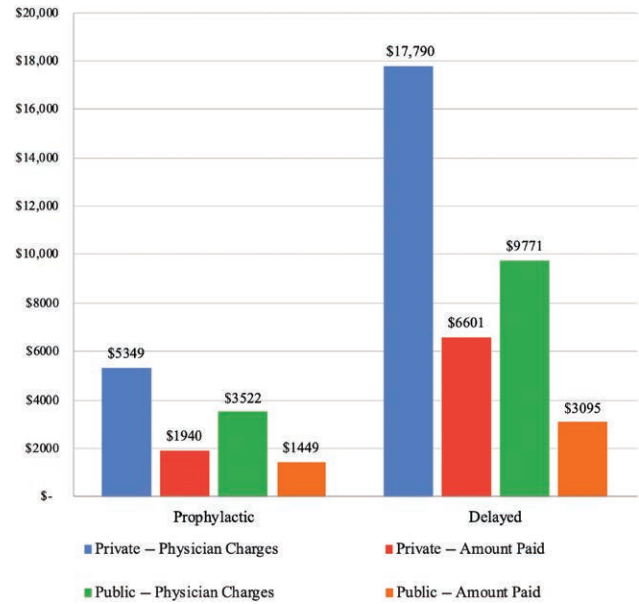


Fig. 3. Hospital charges/payments/costs by surgery and payor type.

public insurance undergoing a prophylactic procedure was \$52,184.10, the total payment was \$8,437.19, with a direct variable cost of \$3,854.00, resulting in a contribution margin of +\$4,583.19. The payment-to-charge ratio was 16.17%.

For patients undergoing delayed LVB and VLNT, the average total charges for patients with private insurance was \$52,708.33, the average total payment was \$14,313.82 with an average payment-to-charge ratio of 25.90%. The average direct variable cost was \$6,116.26, resulting in an average contribution margin of +\$8,197.57 per procedure. The average total charge for patients with public insurance undergoing delayed procedures was \$46,560.22. The average total payment was \$11,767.59 with an average payment-to-charge ratio of 24.26%. The average direct variable cost was \$5,887.08, resulting in an average contribution margin of +\$5,880.51 per procedure.

Physician Charges and Payments by Procedure and Payor (Fig. 3)

For patients undergoing prophylactic LVB, the average physician charges for patients with private insurance was \$5,348.67, while the average amount paid by the insurance was \$1,940.17, resulting in an average reimbursement rate of 41.71% of charges. Physician charges for the patient with public insurance undergoing a prophylactic procedure was \$3,522.00, while the amount paid by the insurance was \$1,449.39, amounting to 41.15% of charges. For patients who underwent delayed microsurgical lymphatic procedures, the average physician charges for patients with private insurance was \$17,789.67, while the amount paid by the insurance was \$6,601.26, resulting in a reimbursement rate of 46.43% of charges. The average physician charges for patients with public insurance undergoing delayed procedures was \$9,770.89, while the

amount paid by the insurance was \$3,094.57, amounting to 30.79% of charges.

DISCUSSION

Secondary lymphedema is a common complication of oncologic surgeries, particularly when combined with chemotherapy and radiation. At the time of this study there is minimal data to act as a benchmark of the total surgical costs and payments received by an active institutionally employed academic surgeon performing lymphatic microsurgery. The goal of this study was to review the cost and payment data for microsurgical lymphedema procedures performed by the senior author (KC) at William Beaumont Hospital in Royal Oak, Michigan.

Our study shows that in patients who undergo surgical treatment for lymphedema, the average contribution margin, and therefore hospital overall profit per procedure is roughly +\$5251 per case, with a payment-to-charge ratio of 22%. Our literature review failed to identify any published literature standard of payments received for VLNT or LVB, and reported very limited data regarding similar contribution margins for other routine cases. Data from the OB/GYN literature have shown a profit margin for robotic surgery of +\$3484 (reimbursement ratio 28%) and laparoscopic surgery of +\$2264 (reimbursement ratio 37%) for the treatment of endometrial cancer.¹¹ For comparison, urologic data for both laparoscopic and robotic prostatectomies have actually been shown to have a negative reimbursement for the hospital, with financial incentive to pursue open surgery; although with a higher morbidity to the patient.¹² These OB/GYN and Urologic cases are covered by insurance routinely. Our data show that lymphedema microsurgery is reimbursed at our facility, and the hospital is experiencing a significant positive contribution margin from the procedures, compared with other published figures.

The historical standard of care for patients suffering from lymphedema is a lifetime of complete decongestive therapy. The four components of complete decongestive therapy are manual lymphatic drainage, compression therapy, lymph-reducing exercises, and skin care.¹³ Compression therapy alone has been shown to decrease rates of yearly hospitalizations from 45% to 32% ($P < 0.0001$), and outpatient hospital visits from 95% to 90%, ($P < 0.0001$).¹⁴ Lifelong medical intervention, with the subsequent physical and mental patient burdens highlight the insufficiency of traditional treatments in addressing lymphedema. Medical management, when closely adhered to, results in only a 13% decrease in rate of hospitalization and an 18% decrease in total healthcare costs annually.¹⁴ This also does not address the medical costs related to infection with or without progression to sepsis, nor the development of Stewart Treves syndrome, which has been shown in multiple case reports to undergo remission following lymphatic surgery.¹⁵ Lymphovenous bypass resulted in cessation of medical therapy for 85% of patients studied in an 1800 patient review of patients with primarily stage II (39%) and III (52%) disease, with over 80% of patients having objective volume decreases in their affected extremity.¹⁶

Therapeutic treatments are challenging financially and logistically for patients. Long-term breast cancer survivors with lymphedema may face up to 112% higher out-of-pocket costs than those without lymphedema.¹⁷ A recent multicenter prospective study found the average out-of-pocket costs for medical management of lymphedema could be up to 10% of a patient's standardized total income by consumption.¹⁸ Notably, these cost analyses do not account for the productivity loss and decreased quality of life many patients report as they endure indefinite decongestive therapy.

Although most insurance companies will cover reconstructive surgery following oncological procedures, reimbursement for treatment of lymphedema has been limited, despite the financial incentive of possible liberation from medical therapy. From a societal and a payor perspective, lymphatic surgery coverage may ultimately reduce overall health care expenses.¹⁹ This is particularly true for insurers that provide coverage for conservative treatments as these costs may reduce to zero for patients who respond well to surgery.¹⁹

Head et al addressed the economics of medical and surgical therapy by modeling the lifetime economics of lymphovenous bypass in a breast cancer patient using a single payor model in the Canadian healthcare system.²⁰ The expected net benefit of surgical treatment for lymphedema is directly correlated with the patient's overall lifespan and benefit of therapy. They use a life expectancy of 15 years for a model patient with stage II breast cancer and estimate the overall cost of decongestive therapy alone to be $> \$30,000$. Conversely, successful surgery with cessation of further compressive therapy is $\sim \$15,000$. Their estimates did not include complications related to medical therapy, such as progression of disease, infection, sepsis, cancer, and loss of productivity in the model patients.

Their cost estimate is similar to that of our findings—an average payment received of $\sim \$11,000$ per surgery without accounting for diagnostic work up. They further argue that the cost for surgery is at least comparable to medical therapy, with significant cost savings seen in patients who are able to discontinue decongestive therapy.²⁰

Prophylactic lymphatic surgery has also been shown to yield measurable symptom prevention and cost benefits in the field of oncologic breast surgery. Jørgensen et al performed a systematic review and meta-analysis of the literature on prophylactic LVB at the time of lymphadenectomy and found a significant reduction in the incidence of lymphedema in patients who underwent prophylactic LVB.²¹ This was equivalent to one-third of the incidence of lymphedema in their control group.²² A recent cost-minimization analysis was performed comparing patients undergoing mastectomy and axillary lymph node dissection with mastectomy, axillary dissection, and prophylactic lymphovenous bypass. They predicted that if all patients underwent prophylactic bypass, regardless of if the patient developed lymphedema, there was \$7646 cost savings (45.2% in their treatment) per patient through limitation of annual medical therapy.²³

Common criticisms of these cutting-edge microsurgical techniques persist with the limited amount of published long-term outcome data. However, we believe that as time and further studies continue to be published in favor of improved quality of life, improved disease management, and cost-effectiveness, that the case for labeling microsurgical lymphatic procedures as experimental will be inaccurate.

Our particular study is limited by the fact that it is a single center, single surgeon review with a small sample size. Although this data may be representative of a typical microsurgical practice in America, it may not be generalizable to all practice settings and regulatory environments in the United States, and outcomes also may not be generalizable as microsurgical lymphatic procedures require additional training and expertise for optimal outcomes. We do not have data regarding patients who were refused surgery due to lack of insurance pre-authorization for either therapeutic or prophylactic surgery, thus resulting in a sampling bias. Preoperative imaging was performed in the clinic and the cost data for this imaging is unavailable. However, this cost data would be unlikely to mitigate the benefits of surgery over prolonged conservative/medical therapy as estimated by other review articles.

CONCLUSIONS

Lymphovenous bypass and VLNT offer significant benefits in both disease burden and quality of life, with the possibility of a cure for an otherwise highly morbid, persistent disease. Our experience has been that obtaining reimbursement for the surgical treatment of lymphedema is possible, payment-to-charge ratios are comparable to other surgical procedures, and surgery results in positive contribution margins for the hospital. Through growing awareness of lymphedema as an expensive preventable complication following

oncological surgery, further lobbying should focus on eliminating any barriers between coverage for both therapeutic and prophylactic procedures as patients, hospitals, and the healthcare systems all benefit.

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