The Cutaneous, Net Clinical, and Health Economic Benefits of Advanced Pneumatic Compression Devices in Patients with Lymphedema

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Word Count: 3004
Number of text pages: 11 pages, excluding Abstract, Tables and References
Number of references: 24
Number of figures: 0
Number of tables: 3
Brief title: Reduction in Lymphedema Related Cellulitis

Abstract

Importance: The prevalence and clinical burden of lymphedema is known to be increasing. Nevertheless, evidence-based comparative effectiveness data regarding lymphedema therapeutic interventions has been poor.

Objective: To examine the impact of an advanced pneumatic compression device (APCD) on cutaneous and other clinical outcomes and health economic costs in a representative privately insured population of lymphedema patients.

Design: Retrospective analysis of a de-identified private insurance database from 2007 through 2013. Multivariate regression analysis comparing outcomes for the 12 months pre and post-APCD purchase, adjusting for baseline patient characteristics.

Setting: Commercially insured and Medicare Managed Care enrollees from a large, national United States managed care health insurer.

Participants: Patients with lymphedema who received an APCD. The study population was evaluated as cancer- and non-cancer-related lymphedema cohorts.

Intervention(s) for Clinical Trials or Exposure(s) for observational studies: Receipt of an APCD.

Main Outcome(s) and Measure(s): Rates of cellulitis, use of lymphedema-related manual therapy, outpatient hospital visits, and inpatient hospitalizations. Lymphedema-related direct costs for home healthcare, hospital outpatient care, office visits, emergency room use, and inpatient care.

Results: The study sample included 718 patients (374 in the cancer cohort and 344 in the non-cancer cohort). In both cohorts, use of an APCD was associated with similar reductions in adjusted rates of cellulitis episodes (from 21.1% to 4.5%, $p<0.001$ in the cancer cohort; and 28.8% to 7.3%, $p<0.001$ in the non-cancer cohort), lymphedema-related manual therapy (from 35.6% to 24.9%, $p=0.001$ in the cancer cohort; 32.3% to 21.2%, $p=0.001$ in the non-cancer cohort), and outpatient visits (from 58.6% to 41.4%, $p<0.001$ in the cancer cohort; 52.6% to 31.4%, $p<0.001$ in the non-cancer cohort). Among the cancer cohort, total lymphedema related costs per patient, excluding medical equipment costs, were reduced by 37% (from $2,597 to $1,642, $p=0.002$). The corresponding decline in costs for the non-cancer cohort was 36% (from $2,937 to $1,883, $p=0.007$).

Conclusions and Relevance: These data demonstrate significant 79% and 75% reductions in episodes of cellulitis (cancer vs. non-cancer cohorts), and a significant reduction in outpatient care and costs within a one-year timeframe of APCD acquisition in patients with both cancer-related and non-cancer related lymphedema.

Introduction

Secondary lymphedema affects an estimated 2 to 3 million people in the U.S.[1, 2] . Interstitial lymph accumulation contributes to loss of skin integrity, irreversible collagen deposition and induration, and cellulitis [3, 4]. Lymphedema is characterized by the abnormal accumulation of fluid in tissues that is associated with edema, recurrent cellulitis, loss of physical function, and psychological distress with diminished quality of life [5-7]. Lymphedema cannot be cured, but the establishment of the diagnosis and initiation of targeted therapies, by dermatologists who frequently care for the patients with cellulitis can ameliorate the impact and progression of the disease [8, 9]. Antibiotic therapies are useful to modify the risk of a first episode of cellulitis, but patients remain at heightened risk for recurrent cellulitis and/or systemic infection. Lymphedema-related cellulitis is common, functionally important, and dangerous. It thus represents a critically important health endpoint that merits focused study in population-based lymphedema research.

In the absence of a robust comparative effectiveness evidence base, the current standard of lymphedema care is the labor-intensive multi-modal approach known as combined decongestive therapy (CDT) [9]. The components of CDT include professionally-administered manual lymph drainage, multi-layer bandaging, decongestive exercise, skin care, and education in long-term lymphedema self-management. Adjunctive treatment modalities, such as use of a pneumatic compression device (PCD) provide additional, and possibly more effective, management options. PCDs have been shown to be effective physiologically, as they improve lymphatic function and lymph flow [10] and reduce edema volume [11-16], and clinically, as they improve patient reported symptoms and quality of life [11, 16]. Yet, despite the recent expansion of the efficacy evidence base, PCD effectiveness data derived from real world settings has been sparse.

The measurement of effectiveness, representing a measurement of the clinical benefit of a therapy in a general population, is widely considered to represent a key evidential gold standard [17]. Lymphedema therapeutic effectiveness has been demonstrated in patients with cancer, inasmuch as PCD use has been associated with significant decreases in rates of cellulitis diagnoses, outpatient services, and hospitalization utilization [5]. Average baseline healthcare costs were high but decreased significantly in the year after receipt of a PCD. However, that study did not evaluate the relative benefit of the various types of PCDs currently available, nor did it evaluate the outcomes in individuals with non-cancer-related lymphedema.

The most advanced PCD is a device designed for home use that delivers external pneumatic compression through multiple inflatable compartments and utilizes a calibrated, gradient compressor. These advanced PCDs (APCDs) have more garment chambers than earlier, less-advanced devices, and provide a greater level of adjustability and programmability, providing potential individuated treatment advantages. In this study, we measured the effectiveness of an APCD on cutaneous and systemic clinical outcomes, as well as associated health economic costs within a representative privately insured population of lymphedema patients. This study was designed to evaluate patients with both cancer and non-cancer-related lymphedema who were prescribed and received an APCD.

Methods

Setting and Data Source. This study was performed using a de-identified Normative Health Information (dNHI) database that included patient claims information from 2007 through 2013. The Institutional Review Board of University of Minnesota waived the need for ethical approval for our study. The dNHI includes over 34 million individuals each year, comprised of both commercially insured and Medicare Managed Care enrollees from a large, national United States

(U.S.) managed care health insurer affiliated with Optum, Inc. (Eden Prairie, MN). The enrollment database includes a geographically diverse U.S. population with similar age- and gender- distribution to that reported by the U.S. Census Bureau for the commercially-insured and the Medicare Managed care population.

The dNHI contains enrollment data, as well as medical and pharmacy claims data. Medical (facility and professional) claims incorporate diagnosis codes recorded with International Classification of Disease, Ninth Edition, Clinical Modification (ICD-9-CM), procedures recorded with ICD-9-CM procedure codes, Current Procedural Terminology (CPT) codes, or HCPCS and revenue codes. No identifiable protected health information was accessed during this study and de-identified data were accessed in accordance with the Health Insurance Portability and Accountability Act. The study was exempted from human subjects review at the University of Minnesota.

Study Population. Patients were identified by the presence of a claim for a PCD, identified with HCPCS code E0652 (pneumatic compressor, segmental home model with calibrated gradient pressure) or E0651 (pneumatic compressor, segmental home model without calibrated gradient pressure) during the time period of January 1, 2008 through November 30, 2012 (n=21,104). In order to identify health services utilization and other outcomes, both before and after acquisition of the PCD, patients were required to have continuous enrollment in the health plan with medical and pharmacy benefits for 12 months before and 12 months after the first claim date for the -PCD (index date) (n=6,760). To ensure correct identification of a first exposure to PCD use, patients were excluded if they had a claim for a PCD during the pre-index period (n=6,702). Finally, in order to identify users with a lymphedema diagnosis, the study sample was restricted to individuals with at least one claim with a primary or secondary

diagnosis code for lymphedema during the 12 months prior to receiving the PCD (n=3,415). Of these patients, 718 acquired the target APCD device and therefore were assigned to the study sample. The total treatment population was then subdivided into cancer and non-cancer cohorts.

A cohort of cancer-related lymphedema patients was distinguished *pre hoc* in the study sample. Patients were identified with cancer-related lymphedema if they had one or more medical claims with ICD-9-CM diagnosis codes 140.xx-195.xx, 199.xx, or 200.xx-209.xx during at least 12 months prior to the receipt of the APCD (n=374). These codes include cancers of the (a) breast; (b) bone, connective tissue, or skin; (c) digestive organs and peritoneum; (d) genitourinary organs; (e) lip, oral cavity, and pharynx; (f) lymphatic and hematopoietic tissue; (g) neuroendocrine tumor; (h) respiratory and intrathoracic organs and (i) other unspecified sites. Patients whose claim history did not include such cancer codes were designated in the non-cancer cohort (n=344).

Advanced PCD Intervention: This study was designed to evaluate the impact of a specific APCD on lymphedema-related cellulitis and systemic clinical and health cost outcomes in individuals with lymphedema. The APCD utilized for this analysis was the Flexitouch System® (Tactile Medical, Minneapolis, MN, USA) (HCPCS E0652). This device was selected for the relatively robust data from earlier investigations with this device, that define both physiologic mechanisms and specific clinical outcomes associated with measurable efficacy [10, 11, 15, 18, 19], thus offering the possibility to evaluate this potential efficacy in a national insured population. In addition, because the manufacturer is also the provider submitting the insurance claims, it was uniquely feasible to cross match provider details with device codes in order to evaluate this single intervention.

Patient Demographic and Clinical Characteristics. The dNHI database included information on patient demographic and socioeconomic characteristics, such as age, gender, race/ethnicity (non-Hispanic Asian, non-Hispanic Black, non-Hispanic White, Hispanic, Unknown), census region, type of insurance (commercial or Medicare) and average income. In addition, we identified co-morbid conditions during the 12 months prior to receipt of the device (baseline). The presence of obesity, diabetes, hypertension or renal disease was identified through the relevant ICD-9-CM and CPT/HCPCS codes in the medical claims. For the cancer cohort, we identified the types of baseline cancer (described above). Finally, we computed the baseline Charlson co-morbidity score [20].

Clinical and Healthcare Utilization Outcomes. A broad, clinically relevant set of healthcare utilization outcomes were then evaluated for each patient for the 12 months pre- and post-APCD receipt. Cellulitis infections were identified as the number of medical claims with a primary or a secondary diagnosis code for cellulitis. Additional health outcomes included binary indicators for any inpatient hospitalizations, any use of manual therapy, and any outpatient hospital visits. Use of manual therapy was defined by any medical claim with a CPT code for physical or occupational therapy (PT/OT). Only lymphedema-related clinical outcomes were considered. Outcomes were designated as lymphedema-related (LE) if the corresponding claim had a primary or secondary lymphedema diagnosis code (ICD-9-CM of 457.0, 457.1, or 757.0).

Healthcare Costs. The American Medical Association "place of service codes" as provided in claims were used to designate costs at various healthcare sites for each patient for the 12 month period preceding and that following APCD receipt. The settings included home healthcare, hospital outpatient, inpatient, and emergency room visits, with separate aggregation of durable medical equipment, laboratory, and pharmacy expenses. Outpatient costs were separated among

cellulitis, manual therapy claims (claims which included a PT/OT therapy CPT code) and any other service provided in the hospital outpatient setting. Total costs were calculated as the sum of payment by the health plan and beneficiary, facility payments, and professional service fees. Analogously to clinical outcomes determinations, lymphedema-related costs were identified based on associated primary or secondary ICD-9-CM codes for lymphedema.

Statistical Analysis. The final analytic extract included two observations for each individual. The first observation corresponded to data obtained during the 12 months prior to the "index date", defined as the first claim date at which the APCD was acquired (baseline). The second observation corresponded to the 12-month data obtained after the index date (follow-up). We utilized a multivariate regression analysis to estimate and compare the clinical and cost outcomes per patient in the baseline period to the corresponding outcomes in the follow-up period, adjusting for the baseline patient demographic, clinical and socioeconomic characteristics.

For binary outcome variables (cellulitis, inpatient hospitalizations, use of manual therapy, and outpatient visits), we estimated logistic models. For continuous cost outcomes, we estimated ordinary linear regressions. For each outcome, we estimated adjusted outcomes for the pre-period, follow-up period, and their difference. We allowed the baseline-to-follow-up period differences in outcomes to vary by patients in the cancer and the non-cancer cohorts. We conducted two-tailed t-tests to test whether the baseline to follow-up changes in outcomes differed between cancer and non-cancer patients. We reported Huber/White robust standard errors [21-23]. All analyses were conducted using STATA version 12 (STATA Corp, College Station, Texas).

Results

This investigation evaluated a cohort of 718 lymphedema patients, 374 in the cancer cohort and 344 in the non-cancer cohort. **Table 1** presents the demographic and clinical characteristics of this population. The sample included a representative, age-stratified set of lymphedema patients, with 19.8% of the sample in the 19-44 years age group; 61.1% in the 45-64 years age group; and 18.4% who were 65 years or older. The majority of patients were female (92.0% in the cancer cohort and 77.0% in the non-cancer cohort). Hypertension was present in 48.1% of the cancer cohort and 56.7% of the non-cancer cohort. Obesity and diabetes were also common, but more so in the non-cancer cohort (obesity was present in 11.5% of the cancer cohort and 38.1% of the non-cancer cohort; diabetes was present in 15.2% of the cancer cohort and 27.6% of the non-cancer cohort). In the cancer cohort, the most prevalent malignancy was breast cancer (75.9%) followed by bone cancer, connective tissue or skin (13.6%) and genitourinary organ cancers (13.1%). Not surprisingly, Charlson co-morbidity index was higher in the cancer cohort relative to the non-cancer cohort (4.3 vs 1.3, $p<0.001$).

Clinical outcomes and lymphedema related healthcare use.

Table 2 presents lymphedema-related clinical and healthcare utilization outcomes adjusted for the differential patient baseline characteristics listed in Table 1 for the cancer and non-cancer cohorts. Receipt of the APCD was associated with a significant decline in the rate of cellulitis diagnoses in the cancer group from 21.1% to 4.5% ($p<0.001$), corresponding to a major 79% decline of these limb infections. In the non-cancer groups, the rates of cellulitis declined from 28.8% to 7.3% ($p<0.001$), corresponding to a decline of 75%. For this cohort, there were also significant reductions in the inpatient hospitalization rate (from 7.0% to 3.2% ($p=0.019$), representing a 54% decline).

In the cancer cohort, 35.6% received manual therapy services in the baseline period. In the follow-up period, the rate of manual therapy declined to 24.9% (p=0.001) representing a decline of 30%. Similarly, the rate of outpatient visits declined from 58.6% to 41.4% (p<0.001) representing a 29% reduction. Inpatient care was relatively infrequent both in the baseline and the follow-up periods (2.7 and 2.1% respectively (p=0.63)).

Similar reductions in the adjusted rates of lymphedema-related healthcare utilization were observed in the follow-up period for the non-cancer cohort. The rates of manual therapy decreased from 32.3% to 21.2% (p=0.001) representing a 34% decline, and the rate of outpatient hospital visits reduced from 52.6% to 31.4% (p<0.001), a 40% decline. As noted in Table 2, the changes in outcomes between baseline and the follow-up period were similar in magnitude between the cancer and non-cancer cohorts.

Lymphedema related healthcare costs.

Table 3 presents lymphedema-related costs, adjusted for the patient baseline characteristics listed in Table 1, for the cancer and non-cancer cohorts. Among the cancer cohort, total costs per patient, excluding medical equipment costs, were reduced by 37% from $2,597 to $1,642 (p=0.002). The greatest contributor to this change was a reduction in outpatient hospital costs from $1,517 to $694 (p<0.001), a substantial 54% reduction. Among the hospital outpatient costs, PT/OT-related outpatient costs declined about 50% from $287 to $145 (p=0.034). Office visit costs also declined by 42% from $468 to $274 (p=0.013).

Cost reductions were similar in magnitude for the non-cancer cohort. Total costs, excluding durable medical equipment, reduced by 36% from $2,937 in the baseline to $1,883 in the follow-up period (p=0.007). Outpatient hospital costs declined by 65% from $1,726 to $606

($p<0.001$). Outpatient hospital costs related to PT/OT halved from $332 to $169 ($p=0.047$). As noted under Table 3, the changes between baseline and follow-up period were not significantly different between the cohorts with the exception of other durable medical equipment costs.

Discussion

Our study demonstrates, for the first time, that receipt of an APCD is associated with significant improvements in key clinical endpoints that are central to defining the health of individuals with lymphedema, without regard to specific etiology. The decrease in rates of cellulitis by 79% and 72% in the cancer-related and non-cancer-related cohorts represent a major direct health benefit to all classes of affected patients. As lymphedema is known to serve as the most potent predictor of recurrent cellulitis, raising this risk 9-fold, the benefit observed in the current study verifies that the high risk is lowered by APCD acquisition and use [24]..

These lower rates of cellulitis are associated with major health service and economic benefits. Individuals with lymphedema, whether cancer-related or not, who suffer from these higher rates of cellulitis, require more intensive outpatient care in rehabilitative settings (e.g., by dermatologists, physical therapists, and primary care clinicians), and they may need inpatient hospitalization to treat skin or systemic infection or other complications. Each of these episodes of care, whether designed to prevent adverse events, to improve quality of life (occupational or physical therapy), or to treat a systemic adverse event (hospitalization) impairs independence and contributes to high healthcare expenditures.

As in all administrative data studies, this investigation has limitations. The use of claims data assumes that coding is accurate. The exact clinical circumstances for each health encounter cannot be specifically deduced. We also are not able to account for the degree of device use.

Finally, it is not methodologically feasible for a "control group" of individuals with lymphedema, but no APCD use, to be accurately identified and for unmatched co-morbidities to be sufficiently identified to provide an accurate comparison of outcomes. Thus, it cannot be known if use of other support garments or antibiotics differed between groups.

Despite these limitations, our study provides definitive evidence that APCD acquisition is associated with improved clinical outcomes and immediate cost reductions. Our study was not designed to forecast cost reductions beyond the 12-month period after the purchase of the APCD, but cost reductions were achieved primarily through reductions in outpatient and office visits that are likely to persist throughout the duration of the disease.

It is also important to note that the cost reductions that we observed likely represent a lower bound in overall cost reductions associated with such device use. As APCD use compliance cannot be measured from these administrative data sources, and as it is known that compliance directly affects clinical efficacy, these outcome data likely include individuals offered device use but for whom high compliance and maximal benefit was not achieved. While our study focused only on healthcare use and costs based on claims coded with a lymphedema diagnosis, it is likely that other types of healthcare use are similarly affected. For example, in additional analyses (not presented in tables), we found reductions in cellulitis rates in patients with lymphedema that were <u>not</u> coded as lymphedema-related; it is likely that these were also due to device-mediated improvements and that a biological relationship existed. In addition, direct healthcare costs represent a fraction of the overall costs related to the lymphedema burden. To the extent that APCD use improves physical functioning and QOL, cost reductions due to improved productivity, lower caretaker costs and reductions in other non-monetary costs are likely significant.

The potential public health implications of our findings are substantial. Episodes of cellulitis are often not counted as a key public health hazard, but they represent, for patients with lymphedema, a hallmark event that is associated with real morbidity and cost, but that can be prevented. Lymphedema is a common, chronic cardiovascular disease that contributes to the public health burden. The availability of effective home-based therapeutic interventions can serve individual patients and reduce this burden. While our findings are based upon the outcomes from one specific device, it is possible other such devices may also reduce patient burden. This warrants explorations in future studies.

Conclusion

This study demonstrates the clinical and economic effectiveness of one common adjunctive lymphedema treatment modality, ACPDs, which is associated with a major decrease in episodes of cellulitis. These data also demonstrate other key treatment benefits that improve individual and population health, with an associated cost reduction. Thus, dermatologists, primary care and vascular physicians, and therapists may utilize PCD therapy to improve skin, limb, and systemic health.

Acknowledgements:

Author Contributions: Dr. Karaca-Mandic had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design*: Dr. Karaca-Mandic, Dr. Hirsch, Dr. Rockson, Dr. Ridner jointly conceptualized the study.
Acquisition, analysis, and interpretation of data: Dr. Karaca-Mandic and Dr. Hirsch acquired the data. Dr. Karaca-Mandic analyzed the data. All authors contributed to the interpretation of the data. *Drafting of the manuscript*: Dr. Karaca-Mandic drafted the initial version of the manuscript. *Critical revision of the manuscript for important intellectual content*: All authors contributed to the critical revision of the manuscript. *Statistical analysis*: Dr. Karaca-Mandic. *Obtained funding*: Dr. Hirsch. *Administrative, technical, or material support*: none *Study supervision*: Dr. Karaca-Mandic and Dr. Ridner

Funding/Support: This study was supported in part by Tactile Medical (Minneapolis, MN) to defray access costs for use of the Optum Health database and defrayed health economic analytic costs. Tactile Medical did not perform any study-related analyses. The investigators had independent control of the study design, full access to all data, and performed the analyses independently. The manuscript was drafted and all versions were edited by the first author.

Role of Sponsors:
Funding/Sponsor was involved?
Design and conduct of the study: No
Collection, management, analysis and interpretation of data: No
Preparation, review, or approval of the manuscript: No
Decision to submit the manuscript for publication: No

Financial disclosure of authors:
• Relationships relevant to this manuscript
Dr. Hirsch serves as Chief Medical Officer of Tactile Medical, a company which manufactures a product used to treat lymphedema. Professor Karaca-Mandic received consultative reimbursement from Tactile Medical for her independent performance of the health economic analyses. These relationships have been reviewed and managed by the University of Minnesota in accordance with its Conflict of Interest policies No other author had any conflicts of interest.

• All other relationships
None of the authors had any other conflicts of interest.

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Table 1. Baseline (12-month pre-device) characteristics of the study sample [n=718]

	All Patients (n=718)	Cancer (n=374)	Non-Cancer (n=344)	Difference (P-Value)
Demographic characteristics				
Age in years, Mean (SD)	54.2 (12.7)	56.1 (11.3)	52.1 (13.8)	<0.001
Age in category No. (%)				
0-18	5 (0.7)	0 (0.0)	5 (1.5)	0.02
19-44	142 (19.8)	58 (15.5)	84 (24.4)	0.003
45-64	439 (61.1)	243 (65.0)	196 (57.0)	0.03
65+	132 (18.4)	73 (19.5)	59 (17.2)	0.41
Female, No. (%)	609 (84.8)	344 (92.0)	265 (77.0)	<0.001
Race, No. (%)				
Asian	13 (1.8)	6 (1.6)	7 (2.0)	0.67
Black	118 (16.4)	56 (15.0)	62 (18.0)	0.27
Hispanic	34 (4.7)	17 (4.5)	17 (4.9)	0.80
White Non-Hispanic	514 (71.6)	280 (74.9)	234 (68.0)	0.04
Unknown	39 (5.4)	15 (4.0)	24 (7.0)	0.08
Clinical characteristics				
Obesity, No. (%)	174 (24.2)	43 (11.5)	131 (38.1)	<0.001
Diabetes, No. (%)	152 (21.2)	57 (15.2)	95 (27.6)	<0.001
Hypertension, No. (%)	375 (52.2)	180 (48.1)	195 (56.7)	0.02
Renal Disease, No. (%)	70 (9.7)	24 (6.4)	46 (13.4)	0.002
Charlson Index, Mean (SD)	2.9 (2.5)	4.3 (2.3)	1.3 (1.6)	<0.001
Type of Cancer, No. (%)				
Breast	284 (39.6)	284 (75.9)		
Bone, Connective Tissue, Skin	51 (7.1)	51 (13.6)		
Digestive Organs and Peritoneum	12 (1.7)	12 (3.2)		
Genitourinary Organs	49 (6.8)	49 (13.1)		
Lymphatic and Hematopoietic Tissue	17 (2.4)	17 (4.5)		
Other and Unspecified Sites	43 (6.0)	43 (11.5)		
Socio-Economic Characteristics				
Census region, No. (%)				
Midwest	198 (27.6)	105 (28.1)	93 (27.0)	0.76
Northeast	63 (8.8)	22 (5.9)	41 (11.9)	0.004
South	363 (50.6)	198 (52.9)	165 (48.0)	0.18
West	68 (9.5)	36 (9.6)	32 (9.3)	0.88
Unknown	26 (3.6)	13 (3.5)	13 (3.8)	0.83
Insurance No. (%)				
Commercial	605 (84.3)	321 (85.8)	284 (82.6)	0.23
Medicare	113 (15.7)	53 (14.2)	60 (17.4)	0.23
Average income ($), Mean (SD)	61,034 (25,397)	63,680 (26,699)	58,148 (23,599)	0.007

Table 2: Adjusted Lymphedema Related Clinical Outcomes and Healthcare Use Before and After APCD Receipt

	Baseline (12 Months Pre-Device)	**Follow-up (12 Months Post-Device)**	**Change (Follow-up - Baseline)**	
	Mean	Mean	Difference	P-value
Cancer Patients				
Rate of Cellulitis Diagnosis (%)	21.1 (2.1)	4.5 (1.1)	-16.6 (2.3)	<0.001
Rate of Inpatient Hospitalizations (%)	2.7 (0.8)	2.1 (0.7)	-0.5 (1.1)	0.631
Rate of Manual Therapy (PT/OT) (%)	35.6 (2.4)	24.9 (2.2)	-10.7 (3.3)	0.001
Rate of Outpatient Hospital Visits (%)	58.6 (2.5)	41.4 (2.5)	-17.1 (3.5)	<0.001
Non-Cancer Patients				
Rate of Cellulitis Diagnosis (%)	28.8 (2.3)	7.3 (1.4)	-21.5 (2.7)	<0.001
Rate of Inpatient Hospitalizations (%)	7.0 (1.3)	3.2 (0.9)	-3.8 (1.6)	0.019
Rate of Manual Therapy (PT/OT) (%)	32.3 (2.4)	21.2 (2.2)	-11 (3.3)	0.001
Rate of Outpatient Hospital Visits (%)	52.6 (2.6)	31.4 (2.4)	-21.2 (3.5)	<0.001

A logit model was used for estimating the adjusted rates of manual therapy, outpatient hospital visits, cellulitis diagnosis and inpatient hospitalizations. Adjusted estimates controlled for characteristics listed in Table 1. PT/OT: Manual therapy was defined by any medical claim with a CPT code for physical or occupational therapy. Changes in outcomes between baseline and the follow-up period were not statistically different in magnitude between the cancer and non-cancer cohorts.

Table 3: Adjusted Lymphedema-Related Costs Before and After APCD Receipt

	Baseline (12 Months Pre-Device)	Follow-up (12 Months Post-Device)	Change (Follow-up - Baseline)	
	Mean	Mean	Difference	P-value
Cancer Patients				
Home Health ($)	247 (47)	284 (41)	37 (62)	0.555
Outpatient ($)	1,517 (120)	694 (95)	-823 (153)	<0.001
Outpatient PT/OT costs ($)	287 (53)	145 (41)	-142 (67)	0.034
All Other Outpatient Costs ($)	1,230 (109)	549 (84)	-681 (137)	<0.001
Office ($)	468 (58)	274 (51)	-194 (78)	0.013
Emergency ($)	71 (19)	46 (11)	-25 (22)	0.256
Inpatient ($)	266 (155)	308 (162)	42 (224)	0.853
Lab ($)	12 (11)	1 (1)	-10 (11)	0.365
Other Service Location ($)	16 (6)	34 (13)	18 (14)	0.185
DME (other) ($)	22 (6)	914 (23)	892 (24)	<0.001
Total Cost less DME other ($)	2,597 (205)	1,642 (224)	-955 (304)	0.002
Non-Cancer Patients				
Home Health ($)	172 (41)	308 (62)	135 (74)	0.069
Outpatient ($)	1,726 (157)	606 (99)	-1,120 (185)	<0.001
Outpatient PT/OT costs ($)	332 (61)	169 (56)	-163 (82)	0.047
All Other Outpatient Costs ($)	1,394 (144)	437 (78)	-957 (164)	<0.001
Office ($)	686 (109)	680 (210)	-5 (237)	0.982
Emergency ($)	98 (57)	17 (9)	-81 (58)	0.160
Inpatient ($)	245 (112)	233 (163)	-13 (198)	0.949
Lab ($)	5 (2)	3 (1)	-2 (2)	0.325
Other Service Location ($)	4 (2)	36 (16)	32 (16)	0.051
DME (other) ($)	17 (5)	719 (26)	702 (27)	<0.001
Total Cost less DME other ($)	2,937 (247)	1,883 (299)	-1,054 (388)	0.007

Multivariate linear regression model was used for estimating the cost outcomes. Adjusted estimates controlled for characteristics listed in Table 1. PT/OT: Manual therapy was defined by any medical claim with a CPT code for physical or occupational therapy. DME (other): Durable medical equipment other than the APCD. Changes in outcomes between baseline and the follow-up period were not statistically different in magnitude between the cancer and non-cancer cohorts except for the DME (other).