Journal of Medical Economics Vol. 15, No. 4, 2012, 664–671

1369-6998
doi:10.3111/13696998.2012.670678

Article 0160.R1/670678

Original article

Direct and indirect costs associated with Dupuytren's contracture

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Key words:
Dupuytren's Contracture – Cost – Work loss

Accepted: 24 February 2012; published online: 21 March 2012
Citation: J Med Econ 2012; 15:664–71

Abstract

Objective:
To compare direct (medical and drug) and indirect (work loss) costs between privately insured US employees with Dupuytren's contracture (DC) and demographically matched controls without DC.

Methods:
Employees aged 18–64 with $\geq$1 DC diagnosis (ICD-9-CM: 728.6, 718.44) with service dates 1/1/2000–3/31/2009 were selected from a de-identified, privately insured claims database ($n \sim 3,000,000$). The index date was defined as the most recent DC diagnosis with continuous eligibility for 6 months prior (baseline period) and 1 year after (study period) diagnosis. Employees with DC were matched 1:1 on age, region, gender, and index date to controls without DC, Peyronie's, or Ledderhose disease diagnoses in their claims histories. Descriptive analyses compared demographic characteristics, comorbidities, resource utilization, direct costs, and indirect costs inflated to 2009 dollars.

Results:
DC employees ($n = 1406$, mean age 49 years) with matched controls met the inclusion criteria. DC employees compared with controls had significantly (all $p < 0.05$) higher baseline comorbidities, including hyperlipidemia (21.1% vs 15.6%), hypothyroidism (3.5% vs 2.0%), cancer (3.1% vs 1.5%), and diabetes (8.1% vs 3.6%). During the study period, DC employees had significantly (all $p < 0.01$) higher rates of inpatient stays (7.7% vs 5.3%), emergency department visits (19.8% vs 13.9%), outpatient visits (100.0% vs 78.4%), physical therapy visits (30.2% vs 7.2%), and any prescription use (85.0% vs 69.2%), as well as higher mean work loss days (14.2 vs 7.3). DC employees had on average significantly (all $p < 0.01$) higher annual direct costs (\$5974 vs \$3175), indirect costs (\$2737 vs \$1309), and total costs (\$8712 vs \$4485) compared with controls during the study period.

Limitations:
Findings did not account for lost productivity at work and were based on a privately insured, employed population, which may not be generalizable to all DC patients.

Conclusions:
Employees with DC had substantially higher comorbidity rates, utilization, and direct and indirect costs compared with demographically matched controls.

Introduction

Dupuytren's contracture (DC) is a progressive condition that is characterized by an abnormal thickening of the palmar fascia of the hand, eventually causing the fingers to curl towards the palm. Initial thickening is painless; nodules (bumps) develop in the palm as collagen (tissue) deposits accumulate. Gradually as the disease progresses, the collagen deposits form a cord from the palm of the hand to a joint on the finger that can cause the fingers to bend into the palm, resulting in a contracture[1–3]. This deformity can impair the function of the hand, limiting patient activities of daily living and reducing patient quality-of-life[4].

A recent study conducted in the US using a web-based survey design estimated the prevalence of DC from 1–7.3%, depending on the stringency of the disease definition[5]. The etiology of DC is unknown; however, men are more likely to be affected than women[6], and other risk factors include: advancing age[3], family history[1], diabetes[7], epilepsy[8], smoking[9], alcohol consumption[9], thyroid dysfunction[10], frozen shoulder[11], and hyperlipidemia[12]. DC is also associated with fibromatoses (benign soft tissue tumors) in other areas of the body, such as Garrod's knuckle pads, plantar fibromatosis (Ledderhose disease), and penile fibromatosis (Peyronie's disease)[13].

Many patients with minimal contractures do not need treatment. However, if treatment is required due to persistent or progressive symptoms, effective, non-surgical options are limited. Corticosteroid injections may be administered to relieve pain if present and to potentially prevent the progression of contracture[14]. Surgery to release the band causing the digital contracture is the most widely used treatment if hand function is impeded or deformity is disabling[1]. There are several types of surgery to treat DC categorized by the amount of diseased tissue removed[15], and the timing and type of surgical intervention varies based on disease severity and other patient factors. Surgery may involve fasciotomy (i.e., the cord is divided) or fasciectomy (i.e., the diseased fascia is excised)[1]. Needle aponeurotomy (i.e., percutaneous needle fasciotomy), which involves a fasciotomy and a percutaneous needle technique under local anesthetic to weaken the diseased cords, is also sometimes utilized as a less invasive procedure to treat DC[15]. Recurrence is common with these procedures, and generally the amount of diseased palmar fascia removed is directly related to decreased rates of recurrence and increased rates of complications[15]. Until recently, there were few other effective, non-surgical options[1]. However, collagenase clostridium histolyticum, an injection treatment of the enzyme collagenase that breaks down the collagen in the diseased cord, was recently approved by the FDA[16] and has been shown to improve finger contractures and joint mobility in advanced disease[4,17].

Due to the high recurrence rates with surgery and needle aponeurotomy and the disability that may result from DC, the condition has the potential to impose substantial economic burden both in terms of direct costs (e.g., cost of surgery, medications, physician visits) and indirect costs (e.g., reduced workplace performance). Previously published studies assessed hospital costs associated with DC in France in 2005 using data from the French National Hospital Database[18] and the clinical management and costs of DC in England using data extracted from a National Health Service (NHS) database[19]. However, studies have not assessed the cost of DC in the US or the work loss costs among employees with DC.

To describe the patient characteristics, direct medical resource, work loss, and costs of patients with DC, we conducted a retrospective claims analysis study that compared patients with DC to demographically-matched patients without DC in a US, privately insured, employed population. The research perspective was that of an employer and considered actual third-party payments to providers for medical services and prescription drugs as well as employer payments for time lost for work due to disability and medically related absenteeism.

Patients and methods

Data source

The study sample was selected from a claims database (Ingenix Employer Solutions) covering ~3 million privately insured employees from 27 US-based companies for services provided from 1999 to the first quarter of 2009. The 27 companies had operations nationwide in a broad array of job classifications and industries (e.g., financial services, manufacturing, telecommunications, energy, food and beverage). The database contained de-identified information on patient demographics (e.g., age and gender), monthly enrollment history, medical, pharmacy, and disability claims. Utilization of medical services was recorded in the database with dates of service, associated diagnoses (up to two codes, using the codes for International Statistical Classification of Diseases and Related Health Problems, ICD-9), performed procedures (Current Procedural Terminology, CPT), and actual payment amounts made to providers. The database also included pharmacy claims with prescribed medications identified by National Drug Code (NDC), date of prescription fill, days of supply, quantity, and actual payment amounts. Short- and long-term disability claims reported dates of work loss and actual employer payments to employees.

Sample selection

Employees with DC

The DC employee sample was drawn from employees aged 18–64 years in companies providing short- and long-term disability data who had at least one DC diagnosis (ICD-CM: 728.6 or 718.44) on or after 1/1/2000. Employees were also required to have at least 6 months of continuous eligibility prior to DC diagnosis (baseline period) and 12 months of continuous eligibility after a DC diagnosis (study period). Employees were required to have active employee status for the duration of the study period to ensure that they were eligible for disability benefits

Table 1. Sample selection process.

Step	Description	*n*
0	All employees in companies providing disability data, 1/1/2000–3/31/2009	2,894,706
1	Employees with at least 1 DC diagnosis (ICD-9-CM: 728.6 or 718.44), 1/1/2000–3/31/2009	8776
2	Continuous eligibility at least 6 months before ('baseline period') and 1 year after the index date ('study period')	5409
3	Aged 18–64 during the baseline and study periods	2590
4	Actively employed during the baseline and study periods	1406
5	Matched on age, region, gender, and index date to controls	1406

during the study period. Thus, employees who retired during the study period were excluded from the study. The index date for employees with DC was defined as the day of the most recent DC diagnosis meeting the continuous eligibility requirements described above. Table 1 shows the selection identification process and sample flow by inclusion/exclusion criteria.

Employee controls without DC

Potential controls were identified among employees aged 18–64 in companies with short- and long-term disability data who had no DC, Peyronie's disease (ICD-9-CM: 607.85), or Ledderhose disease (ICD-9-CM: 728.71) diagnoses in their claims histories between 1999 and 2009. To create a matched control sample that was most comparable to the sample of employees with DC, one employee control with the same age, gender, region, and employee status (i.e., salaried, non-salaried, or unknown) was randomly matched without replacement to each corresponding employee with DC so that every DC employee had his or her own unique control. Controls were also required to have continuous eligibility for at least 6 months before and 1 year after a randomly assigned index date matching the distribution of index dates among employees with DC.

Patient characteristics

Patient characteristics compared between the study and control groups included variables on which the study and control groups were matched (i.e., age, gender, index year, region, employee status), baseline comorbidities, and severity indicators assessed using claims over the 6-month baseline period.

Baseline comorbidities included hyperlipidemia (ICD-9-CM codes: 272.0, 272.1, 272.2, 272.3, 272.4); chronic obstructive pulmonary disease (ICD-9-CM codes: 491, 492, 493.2, 496); Peyronie's disease (ICD-9-CM code: 607.85); Ledderhose disease (ICD-9-CM code: 728.71); frozen shoulder (ICD-9-CM code: 726.0); epilepsy (ICD-9-CM code: 345); alcohol abuse (ICD-9-CM codes: 291.0–291.3, 291.5, 291.8, 291.81, 291.82, 291.89, 291.9, 303, 305.00–305.03); Garrod's knuckle pads (ICD-9-CM code: 728.79); and hypothyroidism (ICD-9-CM codes: 243, 244.8, 244.9). Baseline severity indicators included Charlson Comorbidity Index (including 17 physical conditions predictive of 1-year mortality and individual physical comorbidities included in the index)[20,21].

Direct and indirect resource use

Direct resource use was categorized by place or type of service. Inpatient visits were identified by claims with a place of service specified as hospital inpatient, rehabilitation center, residential treatment center, or psychiatric facility. Emergency department (ED) visits were identified by claims with a place of service specified as emergency treatment center or hospital emergency room or type of service specified as emergency first aid or emergency room, or emergency room-related procedure codes (CPT codes: 99058, 99281, 99282, 99283, 99284, 99285). All other visits were categorized as outpatient/other visits. Resource use was also reported for prescription drug use and a selected subset of outpatient/other visits such as physical therapy (PT) and occupational therapy (OT) visits.

Indirect resource use included work loss due to disability and medically related absenteeism. Days of disability were computed by identifying the total time covered by short- or long-term disability claims. The distinction between short- and long-term disability in the data was not analytically meaningful as both represent the actual employer payments to employees.

Medically related absenteeism days were estimated using medical claims occurring during days of work (e.g., such as an office visit or a hospital inpatient visit). In particular, outpatient/other visits were counted as a half-day of absenteeism while each hospitalization day and emergency department visit was counted as a full day of work loss. Medically related absenteeism days did not include days with medical services occurring during a period of disability but did include the qualifying days missed from work preceding the start of the disability period, excluding any overlap (e.g., if an employee had a short-term disability claim and the employer plan specified that short-term disability begins after 5 work days of illness, then 5 days were added to estimate the medically related absenteeism days excluding any days with medical services already included in the calculation of medically related absenteeism).

Direct and indirect cost calculation

Direct healthcare costs including medical and prescription drug costs were calculated during the 12-month follow-up period. Cost analyses were conducted from the third-party payer's perspective (i.e., costs were defined as payments to providers by third-party payers). Copayments were not included in the estimation of direct costs. Medical costs were calculated for inpatient, ED, and outpatient/other medical services (e.g., outpatient surgery, physician services, laboratory, and other ancillary services, etc.).

Indirect costs during the 12-month study period included actual employer payments for disability days plus imputed costs for medically related absenteeism. Disability costs included payments for short- or long-term disability. Medically related absenteeism costs were calculated by multiplying medically related absenteeism days by the employee's daily wage contained in the eligibility file. Indirect costs did not include costs associated with productivity loss or early retirement.

All costs were indexed to 2009 US dollars, the most recent year of available medical and pharmacy claims, using the Consumer Price Index for Medical Care.

Statistical analyses

Patient characteristics of study group employees with DC were compared to those of matched employees without DC. Categorical variables were compared using McNemar tests. Continuous variables, such as the Charlson Comorbidity Index (used to control for severity), the distributions of resource use counts (e.g., calendar days of therapy, work loss days), and costs that likely had skewed distributions, were compared using nonparametric Wilcoxon signed-rank tests.

As a sensitivity analysis to compare direct and indirect costs controlling for demographic characteristics (i.e., age, gender, index year, region, and employment status), and baseline characteristics (i.e., selected comorbidities and the Charlson Comorbidity Index), multivariate generalized linear models with gamma distribution of the error term and log link function were calculated. The parameter estimates from the models were used to calculate risk-adjusted costs among patients under two hypothetical scenarios: one assuming that all patients had DC and another assuming that none of the patients had DC.

All analyses were conducted using SAS version 9.2 (SAS Institute Inc., Cary, NC). *p*-values less than or equal to 0.05 were considered to indicate statistically significant differences.

Results

Baseline characteristics and comorbidities

The study sample included 1406 employees with DC and 1406 controls matched on age, gender, region, and employee status (Table 1). Employees were on average 49 years old and were mostly men. Compared with employee controls, employees with DC had significantly higher baseline rates of Ledderhose disease, hyperlipidemia, hypothyroidism, cancer, and diabetes, as well as higher baseline severity measured by the Charlson Comorbidity Index ($p < 0.0001$) (Table 2).

Study period direct resource use

Compared with employee controls, employees with DC were significantly more likely to have inpatient stays (7.7% vs 5.3%; $p = 0.0076$), ED visits (19.8% vs 13.9%; $p < 0.0001$), and outpatient/other visits (100% vs 78.4%; $p < 0.0001$). Approximately 30.2% of employees with DC received physical or occupational therapy compared to 7.2% of employee controls. Compared with employee controls, employees with DC also had significantly higher rates of prescription drug use, notably higher rates of anti-hyperlipidemics (23.6% vs 18.2%; $p = 0.0004$), medication related to diabetes (8.3% vs 4.6%; $p < 0.0001$), anti-convulsants (5.6% vs 2.3%; $p < 0.0001$), analgesics (45.6% vs 23.4%; $p < 0.0001$), and anti-depressants (16.4% vs 10.3%; $p < 0.0001$). Approximately 6.1% of employees with DC had at least one fasciectomy (CPT codes: 26121, 26123, or 26125) during the study period.

Overall, these higher resource use rates were associated with more calendar days with medical encounters (which led to more work loss days for estimated medically related absenteeism). On average employees with DC had more than twice the hospital days ($p = 0.0102$) and substantially more outpatient/other visits and ED visits compared with employee controls without DC ($p = 0.0006$) (Table 3).

Study period disability and medically related absenteeism

Employees with DC were significantly more likely to have disability days compared with employee controls (8.2% vs 3.4%; $p < 0.0001$), resulting in a higher mean number of disability days per year (6.68 (SD = 35.89) vs 3.55 (SD = 26.35) days; $p = 0.0002$). Based on their greater utilization rates, employees with DC also had a significantly higher rate of medically related absenteeism and associated absenteeism days compared with employee controls. Overall, DC employees had twice the number of estimated work loss days compared to their controls (14.24 (SD = 36.20) vs 7.31 (SD = 26.82) days; $p < 0.0001$) (Table 4).

Table 2. Baseline characteristics and comorbidities.

Characteristics and comorbidities	Employees with DC ($n = 1406$)	Employee controls ($n = 1406$)	p-value[a]
Demographic characteristics			
Age, years, Mean (SD)	49 (8.6)	49 (8.6)	–
Age distribution, N (%)			
18–30 years	47 (3.3%)	47 (3.3%)	
31–44 years	341 (24.3%)	341 (24.3%)	
45–54 years	584 (41.5%)	584 (41.5%)	
55–64 years	434 (30.9%)	434 (30.9%)	
Male, N (%)	1025 (72.9%)	1025 (72.9%)	–
Employee status, N (%)			
Salaried	506 (36.0%)	506 (36.0%)	
Non-salaried	403 (28.7%)	403 (28.7%)	
Unknown	497 (35.3%)	497 (35.3%)	
Select comorbidities, N (%)[b]			
Hyperlipidemia	297 (21.1%)	220 (15.6%)	0.0002
Chronic obstructive pulmonary disease	10 (0.7%)	12 (0.9%)	0.6698
Peyronie's disease	2 (0.1%)	0 (0.0%)	0.5000
Ledderhose disease	29 (2.1%)	0 (0.0%)	<0.0001
Garrod's nodules	3 (0.2%)	0 (0.0%)	0.2500
Hypothyroidism	49 (3.5%)	28 (2.0%)	0.0167
Charlson Comorbidity Index (CCI), Mean (SD)[c]	0.319 (0.904)	0.165 (0.686)	<0.0001
Select comorbidities included in the CCI, N (%)[c]			
Chronic pulmonary disease	43 (3.1%)	27 (1.9%)	0.0523
Diabetes mellitus	114 (8.1%)	51 (3.6%)	<0.0001
Any malignancy including leukemia and lymphoma	43 (3.1%)	21 (1.5%)	0.0045

[a]McNemar tests were used for comparisons of categorical variables. Wilcoxon signed-rank tests were used for comparisons of continuous variables.
[b]Select comorbidities were defined using ICD-9-CM codes during the baseline period.
[c]The 17 conditions included in the CCI were identified using ICD-9 diagnosis codes reported by Romano *et al.*[21].

Costs

Employees with DC had on average significantly higher direct costs (\$5974 (median = \$3118; SD = \$10,571)) compared to employee controls (\$3175 (median = \$1006; SD = \$7688)), cost difference of \$2799 ($p < 0.0001$). Additionally, total annual indirect costs were on average ~2-times higher for employees with DC (\$2737 (median = \$1241; SD = \$5900)) compared with employee controls (\$1309 (median = \$482; SD = \$3576)), cost difference of \$1428 ($p < 0.0001$) (Table 5).

Multivariate analysis provided similar results to the descriptive comparisons of direct and indirect costs. Employees with DC had on average significantly higher risk-adjusted direct costs (\$6174 (median = \$5223; SD = \$5687)) compared to employee controls (\$3231 (median = \$2733; SD = \$2976)), cost difference of \$2943 ($p < 0.0001$). Risk-adjusted indirect costs for employees with DC were \$2811 (median = \$2320; SD = \$3213) and for controls were \$1370 (median = \$1131; SD = \$1566), cost difference of \$1441 ($p < 0.0001$) (Table 6).

Discussion

The results demonstrate the large financial burden of DC from the employer's perspective. This study drew from a geographically diverse claims database of many large employers to capture actual, recent real-world practice. Employees with DC had on average \$4227 higher total annual costs (i.e., direct (\$2799) and indirect (\$1428)) than employees without DC. Similarly, after adjusting for baseline characteristics, employees with DC had on average \$4415 higher risk-adjusted total annual costs. Considerable resource utilization by patients with DC occurs; utilization of inpatient, outpatient, and ED services is substantially higher among DC employees compared with non-DC employees. Consequently, DC employees had significantly higher direct costs than employees without DC, with approximately twice the mean annual costs of non-DC employees. Indirect costs, resulting from high rates of disability and absenteeism associated with this illness, accounted for a third of the difference in total costs.

Limitations

While based on privately insured employees in the US, the study results, however, may not be generalizable to the national population of patients with DC. The study included only privately insured employees, aged 18–64, that were employed for the duration of the study period. This may lead to a conservative estimate of costs since patients who went on a leave of absence or on early retirement, in addition to those permanently disabled and

Table 3. Direct resource use during the study period.

12-month resource utilization[a]	Employees with DC ($n = 1406$)	Employee controls ($n = 1406$)	*p*-value[b]
Direct resource utilization			
Number (%) of patients with at least one:			
All-cause resource use			
Inpatient stay	108 (7.7%)	74 (5.3%)	0.0076
Emergency Department (ED) visit	279 (19.8%)	196 (13.9%)	<0.0001
Outpatient/other visit	1406 (100.0%)	1102 (78.4%)	<0.0001
PT/OT visits	424 (30.2%)	101 (7.2%)	<0.0001
Hand splinting	117 (8.3%)	14 (1.0%)	<0.0001
Any prescription drug use	1195 (85.0%)	973 (69.2%)	<0.0001
Select prescription drug classes use			
Anti-hyperlipidemics	332 (23.6%)	256 (18.2%)	0.0004
Medication related to diabetes (e.g., insulin, anti-hyperglycemics, etc.)	116 (8.3%)	65 (4.6%)	<0.0001
Anti-convulsants	79 (5.6%)	33 (2.3%)	<0.0001
Thyroid medications	81 (5.8%)	58 (4.1%)	0.0511
Analgesics	641 (45.6%)	329 (23.4%)	<0.0001
Narcotic opioids	501 (35.6%)	206 (14.7%)	<0.0001
Other analgesics	319 (22.7%)	215 (15.3%)	<0.0001
Anti-depressants	231 (16.4%)	145 (10.3%)	<0.0001
Corticosteroid injections (i.e., triamcinolone)	68 (4.8%)	27 (1.9%)	<0.0001
Mean [Median] (SD) number of:			
All-cause resource use			
Inpatient stays	0.11 [0.00] (0.52)	0.06 [0.00] (0.30)	0.0094
Inpatient days	0.47 [0.00] (3.26)	0.21 [0.00] (1.25)	0.0102
ED visits	0.32 [0.00] (1.11)	0.21 [0.00] (0.84)	0.0006
Outpatient/other visits	13.71 [9.00] (14.34)	7.25 [4.00] (10.02)	<0.0001
PT/OT visits	2.48 [0.00] (7.41)	0.73 [0.00] (3.65)	<0.0001
Prescription drugs used (9-digit NDC)	6.49 [5.00] (6.73)	4.13 [3.00] (4.83)	<0.0001
DC surgery resource use			
Number (%) with one fasciectomy	85 (6.0%)		
Number (%) with two or more fasciectomies	1 (0.1%)		
Number (%) with at least one fasciotomy	25 (1.8%)		

[a]Resource utilization was measured during the 12-month post-index study period.
[b]McNemar tests were used for comparisons of categorical variables. Wilcoxon signed-rank tests were used for comparisons of continuous variables.

Table 4. Indirect resource use during the study period.

12-month resource utilization[a]	Employees with DC ($n = 1406$)	Employee controls ($n = 1406$)	*p*-value[b]
Indirect resource utilization			
Number (%) of patients with at least one:			
Disability day	115 (8.2%)	48 (3.4%)	<0.0001
Medically related absenteeism day	1377 (97.9%)	1090 (77.5%)	<0.0001
Work loss day	1405 (99.9%)	1103 (78.4%)	<0.0001
Mean [Median] (SD) number of:			
Disability days	6.68 [0.00] (35.89)	3.55 [0.00] (26.35)	0.0002
Medically related absenteeism days	7.55 [4.50] (9.51)	3.75 [2.00] (6.04)	<0.0001
Work loss days	14.24 [5.00] (36.20)	7.31 [2.00] (26.82)	<0.0001

[a]Resource utilization was measured during the 12-month post-index study period.
[b]McNemar tests were used for comparisons of categorical variables. Wilcoxon signed-rank tests were used for comparisons of continuous variables.

supported by government programs (e.g., Medicare, Medicaid), were not included in this analysis, thus excluding a high cost population. Additionally, excluding patients that were 65 years of age or older removes a population of patients with an increased risk for this disease[3]. Because this study used claims data, the findings are also subject to the usual limitations of administrative datasets, such as inaccurate or incomplete reporting or diagnoses or incomplete assembly of claims.

While the results from this study demonstrate the substantial economic burden of DC, the estimated costs of DC presented are likely an underestimate of the true burden of

Table 5. Direct and indirect costs during the study period ($2009).

12-month costs[a]	Employees with DC ($n = 1406$)	Employee controls ($n = 1406$)	p-value[b]
Total direct costs, Mean [Median] (SD)	$5974 [$3118] ($10,571)	$3175 [$1006] ($7688)	< 0.0001
Medical costs	$4733 [$1928] ($9691)	$2321 [$424] ($7041)	<0.0001
Hospital inpatient costs	$969 [$0] ($6509)	$543 [$0] ($4431)	0.0186
ED costs	$118 [$0] ($507)	$81 [$0] ($404)	0.0003
Outpatient/other costs	$3646 [$1,799] ($5418)	$1697 [$398] ($4615)	<0.0001
PT/OT costs	$154 [$0] ($545)	$48 [$0] ($484)	<0.0001
Hand splinting costs	$9 [$0] ($51)	$1 [$0] ($7)	<0.0001
Prescription drug costs	$1241 [$450] ($2332)	$855 [$127] ($2350)	<0.0001
Total DC-related direct costs	$501 [$92] ($1337)		
Total indirect costs, Mean [Median] (SD)	$2737 [$1241] ($5900)	$1309 [$482] ($3576)	<0.0001
Disability costs	$732 [$0] ($5323)	$308 [$0] ($3078)	<0.0001
Medically related absenteeism costs	$2006 [$1088] ($2913)	$1001 [$455] ($1873)	<0.0001
Total costs, Mean [Median] (SD)	$8712 [$4754] ($13,490)	$4485 [$1660] ($9529)	<0.0001

[a]Costs were measured during the 12-month post-index study period. All costs were inflated to 2009 US$. Direct costs were inflated using the CPI for Medical Care. Indirect costs were inflated using average hourly compensation data from the Bureau of Labor Statistics.
[b]Wilcoxon signed-rank tests were used for comparisons of continuous variables.

Table 6. Risk-adjusted direct and indirect costs during the study period ($2009)*.

Risk-adjusted 12-month costs*	Employees with DC ($n = 1406$)	Employee controls ($n = 1406$)	p-value[a]
Total direct costs, Mean [Median] (SD)	$6174 [$5223] ($5687)	$3231 [$2733] ($2976)	<0.0001
Total indirect costs, Mean [Median] (SD)	$2811 [$2320] ($3213)	$1370 [$1131] ($1566)	<0.0001
Total costs, Mean [Median] (SD)	$9005 [$7622] ($8641)	$4590 [$3885] ($4404)	<0.0001

*Generalized linear models with gamma distribution and log link were used to calculate and compare risk-adjusted key cost outcomes between DC employees and controls, adjusting for baseline characteristics such as age and comorbidities. Only comorbidities with at least 5% and less than 95% prevalence in the DC or control group were included in the model. Potential confounders included age, gender, index year, region, employee status (i.e., salaried, non-salaried, unknown), the Charlson Comorbidity Index (CCI), and hyperlipidemia.
[a]p-values were calculated for the variable in the models that controlled for whether an employee had DC.

DC on the employer for a variety of reasons. Sick time at home was not fully measured; we captured only work time lost that was associated with illness or medical treatment. We do not account for the opportunity cost for work force disruptions due to disability, which may include reduced on-the-job productivity (i.e., presenteeism), administrative and training expenses for replacement workers, and days missing for sick time. Direct medical services costs are also lower bound estimates since they do not include out-of-pocket costs that are borne by the employee (e.g., copayments, coinsurance, and deductibles). Since this is the first economic exploration of DC on employers in the US, certain topics warrant further investigation to complete the cost picture of this condition, including the costs associated with surgery (e.g., fasciectomy) as treatment for this condition.

Conclusion

This is the first study to estimate the direct and indirect costs associated with DC in the US. The study findings show that DC poses a substantial employer burden in terms of healthcare costs, medically related absenteeism, and disability costs. Compared to non-DC employees, DC employees had higher comorbidity rates, utilization, and direct and indirect costs.

Transparency

Declaration of funding
This study was funded by Auxilium Pharmaceuticals, Inc., Malvern, PA.

Declaration of financial/other interests
D.M., J.I., H.B., and R.S. have disclosed that they are employees of Analysis Group, Inc., a company that received funding from Auxilium Pharmaceuticals, Inc. to conduct this study. P.S. has disclosed that he is an employee of Auxilium Pharmaceuticals, Inc.

Acknowledgments
This study was presented at the ISPOR 16th Annual International Meeting in Baltimore, Maryland, May 21-25, 2011.

CMRO peer reviewers may have received honoraria for their review work. The peer reviewers on this manuscript have disclosed any relevant financial relationships.

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