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Trajectories of health care service utilization and differences in patient characteristics among adults with specific chronic pain: analysis of health plan member claims

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Introduction: The lack of consistency surrounding the diagnosis of chronic non-cancer pain, treatment approaches, and patient management suggests the need for further research to better characterize the chronic non-cancer pain population.

Objective: The purpose of this study was to identify distinct trajectories of health care service utilization of chronic non-cancer pain patients and describe the characteristic differences between trajectory groups.

Patients and methods: This study utilized the MarketScan claims databases. A total of 71,392 patients diagnosed with either low back pain or osteoarthritis between 2006 and 2009 served as the study sample. Each subject's claims data were divided into three time periods around an initial diagnosis date: pre-period, post-Year 1, and post-Year 2. Subjects were categorized as either high (H) or low (L) cost at each post period, resulting in the creation of four trajectory groups based on the post-Year 1 and 2 cost pattern: H-H, H-L, L-H, and L-L. Multivariate statistical tests were used to predict and discriminate between trajectory group memberships.

Results: The H-H, L-H, and H-L groups each utilized significantly greater pre-period high-cost venue services, post-Year 1 outpatient services, and post-Year 1 opioids compared to the L-L group ($P < 0.001$). Additionally, the H-H and L-H groups displayed elevated Charlson comorbidity index scores compared with the L-L group ($P < 0.001$), with each showing increased odds of having both opioid dependence and cardiovascular disease diagnoses ($P < 0.01$).

Conclusion: This study identified patient characteristics among chronic pain patients that discriminated between different levels of post-index high-cost venue service utilization and trajectories of change in the same. With implications for managed care program implementation and resource management, this study highlights results from a developed algorithm that employed a variety of accessible data elements to effectively discriminate between patients based on their pattern of high-cost venue service utilization over time.

Keywords: opioids, pharmacoeconomics, addiction, health care, claims analysis

Introduction

"Chronic pain," defined by the International Association for the Study of Pain, is any pain that persists beyond the expected healing phase following an injury, is any pain that persists beyond the expected healing phase or longer than three months.[1] However, alternative definitions have been used when pain persists for more than 6 months.[2] The lack of consistency surrounding the diagnosis of chronic non-cancer pain (CNCP), treatment

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approaches, and patient management suggests the need for further research on better characterizing the CNCP population.

CNCP is often associated with primary diagnoses such as low back pain (LBP), osteoarthritis (OA), fibromyalgia, and diabetic neuropathy.[3–5] CNCP patients have numerous non-pharmacologic treatment options available to them, including exercise, psychological and behavioral interventions, and a variety of non-traditional treatment approaches including acupuncture, vitamins and herbal preparations.[6] However, the most common form of treatment for CNCP is opioid analgesic medication. These medications, while highly effective at relieving pain, are associated with elevated risk for addiction, opioid-induced adverse events, decrement in level of functioning, and increased use of high-cost venue health care services.[5,7,8] On average, for those diagnosed with CNCP, pain tends to persist for a median of 10 years (range 3–50 years), and while pain persists, so does opioid therapy, facilitating the emergence of secondary disorders. Furthermore, in opposition to the World Health Organization's analgesic ladder,[9] the most commonly prescribed opioid analgesic is oxycodone, indicated for moderate to severe pain (representing 53% of all opioid use).[4,10]

Compared with their non-pain counterparts, patients experiencing CNCP also tend to use more health care services, resulting in an increase in health care spending.[11,12] With estimates of up to 26% of the population reporting persistent pain during the prior 6 months,[13] research on drivers, service utilization, provider practice patterns, and treatment outcomes are of increasing importance to payers. Previous research has focused on the sequelae of LBP in relation to patient recovery or symptomatology at various time points (3, 6, or 12 months) but studies of longer duration are less common within the literature and may be of value to payers.[13]

Payers are becoming more aware of the costs associated with opioid analgesia overuse and the emergence of addiction[15] as well as the potential benefit of effective interventions to patients as well as their employer clients. To address the increased health care service utilization and associated costs as well as the personal suffering associated with CNCP, many health plans and other payers have made management of these patients a priority.[16] Given the high prevalence of pain-related conditions, the efficient and effective delivery of these programs requires tools to identify pain patients at greatest risk for utilizing high-cost venue services, based on pre-morbid predictors and other process variables. Therefore, the aim of the present study was to identify and describe patient groups by their changes in or stability of health care expenditure as a proxy of their pain intensity. Specifically, the two main study objectives were: (1) to develop a method of defining distinct patient groups based on health care expenditure patterns and (2) to determine the characteristics associated with membership in these groups.

Methods

Sample selection

A random sample (25%) of patients with a diagnosis of LBP or OA was extracted from the MarketScan database (N = 4.4 M) of aggregated redacted commercial claims during calendar years 2006 through 2009. The following inclusion and exclusion criteria were imposed on all subjects:

- at minimum, three *International Classification of Diseases, Ninth Revision, Clinical Modification* diagnoses of either LBP or OA spanning ≥ 180 days during the 18-month case-finding window (subjects evidencing both diagnoses were excluded)
- continuous eligibility for the 30-month measurement period
- six-month pre-event pain-naive period
- at least 18 years of age
- absence of cancer, schizophrenia, traumatic brain injury, and mental retardation diagnoses during the study period.

For all subjects, three study-period windows were created:

1. pre-period: the six-month pre-pain diagnosis period
2. post-Year 1: the first 12-month post-pain diagnosis follow-up period
3. post-Year 2: the second 12-month post-pain diagnosis follow-up period.

Statistical analyses

The statistical analysis involved four steps.

Demographic, service utilization and costs by diagnosis group

Demographic information, including baseline comorbidities, was calculated for each diagnosis group. Additionally, during each of the three primary study periods, service utilization and cost estimates were calculated for each group. Claims reversals were removed before any cost estimates were made.

Development of health care utilization and costs latent factors

Second, latent variables that represented service utilization and health care expenditure were used to model patient health-related behavior during the pre- and each of the two post-periods. The goal was to produce a simple dimensional scale that represented service and pharmacy utilization and cost of care based on summarized administrative claims for service and pharmacy. The manifest variables were inpatient admissions, emergency room (ER) visits, the summed total of inpatient and ER costs, physician/clinic visits, laboratory days, prescription fills, and total outpatient costs. A two-factor solution adequately represented the data based on eigenvalues > 1.0 and scree plot analysis. The two factors showed consistency across measurement periods, with the manifest indicators loading in the same order providing for adequate metric invariance.[17] The pattern of manifest indicator loadings into the two factors may be summarized as:

- Factor 1: high-cost venue service use intensity (HCVSUI)
- Factor 2: outpatient service use intensity (OPSUI)

Factor scores for both HCVSUI and OPSUI for the pre-period as well as for both post-index periods were stored for each case, as these values were used in the clustering and final model.

Clustering cases on latent factor scores and creation of trajectory groups

K-means clustering of case-level HCVSUI factor scores at post-Year 1 and post-Year 2 separated cases into high and low HCVSUI factor scores at both periods. Trajectory groups were then based on change in group membership from post-Year 1 to 2. Finally, once cases were separated into trajectory groups, group membership was predicted using multivariate analyses. Descriptive statistics included group comparisons on demographic and comorbidity profiles, in addition to service utilization and cost estimates during the follow-up periods.

Predicting trajectory groups

Identifying predictors of trajectory group membership was the final step of these analyses. Therefore, given that trajectory group was a polytomous categorical variable, a multinomial regression model was used. Multinomial regression analysis predicted group trajectory membership using pre-period service utilization, comorbid diagnoses, pharmacy utilization, and post-Year 1 OPSUI scores. Demographic information (eg, age, sex, employment status), primary diagnosis (eg, diabetes, specific back injury), comorbid diagnoses (ie, individual diagnoses as well as the Charlson comorbidity index), and service utilization during the pre- and post-periods (ie, the 6 months prior to and 2 years subsequent to the appearance of a pain diagnosis) were regressed onto trajectory groups.

Results

Analyses by diagnosis group

The final study sample, after applying inclusion and exclusion criteria, included 71,392 patients with LBP (N = 37,991) or OA (N = 33,401). Table 1 highlights descriptive demographic statistics for the sample. Overall, the sample was predominantly female (59.1%), aged 47.7 ± 9.27 years old, and residing in the southern (49.6%) and north central (29.3%) regions of the USA. The mean Charlson comorbidity index (a measure of overall illness) of the sample was 0.22 ± 0.55, with nearly a quarter of the sample having a history of both cardiovascular disease (22.4%) and psychotropic prescription fills (22.3%). Table 2 presents estimates of service utilization and cost measures annualized across the 2-year follow-up measurement period. An average of 0.15 per person per year inpatient hospital admissions, totaling US$2728 annually, was incurred by this sample. Similarly, the sample used an average of 0.41 ER visits totaling US$229 each. The sample used an average of 7.72 visits to physician offices at an annual cost of US$590, and filled 19 prescriptions (for any prescription medication) at an annual cost of US$1534. The average annual per patient health care cost incurred by this sample during the two-year post-period was US$10,412.

Latent factor analysis

Principal component factor analyses of service utilization and cost manifest indicators at pre-period, post-Year 1 and post-Year 2 returned a two-principal component solution (calculated separately for each year) based on eigenvalue > 1.00 and scree plot. Loadings ≥ 0.40 were considered significant. Upon rotation, the two factors were (1) HCVSUI, representing the manifest variables of inpatient admissions, ER visits, and the summed total of inpatient and ER costs; and (2) OPSUI, representing the manifest variables of physician/clinic visits, laboratory days, prescription fills, and total outpatient costs. Figures 1 and 2 show the final factor diagrams with standardized estimates.

Clustering analysis

The K-mean cluster procedure was chosen to assign cases to service utilization intensity groups because it is the most robust for working with large samples. For the HCVSUI factors, both two and three cluster solutions adequately represented the data, but for parsimony and ease of interpretation, the two-cluster solution was adopted. At each time period

Table 1 Study sample descriptive statistics by pain group

Variable	LBP group (N = 37,991)		OA group (N = 33,401)		Total (N = 71,392)	
	Mean/f	(SD)/%	Mean/f	(SD)/%	Mean/f	(SD)/%
Male	16,109	42.4%	12,500	37.4%	28,609	40.1%
Age	46.00	9.73	49.57	8.32	47.67	9.27
Northeast region	2525	6.6%	2296	6.9%	4821	6.8%
North central region	11,533	30.4%	9357	28.0%	20,890	29.3%
South region	18,342	48.3%	17,091	51.2%	35,433	49.6%
West region	5454	14.4%	4518	13.5%	9972	14.0%
Unknown region	137	0.4%	139	0.4%	276	0.4%
Charlson comorbidity index	0.19	0.52	0.24	0.58	0.22	0.55
Related comorbidities						
Depression	1105	2.9%	1010	3.0%	2115	3.0%
Anxiety	1179	3.1%	793	2.4%	1972	2.8%
Opioid dependence	486	1.3%	283	0.8%	769	1.1%
Bipolar disorder	219	0.6%	154	0.5%	373	0.5%
Sleep disturbance/insomnia	1782	4.7%	1647	4.9%	3429	4.8%
Sickle cell disease	6	0.0%	8	0.0%	14	0.0%
Fibromyalgia	1351	3.6%	999	3.0%	2350	3.3%
Cardiovascular disease	7398	19.5%	8610	25.8%	16,008	22.4%
Migraine/chronic headache	1098	2.9%	734	2.2%	1832	2.6%
Post-traumatic stress disorder	94	0.2%	69	0.2%	163	0.2%
Related covariates						
Mental health visits (N)	2664	7.0%	2240	6.7%	4904	6.9%
Psychotropic Rx fills (N)	8519	22.4%	7431	22.2%	15,950	22.3%

Note: Data are derived from the pre-period.
Abbreviations: LBP, low back pain; OA, osteoarthritis; Rx, prescription; SD, standard deviation.

(pre, post-Year 1 and 2), cases were clustered into two groups that mapped onto "high" and "low" levels of HCVSUI factor scores.

Trajectory groups analyses

Once clustered, patients were further grouped based on change in group status from post-Year 1 to post-Year 2. Change in cluster membership over time was calculated to designate valence of HCVSUI trajectory and four specific trajectory groups were identified:

1. High to High: post-Year 1 high HCVSUI to post-Year 2 high HCVSUI
2. Low to High: post-Year 1 low HCVSUI to post-Year 2 high HCVSUI
3. High to Low: post-Year 1 high HCVSUI to post-Year 2 low HCVSUI
4. Low to Low: post-Year 1 low HCVSUI to post-Year 2 low HCVSUI.

Tables 3–5 present the univariate statistics for patient characteristics, service utilization, and costs by HCVSUI trajectory group. Patients who remained in the high HCVSUI category through both post-periods comprised the smallest group (N = 469; 0.66%) but also accounted for the highest overall per member per year (PMPY) health care spend at US$69,032 and US$80,148 for post-Year 1 and 2, respectively ($P < 0.001$). Further, the High to High group had the highest prevalence of all measured baseline comorbid conditions. The group that changed from Low to High was the next smallest (N = 1612; 2.26%), with their PMPY total health care costs more than quadrupling from US$15,366 in post-Year 1 to US$68,787 in post-Year 2. Conversely, the High to Low group (N = 2553; 3.58%) reduced their total PMPY health care spend substantially from US$61,664 in post-Year 1 to US$13,891 in post-Year 2. Finally, the Low to Low group comprised the majority of the sample (N = 66,758; 93.51%) and spent the least overall PMPY, US$8,579 and US$7,503, during post-Year 1 and 2, respectively. Figures 3 and 4 show graphical representations of select cost data.

Table 6 presents the final trimmed multinomial model. Based on the full set of a priori predictors and covariates, neither the goodness-of-fit statistic ($P < 0.01$), nor the omnibus test (pseudo $R^2 = 0.028$) was acceptable. The model was trimmed of specific predictors and covariates based on two criteria: (1) those that did not adequately predict the criterion variable and (2) those that were not imperative to the theoretical model. A second model, based on a subset of the predictors and covariates used in the original model resolved and reached acceptable levels of both goodness of fit ($P = 1.0$) and the omnibus test (pseudo $R^2 = 0.169$).

Table 2 Post-index service utilization and cost* of care by pain group

Variable	LBP group (N = 37,991)		OA group (N = 33,401)		Total (N = 71,392)	
	Mean/f	**(SD)/%**	**Mean/f**	**(SD)/%**	**Mean/f**	**(SD)/%**
High-cost venue manifest variables						
Number of inpatient hospital admissions	0.13	0.38	0.17	0.4	0.15	0.39
Number of people with ≥1 hospital admission	7125	18.75%	7588	22.72%	14,713	20.61%
Number of inpatient hospital days	0.48	2.3	0.63	2.42	0.55	2.36
Total inpatient hospital costs	$2471.28	$9972.41	$3019.45	$9658.93	$2727.74	$9830.73
Number of emergency room visits	0.41	1.18	0.4	1.12	0.41	1.15
Number of people with ≥1 emergency room visits	13,901	36.59%	12,278	36.76%	26,179	36.67%
Range of emergency room visits	0–81.5		0–64.5		0–81.5	
Total emergency room costs	$236.97	$1,022.58	$220.17	$730.48	$229.11	$897.86
Outpatient health service manifest variables						
Number of physician and clinic visits	7.37	5.67	8.12	5.13	7.72	5.43
Total physician and clinic costs	$565.30	$480.27	$617.44	$503.43	$589.69	$491.92
Total outpatient costs	$5789.19	$8104.21	$6562.13	$8824.32	$6150.81	$8457.49
Number of Rx fills	18.50	24.95	19.43	24.44	18.93	24.72
Total Rx costs	$1509.53	$3399.83	$1562.26	$3377.07	$1534.20	$3389.28
Total cost variables						
High-cost venue services (IP + ER)	$2708.25	$10,189.15	$3239.61	$9839.08	$2956.85	$10,030.33
Total medical costs (IP + OP)	$8260.46	$14,230.66	$9581.57	$14,823.00	$8878.55	$14,525.66
Total health care costs (IP + OP + Rx)	$9,770.00	$15,242.80	$11,143.84	$15,697.22	$10,412.75	$15,482.15

Notes: *All monetary values shown are in US dollars. Data presented are annualized estimates over the entire measurement period.
Abbreviations: ER, emergency room; IP, inpatient; LBP, low back pain; OA, osteoarthritis; OP, outpatient; Rx, prescription; SD, standard deviation.

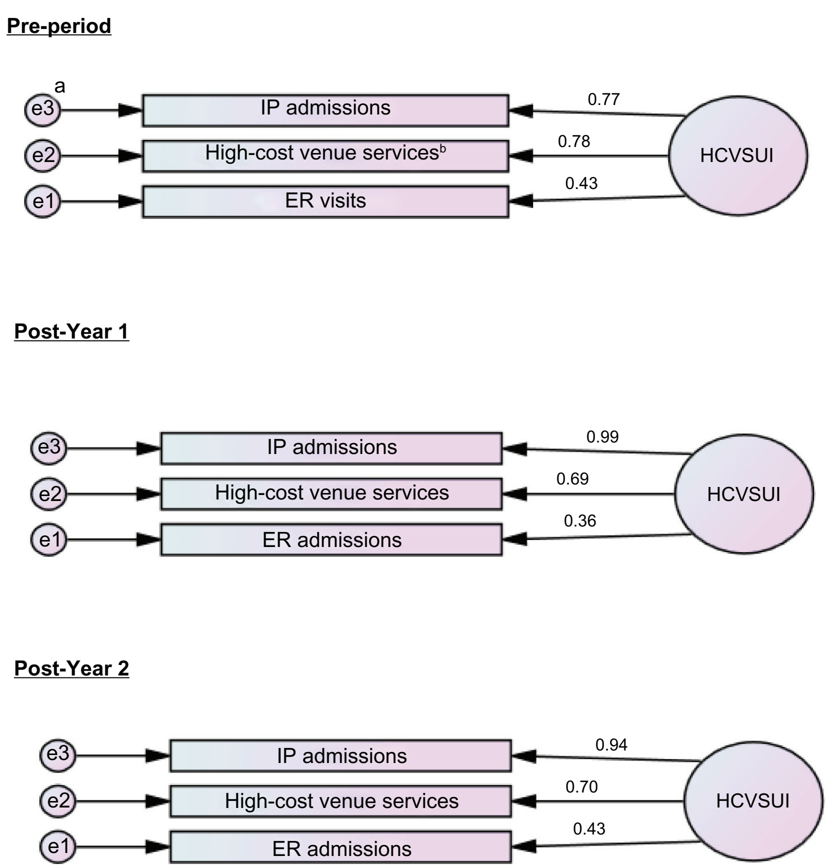

Figure 1 Factor analysis results: high-cost venue service utilization intensity (HCVSUI).
Notes: [a]Error; [b]the high-cost venue services variable is the summed amount of ER and inpatient costs.
Abbreviations: ER, emergency room; HCVSUI, high cost venue service utilization intensity; IP, inpatient.

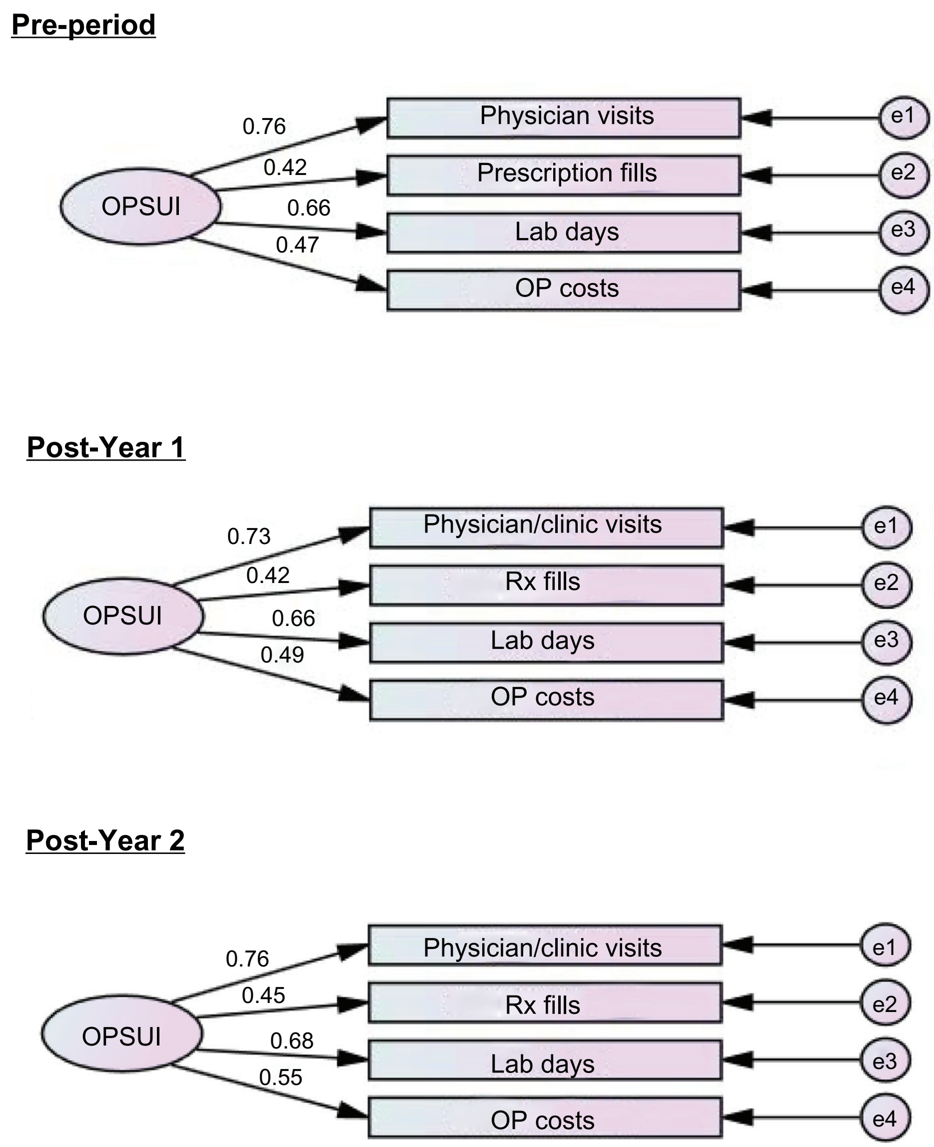

Figure 2 Factor analysis results: outpatient service utilization intensity (OPSUI).
Abbreviations: OP, outpatient; OPSUI, outpatient service utilization intensity; Rx, prescription.

Compared with the Low to Low group, members in the High to High group displayed a nonsignificant positive trend toward being slightly younger ($\beta = -0.013$, $P < 0.05$) and male ($\beta = 0.209$, Exp(β) = 1.232, $P < 0.05$). Further, they utilized greater baseline high-cost venue services ($\beta = 0.263$, $P < 0.001$), greater post-Year 1 outpatient services ($\beta = 0.716$, $P < 0.001$), and filled a greater number of prescriptions for different opioids ($\beta = 0.219$, $P < 0.001$). The High to High group tended to have elevated Charlson comorbidity index scores ($\beta = 0.275$, $P < 0.001$) and were more likely to be diagnosed with the following specific comorbidities during the pre-period: opioid dependence ($\beta = 0.865$, Exp(β) = 2.375, $P < 0.001$), cardiovascular disease ($\beta = 0.317$, Exp(β) = 1.373, $P < 0.01$), and migraine ($\beta = 0.851$, Exp(β) = 2.343, $P < 0.001$). In addition, there was a nonsignificant positive trend for fibromyalgia ($\beta = 0.381$, Exp(β) = 1.464, $P < 0.05$).

Compared with the Low to Low group, members in the Low to High group were significantly older ($\beta = 0.014$, $P < 0.001$), utilized greater pre-period high-cost venue services ($\beta = 0.185$, $P < 0.001$), utilized greater post-Year 1 outpatient services ($\beta = 0.400$, $P < 0.001$), and filled a greater number of prescriptions for different opioids ($\beta = 0.109$, $P < 0.001$). In addition, there was a nonsignificant positive trend toward males ($\beta = 0.118$, Exp(β) = 1.126, $P < 0.05$). The Low to High group tended to have elevated Charlson comorbidity index scores ($\beta = 0.171$, $P < 0.001$) and were more likely to be diagnosed with the following specific

Table 3 Study sample descriptive statistics by trajectory group (based on pre-period information)

Variable	High to high (N = 469)		Low to high (N = 1612)		Low to low (N = 66,758)		High to low (N = 2553)	
	Mean/f	(SD)/%	Mean/f	(SD)/%	Mean/f	(SD)/%	Mean/f	(SD)/%
Low back pain	237	50.50%	807	50.10%	35675	53.40%	1272	49.80%
Osteoarthritis	232	49.50%	805	49.90%	31083	46.60%	1281	50.20%
Male	167	35.60%	626	40.10%	26776	40.10%	1040	40.70%
Age	47.6	9.7	49.7	8.6	47.5	9.3	50.1	8.8
Northeast region	22	4.70%	92	5.70%	4547	6.80%	160	6.30%
North central region	122	26.00%	434	26.90%	19,654	29.40%	680	26.60%
South region	272	58.00%	855	53.00%	32,960	49.40%	1346	52.70%
West region	50	10.70%	223	13.80%	9340	14.00%	359	14.10%
Unknown region	3	0.60%	8	0.50%	257	0.40%	8	0.30%
Charlson comorbidity index	0.77	1.08	0.43	0.81	0.2	0.52	0.43	0.8
Related comorbidities and covariates								
Depression	48	10.20%	92	5.70%	1870	2.80%	105	4.10%
Anxiety	27	5.80%	64	4.00%	1789	2.70%	91	3.60%
Opioid dependence	23	4.90%	38	2.40%	654	1.00%	54	2.10%
Bipolar disorder	10	2.10%	24	1.50%	318	0.50%	21	0.80%
Sleep disturbance/insomnia	40	8.50%	136	8.40%	3056	4.60%	197	7.70%
Sickle cell disease	8	1.70%	2	0.10%	4	0.00%	0	0.00%
Fibromyalgia	42	9.00%	71	4.40%	2130	3.20%	107	4.20%
Cardiovascular disease	192	40.90%	582	36.10%	14,354	21.50%	879	34.40%
Migraine/chronic headache	60	12.80%	68	4.20%	1593	2.40%	111	4.30%
Post-traumatic stress disorder	4	0.90%	5	0.30%	146	0.20%	8	0.30%
Mental health visits (N)	83	17.70%	177	11.00%	4417	6.60%	227	8.90%
Psychotropic Rx fills (N)	216	46.10%	531	32.90%	14,437	21.60%	765	30.00%
HCVSUI factor score	2.18	4.85	0.4	1.97	–0.04	0.79	0.45	1.93
OPSUI factor score	1.5	2.2	0.5	1.35	–0.04	0.93	0.5	1.58

Abbreviations: HCVSUI, high-cost venue service utilization intensity; OPSUI, outpatient service utilization intensity; Rx, prescription; SD, standard deviation.

comorbidities during the pre-period: opioid dependence ($\beta = 0.563$, $\text{Exp}(\beta) = 1.755$, $P < 0.01$), cardiovascular disease ($\beta = 0.321$, $\text{Exp}(\beta) = 1.379$, $P < 0.001$), and bipolar disorder ($\beta = 0.665$, $\text{Exp}(\beta) = 1.944$, $P < 0.01$). In addition, there was a nonsignificant positive trend for depression ($\beta = 0.227$, $\text{Exp}(\beta) = 1.255$, $P < 0.05$).

Compared with the Low to Low group, members in the High to Low group were significantly older ($\beta = 0.020$, $P < 0.001$), more likely to be male ($\beta = 0.260$, $\text{Exp}(\beta) = 1.297$, $P < 0.01$), utilized greater baseline high-cost venue services ($\beta = 0.179$, $P < 0.001$), utilized greater post-Year 1 outpatient services ($\beta = 0.645$, $P < 0.001$), and filled a greater number of prescriptions for different opioids ($\beta = 0.102$, $P < 0.001$). The High to Low group did not have elevated Charlson comorbidity index scores ($P > 0.05$); however, they were more likely to be diagnosed with opioid dependence ($\beta = 0.493$, $\text{Exp}(\beta) = 1.637$, $P < 0.01$). In addition, there were nonsignificant positive trends for cardiovascular disease ($\beta = 0.113$, $\text{Exp}(\beta) = 1.119$, $P < 0.05$) during the pre-period and members were less likely to be diagnosed with depression ($\beta = -0.256$, $\text{Exp}(\beta) = 0.774$, $P < 0.05$).

Discussion

The goals of the long-term pharmaceutical management of CNCP are largely palliative and rely on one or a combination of opioid therapy, neurological medications, and/or antidepressants. As has been adequately documented elsewhere, it is a challenge for practitioners to manage their CNCP patients regardless of the implemented treatment strategy.[18,19] Finding the right balance between pain relief and appropriate medication combinations and levels is particularly challenging when addressing opioid therapy. There is a dearth of literature on the use of long-term opioid therapy for CNCP, although Chou and colleagues[20] have published guidelines and the World Health Organization's analgesic ladder provides some guidance as well.[9] Most agree that maximization of the patient's level of functioning is of paramount importance. However, health plans would argue that, in addition, efficiency or reduction in unnecessary use of high-cost venue services is equally important. This study highlights patient markers that might be used to meet both of these goals.

First, if service utilization can be taken as a proxy of patient level of functioning, an increased utilization of hospital-based services would indicate poor overall outcomes

Table 4 Post-period 1 service utilization and costs* by trajectory group

Variable	High to high (N = 469)			Low to high (N = 1612)			Low to low (N = 66,758)			High to low (N = 2553)		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Health services utilization and costs												
Number of Rx fills	49.8	40	51.3	29.3	18	34.1	17.1	8	23.6	32.4	24	35.9
Total Rx costs	$4402	$1776	$9504	$2549	$773	$5022	$1345	$264	$3137	$2592	$1006	$4393
Number of IP hospital admissions	2.3	2	2.2	0.2	0	0.4	0.1	0	0.3	1.7	2	0.9
Number of IP hospital days	12.3	7	17.3	0.6	0	1.6	0.2	0	1	7.3	5	9.3
Total IP hospital costs	$39,885	$28,010	$43,205	$2116	$0	$5647	$1102	$0	$4348	$43,974	$36,842	$41,247
Number of emergency room visits	6.6	4	9.1	0.8	0	1.4	0.3	0	0.7	2.2	1	3.2
Total emergency room costs	$3532	$1730	$7499	$449	$0	$1155	$169	$0	$606	$1077	$396	$1917
Number of physician and clinic visits	16.2	14	11.6	11.5	10	7.7	8.1	7	5.7	12.2	11	7.5
Total physician and clinic costs	$1309	$1068	$997	$900	$734	$702	$599	$496	$514	$964	$809	$679
Total OP costs	$24,745	$16,427	$29,494	$10,701	$7005	$20,033	$6132	$4021	$7610	$15,099	$10,727	$22,406
High-cost venue services (IP + ER)	$43,417	$32,037	$43,208	$2564	$0	$5739	$1271	$0	$4405	$45,050	$37,301	$41,170
Total medical costs (IP + OP)	$64,630	$48,032	$57,222	$12,817	$8416	$20,968	$7234	$4271	$9111	$59,072	$48,700	$48,670
Total medical costs (IP + OP + Rx)	$69,032	$54,074	$58,128	$15,366	$10,628	$22,252	$8579	$5483	$10,024	$61,664	$51,082	$48,994
Factor scores												
HCVSUI	4.86	–	3.9	0.09	–	0.66	–0.16	–	0.46	3.29	–	1.9
OPSUI	2.13	–	2.22	0.6	–	1.4	–0.07	–	0.89	1.07	–	1.61
Multiple opioid Rx fills post-year 1	2.4	2	2.7	1.4	1	1.8	0.8	0	1.3	1.5	1	1.9

Note: *All monetary values shown are in US dollars.
Abbreviations: ER, emergency room; HCVSUI, high-cost venue service utilization intensity; IP, inpatient; OP, outpatient; OPSUI, outpatient service utilization intensity; Rx, prescription; SD, standard deviation.

Table 5 Post-period two service utilization and costs* by trajectory group

Variable	High to high (N = 469)			Low to high (N = 1612)			Low to low (N = 66,758)			High to low (N = 2553)		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Health services utilization and costs												
Number of Rx fills	52.9	44	51.3	37.3	30	37.4	18.2	10	24.1	29.8	19	34
Total Rx costs	$5137	$2096	$11,832	$3098	$1320	$5533	$1490	$315	$3343	$2,704	$891	$4875
Number of IP hospital admissions	2.5	2	1.9	1.9	2	0.9	0.1	0	0.3	0.2	0	0.4
Number of IP hospital days	13.6	8	19.9	9	6	10.9	0.2	0	0.9	0.6	0	1.8
Total IP hospital costs	$48,237	$31,367	$66,801	$49,531	$39,111	$52,112	$1057	$0	$4615	$2105	$0	$6199
Number of emergency room visits	6.7	4	8.6	2.7	2	3.8	0.3	0	0.7	0.6	0	1.3
Total emergency room costs	$3806	$1883	$7196	$1555	631	$3608	$161	$0	$669	$370	0	$1,012
Number of physician and clinic visits	15.5	13	10.7	12.8	11	8.1	6.7	5	5.6	9.6	8	7.5
Total physician and clinic costs	$1318	$1045	$1039	$1071	$899	$841	$517	$398	$499	$775	$613	$720
Total OP costs	$26,775	$16,508	$35,003	$16,158	$11,426	$20,827	$4956	$2,721	$7859	$9,082	$4923	$18,462
High-cost venue services (IP + ER)	$52,042	$33,650	$67,188	$51,086	$40,436	$52,108	$1218	$0	$4697	$2,476	$0	$6290
Total medical costs (IP + OP)	$75,011	$53,101	$80,585	$65,689	$53,202	$58,384	$6013	$2,848	$9611	$11,187	$5750	$19,869
Total health care costs (IP + OP + Rx)	$80,148	$58,914	$81,821	$68,787	$55,966	$58,841	$7503	$4,052	$10,683	$13,891	$7944	$20,977
Factor scores												
HCVSUI	5.51	–	4.29	3.86	–	2.26	−0.14	–	0.46	0.09	–	0.68
OPSUI	2.26	–	2.18	1.31	–	1.57	−0.69	–	0.9	0.55	–	1.43
Multiple opioid Rx fills post-year 1	2.5	2	2.8	1.8	1	2.2	0.8	0	1.2	1.1	0	1.6

Note: *All monetary values shown are in US dollars.

Abbreviations: ER, emergency room; HCVSUI, high-cost venue service utilization intensity; IP, inpatient; OP, outpatient; OPSUI, outpatient service utilization intensity; Rx, prescription; SD, standard deviation.

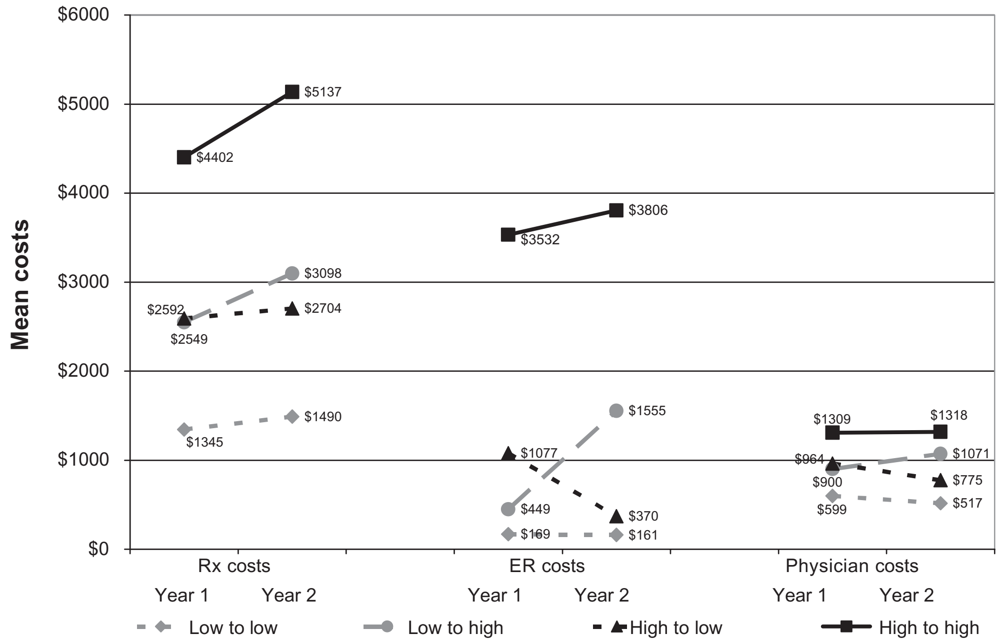

Figure 3 Mean service utilization costs (in US dollars).
Abbreviations: ER, emergency room; Rx, prescription.

to which suboptimal pain management may be a contributor. In the present study, predictors of post-Year 1 and post-Year 2 high-cost venue service utilization included history of high-cost service utilization, the Charlson comorbidity index score, history of opioid dependence, and cardiovascular disease. Specifically, among those that remained consistently among the highest utilizers of high-cost venue services, migraine headache and a directionally correct trend ($P < 0.05$) for fibromyalgia were significant predictors. Furthermore, those in the Low to High group were more likely to have a history of mood disorder – specifically, bipolar – and a directionally correct trend ($P < 0.05$) for depression. In addition, both the count of different opioid medications filled during the first year of treatment as well as the history of intensity of outpatient service utilization were positively associated with high utilization of high-cost venue services.

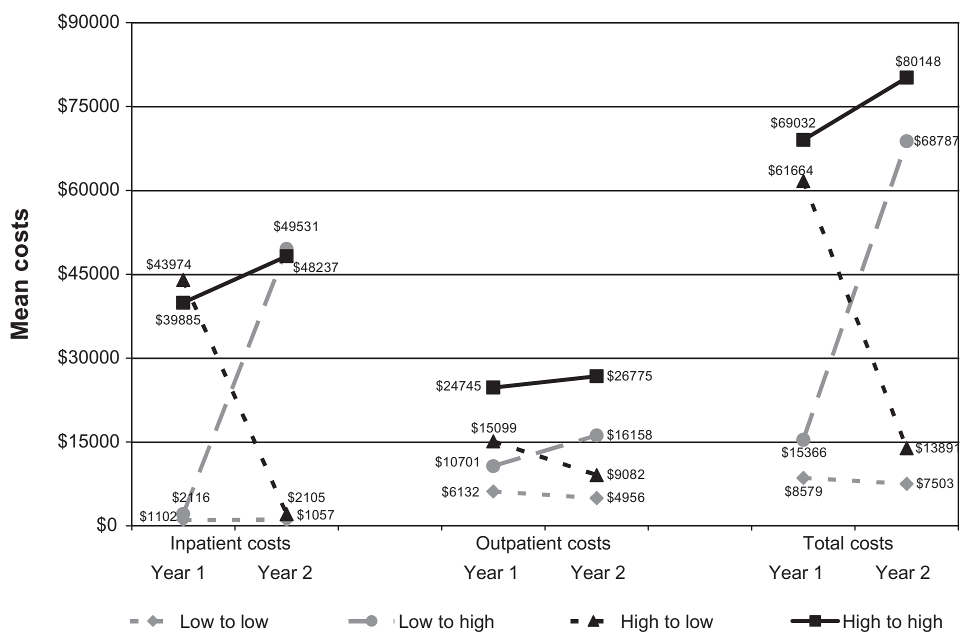

Figure 4 Mean total costs (in US dollars).

Table 6 Final multinomial model of hospital-based service use by trajectory group[a]

	B	df	Significance	Exp(β)
High to high				
Intercept	−5.485	1	0.000	
Age	−0.013	1	0.019	0.987
Pre-period HCVSUI	0.263	1	0.000	1.301
Post-period 1 OPSUI	0.716	1	0.000	2.047
Charlson comorbidity	0.275	1	0.000	1.317
Number of different opioids filled at post-period 1	0.219	1	0.000	1.245
Low back pain group	−0.194	1	0.052	0.824
Osteoarthritis group	0[b]	0		
Male	0.209	1	0.046	1.232
Depression diagnosis	0.324	1	0.059	1.383
Opioid dependence diagnosis	0.865	1	0.000	2.375
Bipolar diagnosis	0.510	1	0.158	1.664
Fibromyalgia diagnosis	0.381	1	0.035	1.464
Cardiovascular disease diagnosis	0.317	1	0.003	1.373
Migraine diagnosis	0.851	1	0.000	2.343
Low to high				
Intercept	4.848	1	0.000	
Age	0.014	1	0.000	1.014
Pre-period HCVSUI	0.185	1	0.000	1.203
Post-period 1 OPSUI	0.400	1	0.000	1.492
Charlson comorbidity	0.171	1	0.000	1.186
Number of different opioids filled at post-period 1	0.109	1	0.000	1.116
Low back pain group	−0.031	1	0.555	0.970
Osteoarthritis group	0[b]	0		
Male	0.118	1	0.026	1.126
Depression diagnosis	0.227	1	0.048	1.255
Opioid dependence diagnosis	0.563	1	0.001	1.755
Bipolar diagnosis	0.665	1	0.003	1.944
Fibromyalgia diagnosis	0.014	1	0.912	1.014
Cardiovascular disease diagnosis	0.321	1	0.000	1.379
Migraine diagnosis	0.219	1	0.095	1.245
High to low				
Intercept	−4.752	1	0.000	
Age	0.02	1	0.000	1.020
Pre-period HCVSUI	0.179	1	0.000	1.196
Post-period 1 OPSUI	0.645	1	0.000	1.906
Charlson comorbidity	0.042	1	0.171	1.043
Number of different opioids filled at post-period 1	0.102	1	0.000	1.108
Low back pain group	−0.033	1	0.441	0.968
Osteoarthritis group	0[b]	0		
Male	0.260	1	0.000	1.297
Depression diagnosis	−0.256	1	0.020	0.774
Opioid dependence diagnosis	0.493	1	0.001	1.637
Bipolar diagnosis	0.028	1	0.908	1.028
Fibromyalgia diagnosis	−0.141	1	0.188	0.869
Cardiovascular disease diagnosis	0.113	1	0.018	1.119
Migraine diagnosis	−4.752	1	0.122	1.181

Notes: [a]The reference category is: Low to Low; [b]this parameter is set to zero because it is redundant.
Abbreviations: B, beta; Exp(B), exponential beta; df, degrees of freedom; HSUI, ; OPSUI, outpatient service utilization intensity.

The presence of some of these clinical predictors of problematic opioid use and abuse is well documented within the CNCP population[21,22] and opioid use has been related to both poor overall functioning[23] and increased health care costs.[12, 22] The current study revealed the presence of a trend for depression and bipolar disorder associated with the Low to High group and depression was inversely associated with the High to Low group. Additionally, both opioid dependence as well as the number of different types of opioid prescriptions filled were positively predictive of high-cost service utilization. Finally, the overall prevalence of cardiovascular disease in the current sample (22.4%) was below US prevalence estimates (33%),[24] although it did vary significantly across trajectory groups, suggesting its importance in driving costs and as a covariate. However, when removed from the final model, the R^2 was reduced by only 0.001, indicating that it accounted for a small amount of the variance, so may not be as important as other predictors in the model.

One significant predictor in the opposite direction from previous literature and health plan policy is the positive relationship between high-cost venue service utilization and post-Year 1 outpatient service utilization. Though not conclusive, these results do not support the general approach within care management, disease management, and case management programs of coordinating care using lower levels of service (ie, outpatient) to mitigate current or eventual elevated use of high-cost service among the CNCP patient population.[25–28] Further, were this finding confirmed with more definitive data, it would suggest that health plans should reevaluate the effectiveness of standard chronic disease management protocols within this population. Clearly, health plan care management programs should look further into the effectiveness of these programs before assuming that they apply equally to CNCP patients.

An obvious application of an algorithm designed to predict high-cost service utilization based on the present results could be implemented within a health plan's care management process. Health plans may wish to intervene with patients at the greatest risk for utilization of avoidable high-cost venue services. These study results, though not definitive, indicate that there are readily available patient level predictors of high-cost service utilization among CNCP patients. Similarly, providers who are aware of the risk factors associated with high-cost service utilization may be better able to intervene in cases before health care expenditure begins to escalate. The successful identification of patients who are not at elevated risk of high-cost service utilization may be just as valuable. As the present study has shown, it is only a small portion of the entire CNCP population that will likely utilize the most expensive services, so implementation of such a program could be reasonably managed from a cost perspective. Finally, utilization reviewers and case managers within health plans, who often serve as the gatekeepers between individual patients and higher levels of care, may also increase patient care management effectiveness with the information gained from these results.

The primary limitation of the present study was the data source. Although claims data provide large sample sizes of bona fide transactions and services rendered in the health care arena, they do present a number of shortcomings. For one, the data included in this study came from an employer-based claims database that represents multiple health insurance plans and products. The variety of pain management policies are unknown and could not have been controlled. In addition, there is a dearth of clinical information in claims data, which otherwise could have assisted in both the categorization of patients into more meaningful groups and greater accuracy in assessing disease progression and treatment failure/response. Moreover, it should be understood that claims are submitted for reimbursement purposes, not research purposes; therefore, many assumptions about data definitions and, in some cases, how to interpret the results must be made to systematically measure the variables of interest and test research hypotheses. One final limitation, the inclusion of diagnosed opioid abuse/dependence as a predictor in the model, while addressing the effect of opioid use and abuse directly, may have restricted the model, as users/abusers of drugs are more likely to try a greater number and fill more opioid prescriptions.[29] Therefore, including participants in this model who were diagnosed with abuse/dependence of any drug, may lead to a more comprehensive model.

In closing, this study developed an algorithm to discriminate between patients based on use of high-cost venue health care services among CNCP patients. The ultimate goal was to identify patient characteristics that discriminated between different levels of HCVSUI and trajectories of change over time in the same. Overall, the current results improve our understanding of drivers of service utilization and costs among CNCP patients. Most notable among the results are the characteristic differences between trajectory groups and their clinical and care management implications. Characteristics related to CNCP patients across all three groups displayed elevated use of high-cost venue services, pre-period high-cost venue service utilization, post-Year 1 use of outpatient services, use of multiple different opioid medications during post-Year 1, and a history of opioid dependence. Primary diagnosis did not differentiate between the trajectory of high-cost venue service utilization. However, before we recommend that these groups be analyzed together, further analysis of these diagnoses and their effect on service utilization is necessary. By contrast, several other indicators did differentiate between groups and would be good candidates for use in case finding for health plans interested in programs to reduce the use of high-cost services among CNCP patients.

Disclosure

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