

Patient Characteristics and Healthcare Utilization of a Chronic Pain Population Within an Integrated Healthcare System

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In the United States, approximately 100 million adults are affected by noncancer chronic pain (CP).¹ CP causes substantial disability and has an impact on an individual's productivity, functional status, and mood/mental health.²⁻⁴ A report from the Institute of Medicine (now the National Academy of Medicine) estimated that the annual direct and indirect costs of CP in the United States were \$635 billion (in 2010 dollars)—which exceeds the costs of heart disease, cancer, and diabetes.¹

CP has received much attention in recent years due to its prevalence, economic impact, and burden on patients' quality of life; additionally, an aging population has a greater propensity to develop painful conditions. Patients with CP tend to be high utilizers of healthcare resources, and painful conditions (eg, osteoarthritis, joint disorders, back pain) represent some of the most common reasons for healthcare encounters in the United States.⁵ Annual healthcare expenditures are, on average, nearly \$5000 higher for patients with CP than for those without.¹

Patients with CP are not a homogenous population,⁶ as CP is associated with multiple disease states and patients often have more than 1 type of CP, which introduces complexity to pain management. Accordingly, targeted initiatives are needed to better identify, oversee, and coordinate care for patients with CP within the healthcare system and to direct these patients to appropriate resources to manage pain symptoms.

Few studies have evaluated how different types of CP impact the healthcare system. In this study, we sought to characterize the CP population within a community-based healthcare delivery system and to quantify healthcare utilization across types of CP within this population.

METHODS

Study Design and Setting

This study was conducted as a retrospective cross-sectional analysis of Sutter Health electronic health record (EHR) data

ABSTRACT

OBJECTIVES: We sought to characterize the chronic pain (CP) population and healthcare utilization across types of CP within a community-based healthcare system.

STUDY DESIGN: Cross-sectional study of electronic health records data from 2012.

METHODS: Patients 18 years or older with at least 2 encounter diagnoses for CP conditions in 2012 were included in the study. Patients were categorized into non-mutually exclusive CP types: arthritis/joint pain, back/cervical pain, neuropathies/neuralgias, headaches/migraines, and unclassified pain.

RESULTS: Of 1,784,114 patients, 120,481 (6.8%) met the criteria for the CP study cohort. Within the cohort, the most common types of CP were arthritis/joint pain (57%), back/cervical pain (49%), and neuropathy/neuralgias (40%). Patients with neuropathies/neuralgias were older than patients with other pain types and had more comorbidities (for neuropathies/neuralgias: mean age, 59 years; Charlson Comorbidity Index score >3, in 28% of patients). Patients with unclassified pain were most likely to be female (82%). Rates of office and emergency department (ED) visits were highest in patients with unclassified pain (5136 events and 209 events per 1000 patients, respectively). Rates of hospitalizations and 30-day hospital readmissions were highest in patients with neuropathies/neuralgias (70 events and 287 events per 1000 patients, respectively). An increased number of CP types was linearly associated with higher rates of office, ED, and hospital visits.

CONCLUSIONS: Based on prevalence, comorbidities, and healthcare utilization, several types of CP, including neuropathies/neuralgias, arthritis/joint pain, and unclassified pain, appear to be most impactful. Health systems can use these findings to target efforts to improve the management of patients with CP, particularly those with multiple pain-related conditions.

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from January 1 to December 31, 2012. Sutter Health is a community-based, nonprofit, open-network healthcare delivery system that provides ambulatory (primary and specialty care) and inpatient services across northern California. In 2013, the system served more than 3 million patients, with a total of 10 million outpatient visits; 800,000 emergency department (ED) visits; and nearly 200,000 hospital discharges. The EHR system, Epic-Care, is integrated across ambulatory clinics and hospitals, which allows a clinician to view patient information throughout the continuum of care. The clinical population is generally representative of the underlying geographic area with respect to age, sex, and race/ethnicity.

This study was approved by the Institutional Review Board of the Palo Alto Medical Foundation Research Institute. All data were de-identified in accordance with the Health Insurance Portability and Accountability Act standards.

Study Cohort

Patients were included in the study cohort if they were 18 years or older, had at least 2 *International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM)* encounter diagnoses for a CP condition in 2012 that were at least 30 days apart, and had at least 1 encounter of any type prior to 2010 to confirm prior health system contact. Patients were excluded if they had an encounter or problem list diagnosis for a malignancy (other than nonmelanoma skin cancer) in the 2 years prior to 2012 or had surgery in the 3 months prior to the first CP encounter in 2012.

Patients were grouped into 20 non-mutually exclusive CP conditions based on *ICD-9-CM* diagnoses, which were further categorized into 5 types of CP: 1) arthritis/joint pain (arthropathy, osteoarthritis, rheumatoid arthritis, joint pain); 2) back/cervical pain (back pain, cervical radiiculopathy, lumbar radiculopathy, spinal cord injury); 3) neuropathies/neuralgias (postherpetic neuropathy, diabetic neuropathy, neuropathy, neuralgia, surgically induced pain, limb pain); 4) headaches/migraines; and 5) unclassified pain (pelvic pain, abdominal pain, general pain, fibromyalgia).

The *ICD-9-CM* codes for CP conditions were based on well-described criteria from a recent study of CP in a single large healthcare delivery system.⁶ The 5 CP types were based on the anatomic location and pain pathophysiology of CP conditions. These CP types are also based on previous research^{4,7} and were developed with input from both Sutter and Pfizer investigators, including clinical pharmacists and a physician, with the specific exclusion of cancer pain and acute pain that may be due to surgery. The *ICD-9-CM* codes for each CP condition are provided in **eAppendix Table A** (eAppendices available at ajmc.com).

TAKE-AWAY POINTS

Patients with chronic pain (CP) are not a homogeneous population; they differ in terms of age, sex, overall chronic disease burden, and their use of health resources.

- ▶ Certain CP conditions appear to impact the healthcare system more than others, including neuropathies/neuralgias, arthritis/joint pain, and unclassified pain.
- ▶ Patients with multiple CP conditions, regardless of type of condition, used more healthcare resources than patients with fewer CP conditions.
- ▶ Health systems can use these findings to target efforts to improve the management of patients with CP.

Data Collection

Patient demographics, clinical characteristics, and healthcare encounters (office visits, ED visits, hospitalizations, and 30-day hospital readmissions) were obtained retrospectively from the clinical EHR and from administrative databases containing medical claims. We did not restrict encounters to those only related to pain. Race/ethnicity data are from patient self-reports collected as a part of routine clinical practice and were categorized as non-Hispanic white (NHW), African American, East/Southeast Asian (Chinese, Japanese, Korean, Filipino, or Vietnamese), South Asian (Asian Indian), Hispanic (of any race), other (Pacific Islander, American Indian/Alaskan Native, of multiple races, or race reported as “other”), and unknown.

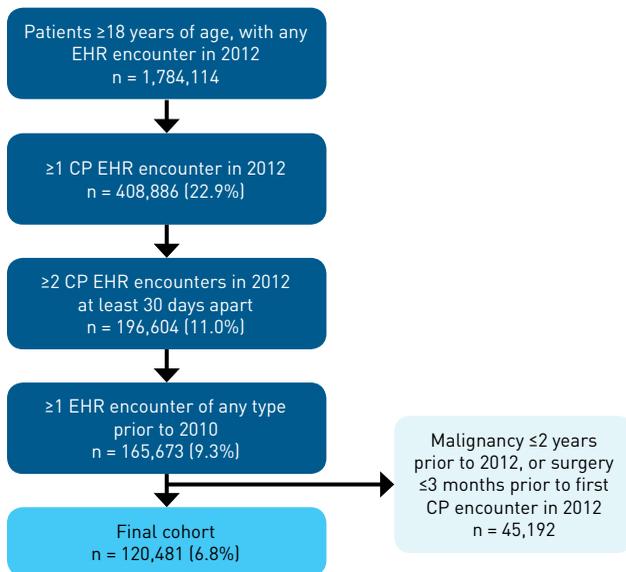
Disease burden was calculated by the Charlson Comorbidity Index (CCI) score.⁸ Insurance type was categorized as commercial (fee-for-service [FFS], preferred provider organization [PPO], health maintenance organization, point of service), Medicare, Medicaid, multiple payers (combination of commercial, Medicare, and/or Medicaid), other, self-pay, or unknown.

Data Analysis

Descriptive statistics were used to summarize continuous variables (means, medians) and binary or categorical variables (relative frequency distributions) for the 5 CP types, as well as for each of the 20 CP conditions. Rates of healthcare resource utilization were calculated as the number of events per 1000 patients in 2012. We applied negative binomial regression models to assess the relationship between the primary outcome of interest, healthcare utilization (counts of office visits, ED visits, hospitalizations, or 30-day hospital readmissions in 2012), and the main predictor of interest: the number of CP types per patient taken as a nominally measured predictor (ie, total number of CP types per patient, with the reference category as 1 CP type).⁹

Patient demographics and characteristics were included as covariates in all models for statistical adjustment (age, sex, race/ethnicity, insurance payer, prior counts of utilization, and geographic region of the clinical catchment area). In the same type of model, we further examined the linear association between healthcare utilization rates and the number of CP types by taking the latter as an ordinal—instead of nominally—measured predictor. Relative

FIGURE 1. Study Cohort Eligibility Flow Diagram



CP indicates chronic pain; EHR, electronic health record.

rates of each outcome were expressed as incident rate ratios (IRRs) with 95% confidence intervals (CI). A *P* value < .05 was considered statistically significant.

RESULTS

Chronic Pain Cohort Selection

We identified 1,784,114 patients who were 18 years or older and had at least 1 EHR encounter of any type in 2012; of these, 23% had at least 1 CP encounter and 11% had at least 2 CP encounters at least 30 days apart (Figure 1). Altogether, 120,481 patients (6.8%) met eligibility criteria for the CP cohort.

Chronic Pain Cohort Characteristics

CP patients were, on average, aged 56 years; the majority was female (66%) and NHW (63%) (Table). Most patients with CP (60%) had more than 1 type (median = 2), 57% had arthritis/joint pain, 49% had back/cervical pain, 40% had neuropathies/neuralgias, 23% had headaches/migraines, and 20% had unclassified pain.

Patients with headaches/migraines and unclassified pain were, on average, younger (mean = 49 and 54 years, respectively) than those with other types of CP and were more likely to be female (81% and 82%, respectively) (Table). Patients with arthritis/joint pain and neuropathies/neuralgias tended to have the highest burden of comorbidity (CCI >3 in 25% and 28% of patients, respectively)

compared with patients with other types of CP. Patients with headaches/migraines were the most likely to be commercially insured beneficiaries (65%) and the least likely to be Medicare beneficiaries (6%). No racial/ethnic differences were found across the types of CP. Patients with unclassified pain were most likely to have more than 1 type of CP (88%), with a median of 3 unique types.

The relative frequency distribution of each CP condition among all CP types is shown in Figure 2. Joint pain was the most common CP condition (41%), followed by back pain (39%). Comorbidity burden by each CP condition is provided in eAppendix Figure A.

Healthcare Utilization

Patients with unclassified pain had the highest rates of crude (unadjusted) office visits (5136 per 1000 patients) followed by those with neuropathies/neuralgias (4865 per 1000 patients) (Figure 3). Crude ED visit rates were highest among patients with unclassified pain (209 per 1000 patients), followed by those with headaches/migraines (180 per 1000 patients).

Crude hospitalization rates were highest among patients with neuropathies/neuralgias (70 per 1000 patients), followed by those with unclassified pain (67 per 1000 patients). Among approximately 5% of patients with CP with a hospitalization in 2012, rates of 30-day readmissions were highest among patients with neuropathies/neuralgias (287 per 1000 patients), followed by those with unclassified pain (255 per 1000 patients).

The crude rates of healthcare utilization for each of the 20 CP conditions are provided in eAppendix Figures B through E. Highest rates of office visits per 1000 patients were found among those with lumbar radiculopathy (6409), surgical pain (6265), neuralgia (6093), fibromyalgia (5434), and general pain (5433) (eAppendix Figure B). Highest rates of ED visits per 1000 patients were found among those with spinal cord injury (347), general pain (226), pelvic pain (226), headaches (206), and surgical pain (205) (eAppendix Figure C). Highest hospitalization rates per 1000 patients were found among those with spinal cord injury (179), diabetic neuropathy (130), postherpetic neuropathy (84), neuropathy (82), and osteoarthritis (80) (eAppendix Figure D). Among patients with a hospitalization in 2012, the highest rates of 30-day readmissions per 1000 patients were found among those with neuralgia (490), diabetic neuropathy (370), rheumatoid arthritis (346), general pain (315), and neuropathy (270) (eAppendix Figure E).

After statistical adjustment for important covariates, an increased number of CP types per patient was associated with a higher rate of office visits (*P* < .001 for all levels vs 1 CP type), ED visits (*P* < .001 for all levels vs 1 CP type), and hospitalizations (*P* < .001 for 2 or 3 CP types vs 1 CP type), but not 30-day hospital readmissions (Figure 4). Linear trends for the relationship between healthcare utilization rates and number of CP types per patients were statistically significant (*P* < .001 each for office visits, ED visits, and hospitalizations). Unadjusted and adjusted point estimates for categorical and linear trends are provided in eAppendix Table B.

TABLE. Baseline Demographics and Clinical Characteristics, Overall and by Types of Chronic Pain*

	All Chronic Pain Patients (N = 120,481)	Arthritis or Joint Pain (n = 68,539)	Back or Cervical Pain (n = 58,925)	Neuropathies or Neuralgias (n = 47,919)	Headaches or Migraines (n = 27,261)	Unclassified Pain (n = 23,677)
Mean age, years ± SD	56.1 ± 16.8	59.0 ± 15.4	55.8 ± 16.6	58.5 ± 16.4	49.3 ± 15.5	53.5 ± 16.2
Age distribution, n (%)						
18-45	34,170 (28.4)	14,952 (21.8)	17,160 (29.1)	11,122 (23.2)	11,815 (43.3)	7863 (33.2)
46-65	51,917 (43.1)	29,868 (43.6)	25,447 (43.2)	20,706 (43.2)	11,576 (42.5)	10,409 (44.0)
≥66	31,394 (28.6)	23,719 (34.6)	16,318 (27.7)	16,091 (33.6)	3870 (14.2)	5405 (22.8)
Female, n (%)	79,605 (66.1)	44,922 (65.5)	38,594 (65.5)	31,036 (64.8)	21,976 (80.6)	19,339 (81.7)
Race/ethnicity, n (%)						
NHW	76,036 (63.1)	43,803 (63.9)	37,184 (63.1)	30,366 (63.4)	16,865 (61.7)	15,185 (64.1)
African American	4868 (4.04)	3032 (4.42)	2402 (4.08)	2007 (4.19)	1053 (3.86)	982 (4.15)
East/Southeast Asian	6722 (5.58)	3818 (5.57)	3173 (5.38)	2684 (5.60)	1428 (5.24)	1034 (4.37)
South Asian	3218 (2.67)	1706 (2.49)	1646 (2.79)	1380 (2.88)	746 (2.74)	582 (2.46)
Hispanic, any race	12,771 (10.6)	7115 (10.4)	6257 (10.6)	5172 (10.8)	3365 (12.3)	2802 (11.8)
Other ^b	6501 (5.40)	3576 (5.22)	3344 (5.68)	2678 (5.61)	1652 (6.06)	1395 (5.89)
Unknown	10,365 (8.60)	5489 (8.01)	4919 (8.35)	3623 (7.56)	2152 (7.89)	1697 (7.17)
Payer, n (%)						
Commercial	67,009 (55.6)	36,133 (52.7)	32,156 (54.6)	25,590 (53.4)	17,821 (65.4)	13,344 (56.4)
Medicare	12,779 (10.6)	8402 (12.3)	6232 (10.6)	6056 (12.6)	1615 (5.92)	2348 (9.92)
Medicaid	4141 (3.44)	2345 (3.42)	2468 (4.19)	1766 (3.69)	1174 (4.31)	1122 (4.74)
Multiple	20,222 (16.8)	13,391 (19.5)	9860 (16.7)	9262 (19.3)	2989 (11.0)	1145 (4.84)
Other	1905 (1.58)	1220 (1.78)	1026 (1.74)	782 (1.63)	423 (1.55)	1280 (5.81)
Self	5687 (4.72)	2917 (4.26)	3017 (5.12)	2063 (4.31)	1391 (5.10)	1145 (4.84)
Unknown	8738 (7.25)	4131 (6.03)	4166 (7.07)	2400 (5.01)	1848 (6.78)	1280 (5.41)
Types of CP conditions, count median (IQR)	2 (1-2)	2 (1-3)	2 (2-3)	2 (2-3)	2 (1-3)	3 (2-3)
Types of CP conditions, distribution, n (%)						
1	47,799 (39.67)	18,428 (26.89)	11,688 (19.84)	7887 (16.46)	6858 (25.16)	2938 (12.41)
2	46,815 (38.86)	28,527 (41.62)	25,379 (43.07)	21,124 (44.08)	10,042 (36.84)	8558 (36.14)
3	19,504 (16.19)	15,645 (22.83)	15,833 (26.87)	13,395 (27.95)	6408 (23.51)	7231 (30.54)
4	5435 (4.51)	5011 (7.31)	5097 (8.65)	4585 (9.57)	3025 (11.10)	4022 (16.99)
5	928 (0.77)	928 (1.35)	928 (1.57)	928 (1.94)	928 (3.40)	928 (3.92)
Median CCI (IQR)	2 (0-3)	2 (1-3)	1 (0-3)	2 (1-4)	1 (0-2)	1 (0-3)
CCI score distribution, n (%)						
0	34,279 (28.4)	15,183 (22.2)	17,351 (29.4)	10,995 (22.9)	11,525 (42.3)	7525 (31.8)
1-3	60,426 (50.2)	36,322 (53.0)	29,627 (50.3)	23,509 (49.1)	12,992 (47.7)	12,131 (51.2)
>3	25,776 (21.4)	17,034 (24.8)	11,947 (20.3)	13,415 (28.0)	2744 (10.1)	4021 (17.0)

CCI indicates Charlson Comorbidity Index; CP, chronic pain; IQR, interquartile range; NHW, non-Hispanic white; SD, standard deviation.

*Patients may have had multiple CP diagnoses across types of conditions; therefore, CP-type categories are not mutually exclusive.

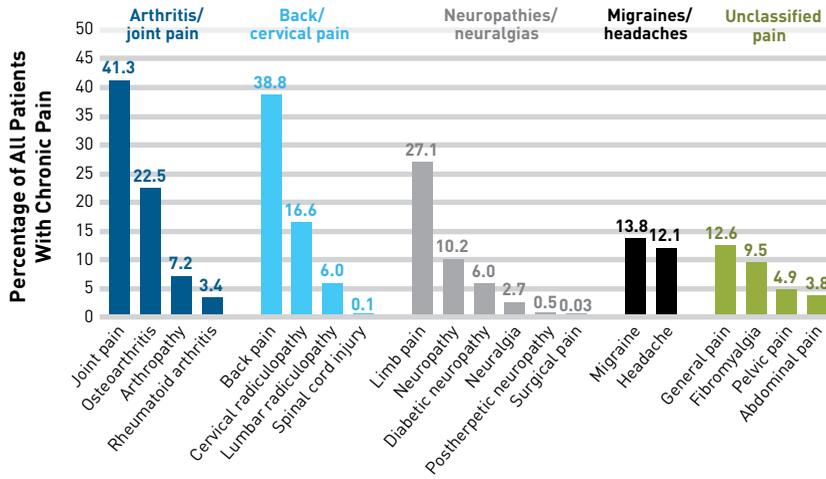
^bOther race/ethnicities include Pacific Islander, American Indian/Alaskan Native, multiple races reported, or race reported as "other."

DISCUSSION

In this large, cross-sectional analysis of patients with noncancer CP from a community-based healthcare delivery system in northern California in 2012, we found that the most common type of CP was

arthritis/joint pain, with more than half of all patients with CP having a diagnosis of this type (57%). Among the 20 individual CP conditions, the most common were joint pain (41%), back pain (39%), limb pain (27%), osteoarthritis (23%), and cervical radiculopathy (17%). We also

FIGURE 2. Relative Frequency Distribution of Chronic Pain Condition Among All Patients With Chronic Pain (n = 120,481)



Chronic pain conditions are shown grouped by chronic pain type. Chronic pain types/conditions are not mutually exclusive.

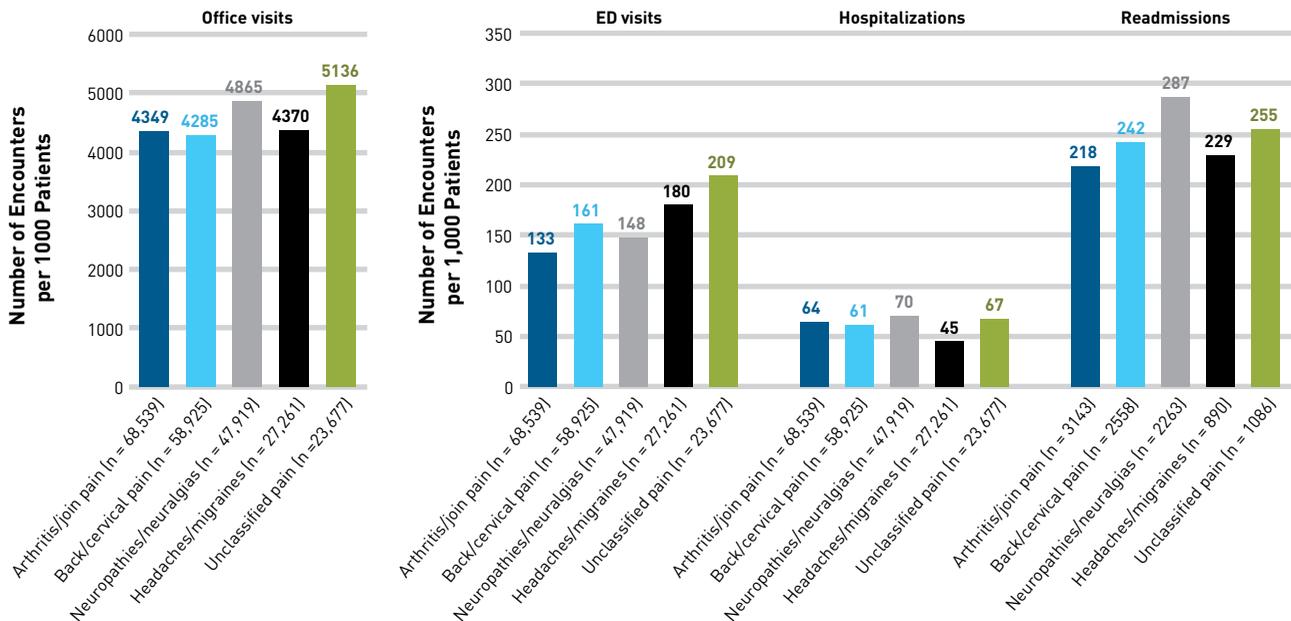
found that the majority of patients with CP had more than 1 type of pain (60%), with a median of 2 unique CP types per patient; those with unclassified pain were most likely to have multiple CP types. Furthermore, patients across the various types of CP were heterogeneous with respect to age, sex, and disease burden, but were largely similar by

race/ethnicity. In terms of healthcare utilization, patients with unclassified pain had the highest crude rates of office visits and ED visits, and patients with neuropathies/neuralgias had the highest crude rates of hospitalizations and 30-day hospital readmissions.

Regardless of CP type, an increased number of types of CP per patient was linearly associated with higher rates of office visits, ED visits, and hospitalizations, but not hospital readmissions. The relationship between the number of conditions and utilization rates was observed even after controlling for important drivers of resource use, including age and prior healthcare utilization. The magnitude of this relationship was most pronounced for office visits and ED visits, but was less for hospitalizations, especially for patients with all 5 CP types. We noted that less than 1% of patients had all 5 CP types (0.77%). Thus, there was limited power to detect statistically significant differences in outcomes between this group and others, particularly for relatively rare events, such as hospitalization or hospital readmissions.

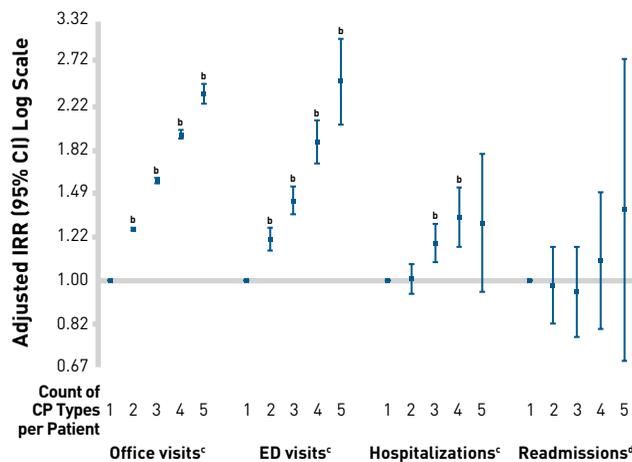
Studies of CP have been previously performed in a variety of healthcare system settings^{6,7,10}; most, however, have focused

FIGURE 3. Crude Healthcare Utilization Rates by Types of Chronic Pain*



ED indicates emergency department.
*Chronic pain types are not mutually exclusive.

FIGURE 4. Relative Healthcare Utilization Rates by Count of Chronic Pain Types^a



CI indicates confidence interval; CP, chronic pain; ED, emergency department; IRR, incident rate ratio.

^aAdjusted IRRs derived from negative binomial regression models for each healthcare utilization outcome (office visits, ED visits, hospitalizations, and 30-day hospital readmissions), with the count of the types of CP per patient as an independent, nominal predictor variable (with a single CP type [1] as the referent group). Vertical error bars represent 95% CI. Statistical adjustment was performed for age, sex, race/ethnicity, insurance payer, and clinical catchment area.

^bP < .001 against referent group (1 CP type per patient).

^cFor office, ED, and hospital visits: n = 120,481.

^dFor 30-day hospital readmissions: n = 4959.

on assessing disease prevalence for individual CP conditions. Lamerato and colleagues recently showed that among patients in an integrated healthcare delivery network, the overall prevalence of CP in 2010 was approximately 10% to 12% and that the most common CP conditions were joint pain, limb pain, back pain, and osteoarthritis.⁶ These data are largely consistent with our findings, using a similar definition of CP; however, in their study, Lamerato and colleagues did not exclude patients with cancer-related pain or acute pain due to surgery. Nevertheless, similar to our study, the authors demonstrated that patients with CP are heterogeneous with regard to age and sex, but are largely similar across racial/ethnic groups.⁶ The results of ours and other studies have shown that females are disproportionately affected by CP conditions; in particular, headaches/migraines and unclassified pain, which is inclusive of pelvic pain and fibromyalgia.^{6,7,10-12}

Our study adds to the current body of knowledge by further demonstrating that patients across various types of CP differ with regard to overall chronic disease burden and rates of healthcare utilization. We also show that the number of concurrent CP types is linearly associated with the incident rates of office visits, ED visits, and hospitalizations. To our knowledge, our study is the first to characterize the relative use of healthcare resources across patients with different types of CP.

Several CP types are potentially the most impactful to the healthcare system, including neuropathies/neuralgias (eg, diabetic neuropathy, neuralgia, postherpetic pain), arthritis/joint pain (eg, osteoarthritis, rheumatoid arthritis), and unclassified pain (eg, general pain, fibromyalgia). Notably, these types of CP are impactful for different reasons. Arthritis and joint pain are highly prevalent conditions, affecting a large number of patients. However, unclassified pain affects fewer patients, who, on average, have more concurrent types of painful conditions and use more outpatient and ED services. On the other hand, neuropathies/neuralgias are relatively prevalent, but more often affect the elderly and are associated with a greater burden of comorbidity, which ostensibly drives higher hospitalization rates and readmissions.

In a 2014 study of Medicare beneficiaries, Johnston and colleagues reported higher average comorbidity index scores among patients with pain from diabetic neuropathy (mean = 3.4) compared with patients with postherpetic neuralgia or fibromyalgia (mean = 1.3, for each). The authors also found that total annual healthcare costs due to inpatient admissions, outpatient services, and outpatient prescriptions were highest among patients with diabetic neuropathy.¹³ Total annual healthcare costs in 2010 US dollars for patients with diabetic neuropathy were \$24,740 compared with \$18,320 and \$16,579 for patients with fibromyalgia and postherpetic neuralgia, respectively. Approaches to mitigating the burden of CP conditions on the healthcare system will likely require individualized strategies.

Limitations

The findings of this study should be interpreted in the context of several limitations. This was a cross-sectional analysis of patients with prevalent, non-mutually exclusive types of CP. We did not have comprehensive information on disease history; thus, variation across CP types, in terms of disease comorbidity and healthcare utilization rates, may be attributable to differences in disease onset and progression.

In our analysis, approximately 7% of all patients within the healthcare system in 2012 had at least 1 of 20 CP conditions based on our eligibility criteria. Our observed point prevalence (7%) is lower than that reported by Lamerato and colleagues (10%-12%) among continuously enrolled patients from a managed-care health system in Detroit, Michigan.⁶ Although geographic or demographic differences between study populations may explain this discrepancy, we recognize that our cohort was different as it was derived from an open-network healthcare system with primarily FFS/PPO beneficiaries. Therefore, the prevalence of CP reported herein may be underestimated.

Identifying the appropriate “denominator” in an open-network healthcare system is problematic and requires further validation since it is difficult to determine the true annual population based on those who have utilized services. We used rather strict eligibility criteria to ensure that patients had previous contact with our health system. Although relaxing these criteria would increase the point

prevalence (Figure 1), we chose higher specificity over sensitivity. Through an Internet-based nationally representative sample of adults in the United States in 2010, the prevalence of CP was estimated at 30.7%,¹⁴ which is much higher than that reported in our study and in the Lamerato study.⁶ This may be due to inherent methodological biases when data are collected from surveys compared with EHR or administrative claims. For example, the detection of patients with CP through encounter diagnoses is dependent on conditions being sufficiently painful to warrant medical services and the healthcare provider to appropriately code the condition.

In this study, we did not take into account reasons for healthcare encounters; thus, utilization rates across different types of CP do not necessarily reflect treatment for specific diagnoses. The use of EHR data from an open-network healthcare system may have also underestimated overall healthcare utilization rates, as patients may have received care outside of the system. However, we do not believe that use of outside resources would be different across the various types of CP. Lastly, the generalizability of the findings to other regions in the United States and to other healthcare systems (eg, closed managed-care systems or the Veterans Affairs system) is unknown.

CONCLUSIONS

The management of CP is of growing interest to healthcare organizations due to its prevalence, economic impact, and burden on patients' quality of life. Several CP types including neuropathies/neuralgias, arthritis/joint pain, and unclassified pain are potentially the most impactful to the healthcare system. Health systems can learn from these findings to target efforts to improve the management of patient with CP, particularly those with multiple pain conditions. ■

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Authorship Information: Concept and design (RJR, SNS, LI, BL, TLC, JCC, TJ, DI); acquisition of data (TJ); analysis and interpretation of data (RJR, SNS, LI, BL, TLC, JCC, TJ, DI); drafting of the manuscript (RJR, SNS, TJ, DI); critical revision of the manuscript for important intellectual content (RJR, SNS, LI, BL, TLC, JCC, DI); statistical analysis (RJR, JCC); obtaining funding (LI, BL, TLC, DI); administrative, technical, or logistic support (BL, TLC, DI); and supervision (BL, TLC, DI).

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eAppendix

eAppendix Table A. *International Classification of Disease, 9th Revision Clinical Modification (ICD-9-CM) Codes for Chronic Pain Conditions and Types*

ICD-9-CM Codes	Chronic Pain Types	Chronic Pain Conditions	Key Words
053.10-053.14, 053.19	NEUROPATHIES AND NEURALGIAS	Postherpetic Neuropathy	Postherpetic Trigeminal Neuralgia, Herpes Zoster with Nervous System Complication, Herpes Zoster Myelitis, Postherpetic Polyneuropathy, Geniculate Herpes Zoster
250.60-250.63, 357.2		Diabetic Neuropathy	Diabetes Mellitus with Neurological Manifestations, Polyneuropathy in Diabetes
337.00, 337.09, 337.1, 355.1, 356.2, 356.3, 356.4, 356.8, 356.9, 357.1, 357.4, 357.5, 357.6, 357.7, 357.81, 357.89, 357.9, 724.3		Neuropathy	Neuropathy, Neuropathies, Polyneuropathy, Polyneuritis, Refsum's Disease, Meralgia Paresthetica, Sciatica
350.1, 729.2		Neuralgia	Neuralgia, Neuritis, Radiculitis
338.22, 338.28		Surgically induced pain	Chronic Post Thoracotomy Pain, Other Chronic Post-Op Pain

337.20, 337.21, 337.22, 337.29, 353.6, 354.4, 355.0, 355.2, 355.3, 355.4, 355.6, 355.71, 355.79, 355.8, 355.9, 729.5		Limb Pain	Reflex Sympathetic Dystrophy, Phantom Limb Pain, Causalgia of the Upper Limb, Causalgia of the Lower Limb, Mononeuritis of Lower Limb, Mononeuritis of Unspecified Site, Pain in Limb, Various Mononeuropathies
595.1, 625.8, 625.9	UNCLASSIFIED PAIN	Pelvic Pain	Other Specified Sx of Fem Gen Organs, Unspecified Sx Assoc w/Fem Gen Organs, Chronic Interstitial Cystitis
564.1		Abdominal Pain	Irritable Bowel Syndrome
338.0, 338.21, 338.29, 338.4, 729.1, 780.96		General Pain	Central Pain Syndrome, Chronic Pain due to Trauma, Other Chronic Pain, Chronic Pain Syndrome, Generalized Pain, Myalgia and Myositis Unspecified (FM)
784.0	HEADACHES OR MIGRAINES	Headache	Headache
346.00-346.03, 346.10-346.13, 346.20-346.23, 346.30-346.33, 346.40-346.43, 346.50-346.53, 346.60-346.63, 346.70-346.73, 346.80-346.83, 346.90-346.93		Migraine	Migraine, Chronic Migraine, Persistent Migraine, Other Forms of Migraine, Variants of Migraine, Hemiplegic Migraine, Menstrual Migraine

<p>274.00-274.03, 696.0, 711.00711.99, 712.80- 712.99, 713.0, 713.1, 713.2, 713.3, 713.4, 713.5, 713.6, 713.8, 714.89, 714.9, 716.10716.19, 716.50- 716.59, 716.80- 716.99</p>	<p>ARTHRITIS OR JOINT PAIN</p>	<p>Arthropathy</p>	<p>Arthropathy, Arthritis, Arthropathies, Polyarthropy, Polyarthropathies, Gout</p>
<p>715.00, 715.04, 715.09-715.18, 715.20-715.28, 715.30-715.38, 715.80, 715.89- 715.98, 716.20- 716.39, 716.60- 716.68, 721.0, 721.1, 721.2, 721.3, 721.41, 721.42</p>		<p>Osteoarthritis</p>	<p>Osteoarthrosis, Allergic Arthritis, Monoarthritis, Climacteric Arthritis, Spondylosis with Myelopathy, Cervical Spondylosis, Lumbosacral Spondylosis, Thoracic Spondylosis</p>
<p>714.0, 714.1, 714.2, 714.30714.33, 714.4, 714.81</p>		<p>Rheumatoid Arthritis</p>	<p>Rheumatoid Arthritis, Felty's Syndrome, Chronic Postrheumatic Arthropathy, Rheumatoid Lung, Juvenile Rheumatoid Arthritis</p>

720.0, 720.1, 720.2, 720.81, 720.89, 725, 729.0, 719.40- 719.49		Joint Pain	Inflammatory Spondylopathies, Sacroilitis, Spinal Enthesopathy, Polymyalgia Rheumatica, Ankylosing Spondylitis, Rheumatism, Fibrositis, Pain in Joint
722.10, 722.11, 722.72, 722.73, 722.80, 722.82, 722.83, 724.01, 724.02, 724.1, 724.2, 724.5, 724.8	BACK OR CERVICAL PAIN	Back Pain	Backache, Symptoms Referable to Back, Lumbago, Pain in Thoracic Spine, Postlaminectomy Syndrome of Lumbar Region, Spinal Stenosis, Spinal Stenosis (Unspecified), Disp Lumbar Disc w/o Myelop, Disp Thoracic Disc w/o Myelop, Disc Disorder Thoracic w/o Myelop, Disc Disorder Lumbar w/o Myelop, Post Laminectomy Syndrome, Post Laminectomy Syndrome Thoracic
722.71, 722.81, 723.0, 723.1, 723.2, 723.3, 723.4, 723.5, 723.6		Cervical Radiculopathy	Displacement of Cervical Disc w/o Myelop, Post Laminectomy Syndrome Cervical, Spinal Stenosis in Cervical Region, Toticollis, Cervicobrachial Syndrome, Cervicocranial Syndrome, Cervicalgia, Panniculitis
724.4		Lumbar Radiculopathy	Thoracic or Lumbosacral Neuritis or Radiculitis
952.00-952.19, 952.2, 952.3, 952.4, 952.8, 952.9		Spinal Cord Injury	Spinal Cord Injury, Cord Syndrome, Spinal Bone Injury, Lesion of Spinal Cord, Caudia Equina Spinal Cord Injury

eAppendix Table B. Relative Healthcare Utilization Rates by Count of Chronic Pain (CP) Types

OFFICE VISITS	Unadjusted	Adjusted^a
Type of CP, count	IRR (95% CI)	IRR (95% CI)
1 (reference)	1.00	
2	1.35 (1.33, 1.37) ^b	1.27 (1.26, 1.28) ^b
3	1.72 (1.69, 1.76) ^b	1.59 (1.57, 1.61) ^b
4	2.33 (2.26, 2.40) ^b	1.97 (1.93, 2.01) ^b
5	2.97 (2.76, 3.18) ^b	2.38 (2.27, 2.49) ^b
Linear Trend	1.32 (1.31, 1.33) ^b	1.256 (1.249, 1.262) ^b
ED VISITS	Unadjusted	Adjusted^a
Type of CP, count	IRR (95% CI)	IRR (95% CI)
1 (reference)	1.00	1.00
2	1.33 (1.26, 1.41) ^b	1.21 (1.15, 1.28) ^b
3	1.86 (1.72, 2.00) ^b	1.45 (1.36, 1.55) ^b
4	2.96 (2.65, 3.32) ^b	1.90 (1.72, 2.10) ^b
5	4.12 (3.21, 5.28) ^b	2.52 (2.06, 3.07) ^b
Linear Trend	1.40 (1.36, 1.40) ^b	1.23 (1.20, 1.26) ^b
HOSPITALIZATIONS	Unadjusted	Adjusted^a
Type of CP Condition, count	IRR (95% CI)	IRR (95% CI)
1 (reference)	1.00	1.00
2	1.05 (0.97, 1.13)	1.01 (0.94, 1.08)
3	1.37 (1.25, 1.51) ^b	1.19 (1.09, 1.30) ^b
4	1.64 (1.41, 1.89) ^b	1.34 (1.17, 1.54) ^b
5	1.54 (1.10, 2.16) ^c	1.31 (0.95, 1.80)
Linear Trend	1.16 (1.12, 1.21) ^b	1.09 (1.06, 1.13) ^b

30-DAY HOSPITAL READMISSIONS	Unadjusted	Adjusted^a
Type of CP, count	IRR (95% CI)	IRR (95% CI)
1 (reference)	1.00	1.00
2	0.89 (0.75, 1.07)	0.98 (0.82, 1.17)
3	0.90 (0.72, 1.11)	0.95 (0.77, 1.17)
4	0.98 (0.71, 1.36)	1.10 (0.80, 1.51)
5	1.22 (0.59, 1.52)	1.39 (0.69, 2.79)
Linear Trend	0.98 (0.91, 1.06)	1.02 (0.93, 1.10)

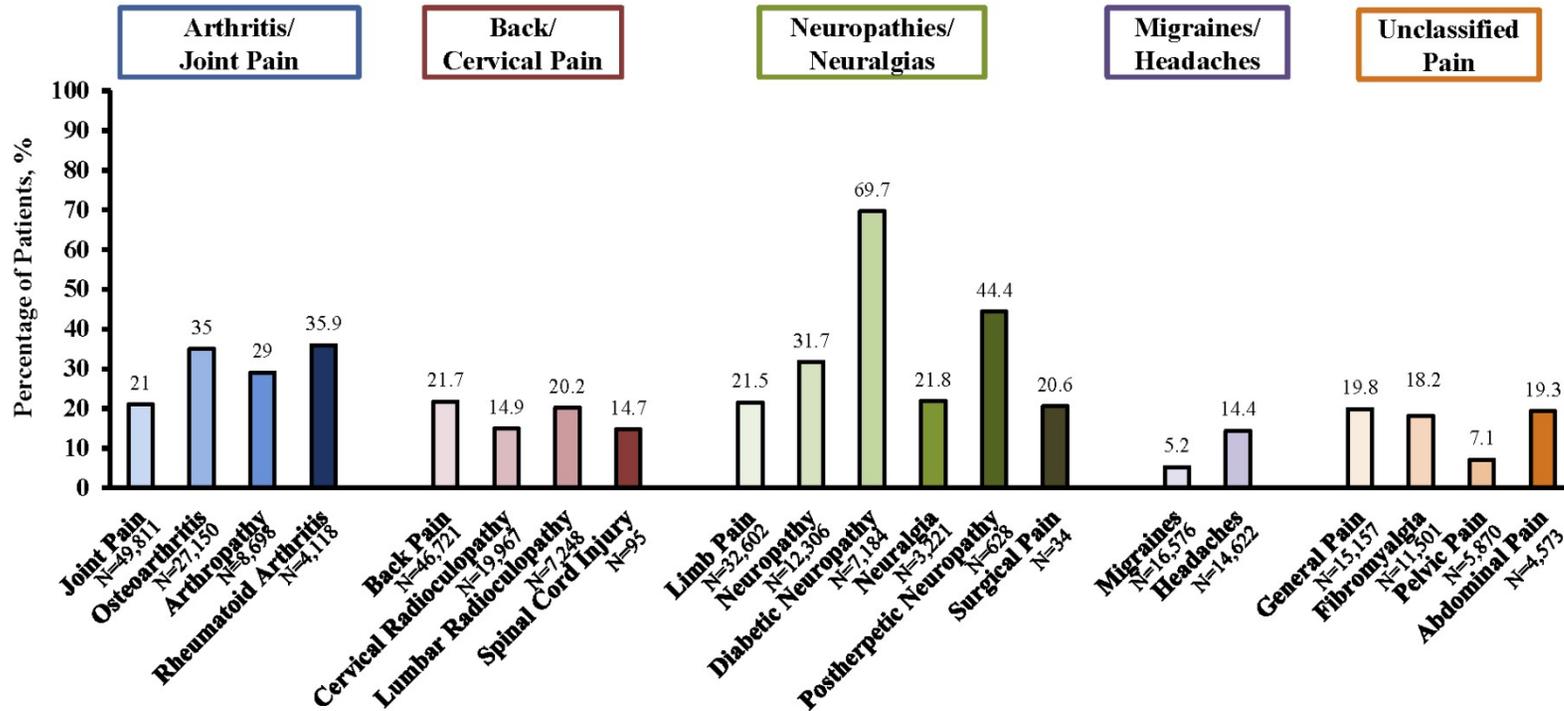
Adjusted incident rate ratios and 95% confidence intervals (CIs) derived from negative binomial regression models for each health utilization outcome (office visits, emergency department (ED) visits, hospitalizations, and 30-day hospital readmissions), with count of the type of CP per patient as an independent, nominal predictor variable (with a single CP type [1] as the referent group). Linear trends are shown for the association between number of CP types per patient (ordinal variable) and each outcome.

^aStatistical adjustment was performed for age, sex, race/ethnicity, insurance payer, and clinical catchment area

^bP<0.001

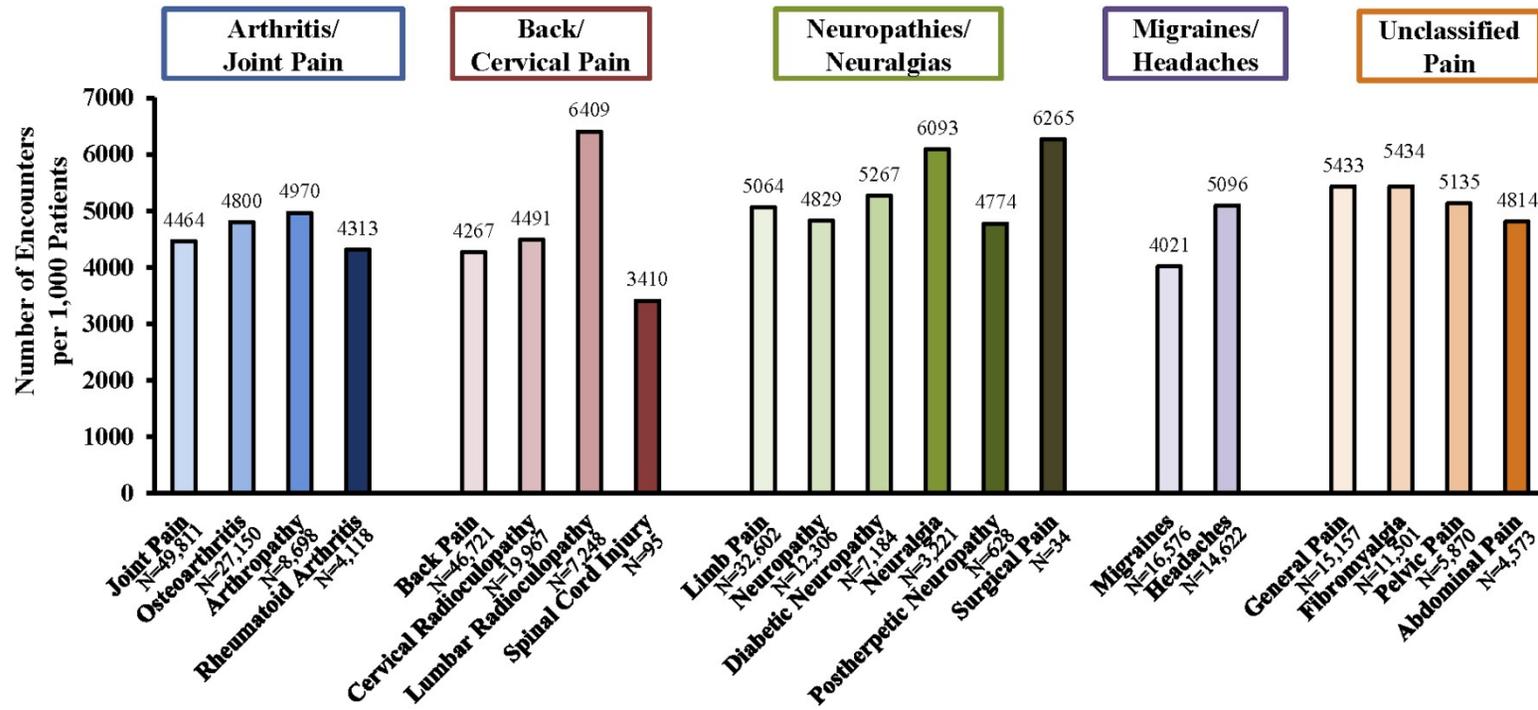
^cP<0.05. For office, ED, and hospital visits: N = 120,481. For hospital readmissions, N =4,959.

eAppendix Figure A. Relative Frequency Distribution of Patients with High Burden of Comorbidity by Chronic Pain Conditions



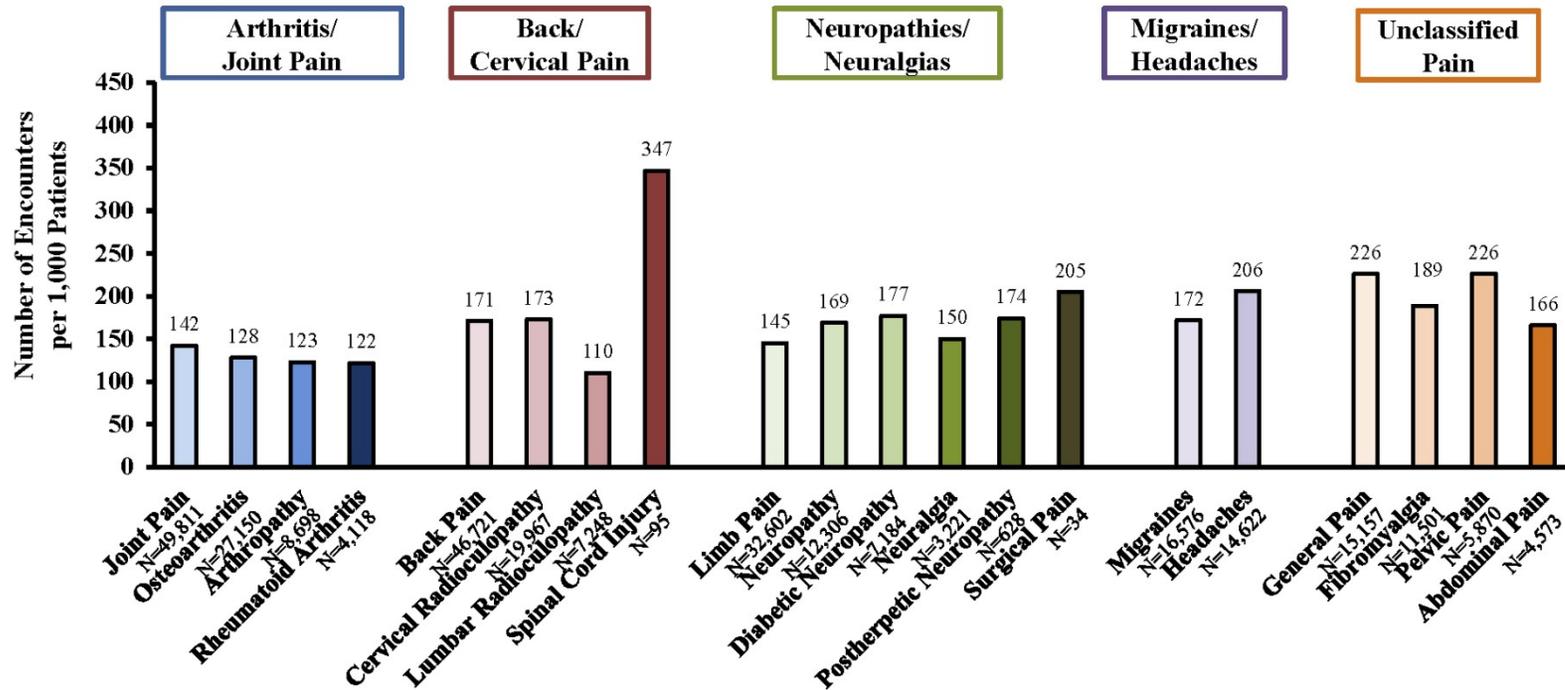
High burden of comorbidity defined as Charlson Comorbidity Index score >3. Chronic pain conditions are shown grouped by chronic pain type. Chronic pain types/conditions are not mutually exclusive.

eAppendix Figure B. Crude Office Visit Rates by Chronic Pain Condition



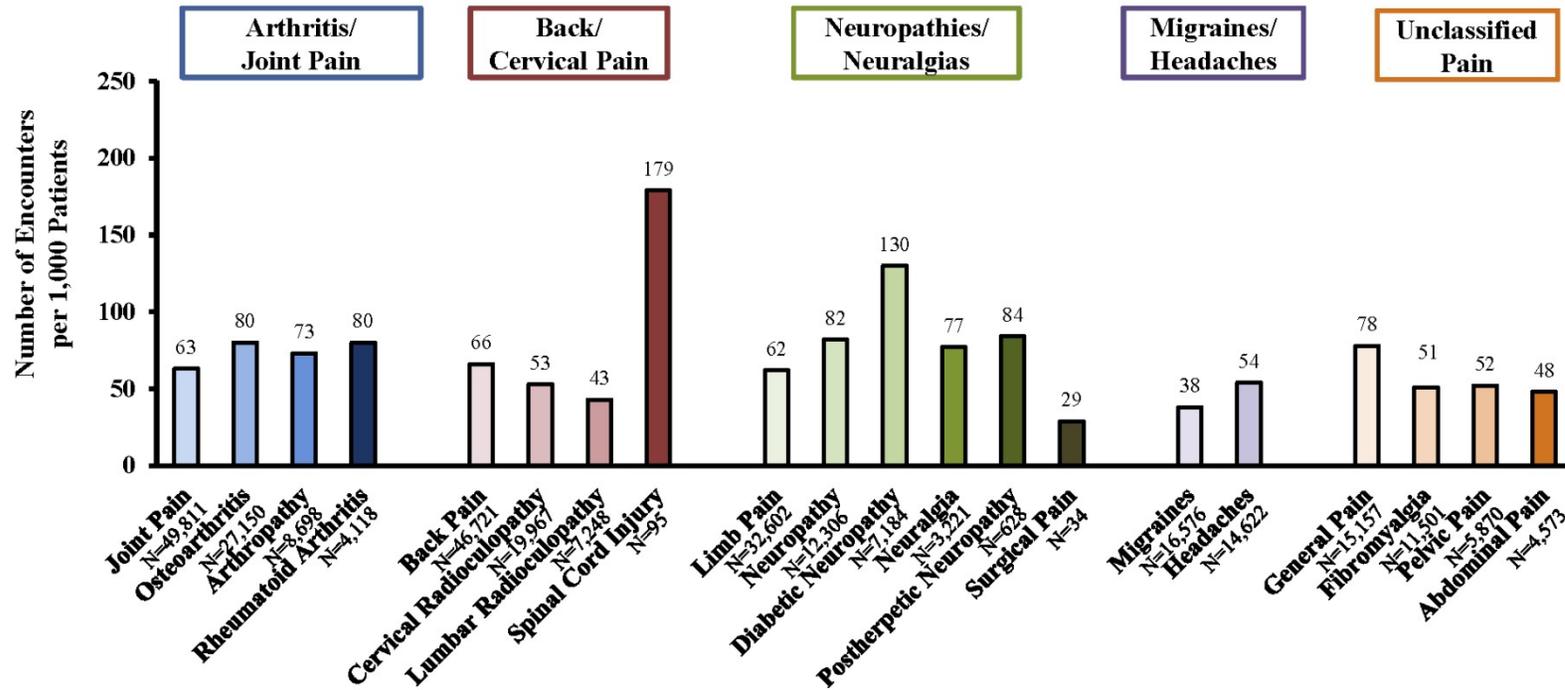
Chronic pain conditions are shown grouped by chronic pain type. Chronic pain types/conditions are not mutually exclusive.

eAppendix Figure C. Crude Emergency Department Visits by Chronic Pain Condition



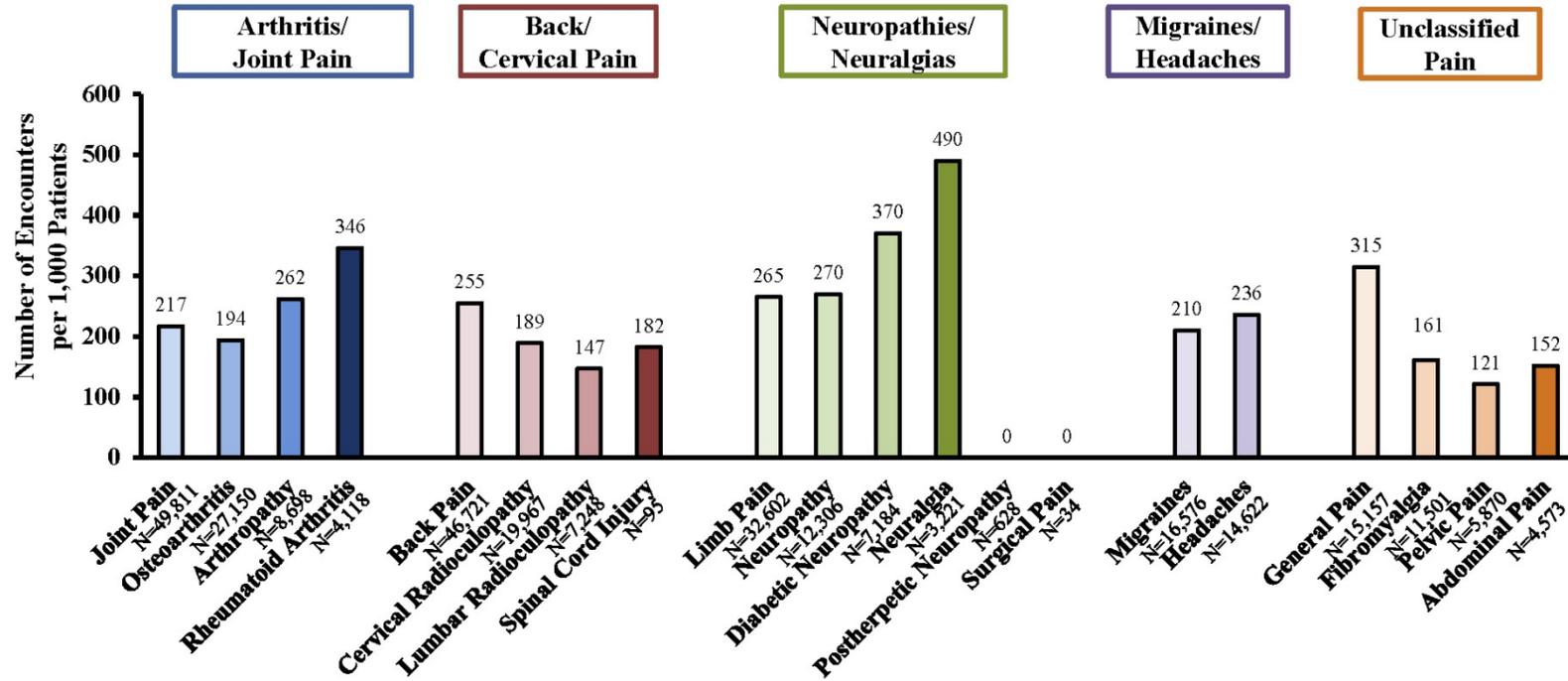
Chronic pain conditions are shown grouped by chronic pain type. Chronic pain type/conditions are not mutually exclusive.

eAppendix Figure D. Crude Hospitalization Rates by Chronic Pain Condition



Chronic pain conditions are shown grouped by chronic pain type. Chronic pain type/conditions are not mutually exclusive.

eAppendix Figure E. Crude 30-Day Hospital Readmission Rates by Chronic Pain Condition



Chronic pain conditions are shown grouped by chronic pain type. Chronic pain type/conditions are not mutually exclusive.