

Longitudinal Care Patterns and Utilization among Patients with New-Onset Neck Pain by Initial Provider Specialty

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Level of Evidence: Level 3 (non-randomized controlled cohort study)

ABSTRACT

Study Design: Retrospective cohort study.

Objective: To compare utilization patterns for patients with new-onset neck pain by initial provider specialty.

Summary of Background Data: Initial provider specialty has been associated with distinct care patterns among patients with acute back pain; little is known about care patterns among patients with acute neck pain.

Methods: Deidentified administrative claims and electronic health record (EHR) data derived from the Optum Labs Data Warehouse, which contains longitudinal health information on over 200M enrollees and patients, representing a mixture of ages and geographical regions across the U.S. Patients had outpatient visits for new-onset neck pain from October 1, 2016 to September 30, 2019, classified by initial provider specialty. Utilization was assessed during a 180-day follow-up period, including subsequent neck pain visits, diagnostic imaging, and therapeutic interventions.

Results: The cohort included 770,326 patients with new-onset neck pain visits. The most common initial provider specialty was chiropractor (45.2%), followed by primary care (33.4%). Initial provider specialty was strongly associated with the receipt of subsequent neck pain visits with the same provider specialty. Rates and types of diagnostic imaging and therapeutic interventions during follow-up also varied widely by initial provider specialty. While uncommon after initial visits with chiropractors ($\leq 2\%$), CT or MRI scans occurred in over 30% of patients with initial visits with emergency physicians, orthopedists, or neurologists. Similarly, 6.8% and 3.4% of patients initially seen by orthopedists received therapeutic injection and major surgery, respectively, as compared to 0.4% and 0.1% of patients initially seen by a chiropractor.

Conclusion: Within a large, national cohort, chiropractors were the initial provider for a plurality of patients with new-onset neck pain. Compared to patients initially seen by physician providers, patients with chiropractor initial providers received fewer and less costly imaging services and were less likely to receive invasive therapeutic interventions during follow-up.

KEY POINTS

- In a national U.S. sample, chiropractors were the initial care provider for a plurality of patients (45.2%) with new-onset neck pain.
- Except for patients initially seen by emergency physicians, patients were most likely to obtain subsequent neck pain visits with providers in the same specialty as the initial visit, including 78.7% and 85.5% of patients initially seen by chiropractors and physical/occupational therapists, respectively.
- Receipt of imaging within 180-days of initial visits was strongly associated with initial care provider specialty with much lower rates of cervical spine MRI among patients initially seen by chiropractors (2.0%) compared to primary care physicians (10.9%) or orthopedists (31.6%).
- Initial provider specialty was also strongly associated with the types and intensity of therapeutic interventions within 180-days of initial visits with manipulative and physical therapies predominating in patients initially seen by chiropractors or physical/occupational therapists and more invasive and costly therapies in patients initially seen by orthopedists.

INTRODUCTION

Neck pain is the fourth most common cause of disability worldwide,¹ resulting in substantial activity limitation, work time lost, and associated costs.^{1,2} Most people experience neck pain over their lifetimes, and the point prevalence of neck pain in the general population likely exceeds 10%.^{3,4}

Prior research among U.S low back pain patients suggests that initial care providers can powerfully influence subsequent care patterns and costs.⁵⁻⁹ In U.S. practice, it is also likely that patients with new-onset neck pain seek initial care from providers of varying specialties. Within a Utah health system, patients with acute neck pain who were initially seen by primary care rather than specialty physicians had lower rates of spinal imaging and injection during follow-up.¹⁰ To our knowledge, the care patterns of patients with acute neck pain have not been evaluated in a national sample, particularly with classification by initial provider specialty.

Our goal was to assess the relationship between provider types and treatment patterns for neck pain, as well as care pathways for neck pain treatment in the six months after the initial neck pain visit within a national sample of commercial and Medicare Advantage enrollees.

MATERIALS AND METHODS

Design, Data, and Subjects

We performed a retrospective cohort study using de-identified administrative claims data from the Optum Labs Data Warehouse (OLDW), which includes medical and pharmacy claims and enrollment records for commercial and Medicare Advantage (MA) enrollees, from the fourth quarter of 2015 through the first quarter of 2020.⁶ The database contains longitudinal health information on enrollees and patients, representing a mixture of ages and geographical regions

across the U.S.¹¹ Since this study involves analysis of de-identified data, the University of California determined that it was exempt from Institutional Review Board approval.

We identified a cohort of commercially insured or MA enrollees, aged 18 to 89 years, who had an initial visit for neck pain based on *International Classification of Diseases, 10th Revision, Clinical Modification* (ICD-10-CM) diagnosis codes on an outpatient provider claim between October 1, 2016 and September 30, 2019 (Supplemental File, Supplemental Digital Content 1, <http://links.lww.com/BRS/C178>). Patients were required to be continuously enrolled with medical and pharmacy coverage for at least 18 months, including 12 months before and at least 6 months after the index date of the neck pain visit. To ensure the cohort represented patients with acute or new-onset neck pain, patients were excluded if they had one of the following exclusion criteria during the 12 months before the index date: 1) any visit for neck pain or injury, based on either ICD-10-CM diagnosis codes or Current Procedural Terminology (CPT®) procedure codes (Supplemental File, Supplemental Digital Content 1, <http://links.lww.com/BRS/C178>); 2) any visit for solid organ malignancy (Supplemental File, Supplemental Digital Content 1, <http://links.lww.com/BRS/C178>); 3) opioid prescription coverage for the 30 days prior to the index date or at least 90 days during the 11 months before that 30-day period; 4) any prescription for buprenorphine. Based on these criteria, we identified 1,027,101 continuously insured patients with new-onset neck pain during the three-year study period (Figure 1). For 50,122 patients with more than one qualifying neck pain episode during the period, we included only the first.

Assignment of Initial Provider

We used physician and facility claims from the index date to classify patients by the following initial provider types: chiropractor, primary care (including family practice and internal medicine), emergency medicine, orthopedics, physical/occupational therapy (PT/OT), neurology, or rehabilitation medicine. Coverage policies of participating health plans during the study period allowed patient self-referral to any of these provider types. Most classifications were based on the provider specialty codes on physician claims, although a small percentage were assigned an PT/OT initial provider based on revenue codes for PT/OT services. Of the 1,027,101 patients with new neck pain diagnoses, 770,326 patients could be assigned one of the initial providers above. Of those who could not be categorized (n=256,775), 57% had neck pain diagnoses on isolated radiology claims, suggesting evaluation for acute illness or injury. Other reasons for non-assignment of an initial provider were isolated neck pain claims from ancillary services (e.g., nursing, home health, social work) or other specialty provider types. When ≥ 2 claims on the same date occurred from different provider types, we prioritized PCPs over specialist physicians, and physician or chiropractor care over PT/OTs.

Outcomes

We assessed utilization outcomes at 30, 90, and 180 days after the index neck pain visit by initial provider, including services received on the index date. First, we examined the frequency of additional neck pain visits for neck pain with providers in the same versus other specialties. Second, by initial provider, we used CPT® procedure codes to identify receipt of the following imaging tests: cervical spine radiography (72040, 72050, 72052), computed tomography (CT) of the cervical spine (72125-72127) or soft tissue of the neck (70490-70492), and magnetic resonance imaging (MRI) of the cervical spine (72141-72142, 72156) or soft tissue of the neck

(70547-70549). Third, we used CPT® procedure codes to identify receipt of the following therapeutic interventions: physical (97161-97163) or occupational (97165-97167) therapy, massage (97124) or other manual therapy (97140), osteopathic (98925-98929) or chiropractic (98940-98943) manipulative therapy, acupuncture (97810-97814), therapeutic injection, and major cervical spinal surgery (Supplemental File, Supplemental Digital Content 1, <http://links.lww.com/BRS/C178>). Because few therapeutic injections and major surgical procedures occurred during the first 30 days of follow-up, we report these outcomes only at 180 days of follow-up.

Covariates

Sociodemographic information included age, sex, rurality of residence (creating binary indicators of “small town” and “rural” residence using Rural-Urban Commuting Area codes),¹² and insurance status (commercial vs. Medicare Advantage). Using claims during the year prior to index date, we used the Elixhauser comorbidity index to assess comorbidities,²² identified prior visits with headache, low back pain, or acute non-cervical trauma, and computed counts of visits with each provider specialty for non-neck pain diagnoses (e.g., chiropractor, primary care, etc.). We also specified the presence of the following diagnoses on the index visit date: cervical dislocation injury, cervical fracture, cervical radiculopathy, cervical myelopathy, headache, and low back pain.

Analyses

We performed bivariate cross-tabulations of utilization outcomes by initial provider. Because of the large magnitude of absolute differences by initial provider and the very large sample sizes, we expected bivariate findings to be robust to multivariate adjustment. To confirm the robustness of bivariate analyses, we performed multivariate adjusted analyses for the following outcomes at 180 days: plain radiography, cervical spine MRI, cervical spine CT, therapeutic injection, and major surgery. For these binary outcomes, we used logistic regression with simultaneous adjustment for age (age squared), sex, commercial vs. Medicare Advantage insurance, small town or rural residential indicators, indicators of four complicating diagnoses at index date (i.e., cervical radiculopathy, cervical myelopathy, headache, and low back pain), indicators of any visits for headache, low back pain, or acute non-cervical trauma during the prior year, and indicators of 35 Elixhauser index comorbidities.²² For the therapeutic injections and major surgery, we also adjusted for an indicator of any recurrent neck pain visits within 6 months after the index date. For major surgery, we also included indicators of cervical dislocation and cervical fracture on the index date. After fitting logistic regression models, we computed adjusted mean rates by entry point provider using predicted marginal means. Analyses were conducted using PROC LOGISTIC and LSMEANS in SAS, Version 9.4 (Cary, NC).

RESULTS

The patient sample included 770,326 patients with a mean age of 51.6 years (SD 17.6); 58.6% were female, and 72.5% had commercial insurance rather than MA (Table 1). Chiropractors were the most common initial provider (45.2%), followed by PCPs (33.4%). Younger and commercially insured patients were more likely to have chiropractor initial providers than older

or MA patients; patients with chiropractor initial providers were more likely than other patients to have concurrent low back pain.

Initial provider specialty was strongly associated with patients receiving subsequent neck pain visits with the same provider type (Table 2). Of patients who initially saw chiropractors or PT/OTs, for example, 78.7% and 85.5%, respectively, had subsequent neck pain visits with providers in the same discipline. After initial visits with orthopedic, neurology, and rehabilitation medicine providers, 40.4% to 48.0% had subsequent neck pain visits with the same discipline. Patients whose initial neck pain provider was an emergency medicine physician were most likely to receive subsequent neck pain care from PCPs (16.1%). Meanwhile, the frequency of subsequent visits for neck pain with provider types that differed from the specialty of the index neck pain visit ranged from 5.5% among patients initially seen by chiropractors to 59.2% among patients with emergency medicine initial providers.

Patterns of imaging utilization during the follow-up period also differed substantially by initial provider (Table 3). Within 180 days of follow-up, plain radiography of the cervical spine was performed on 69.6%, 30.3%, and 26.4% of patients initiating care with orthopedists, PCPs, or emergency physicians, respectively, as compared to 17.7% of patients initiating care with chiropractors and 7.7% initiating care with PT/OTs. While CT and MRI of the neck were uncommon after index visits with chiropractors and PT/OTs, CT or MRI scans occurred within 180 days in over 30% of patients with initial visits with emergency physicians, orthopedists, or neurologists. After initial visits with PCPs, MRI of the cervical spine occurred in 10.9% of patients during the 180-day follow-up, compared with 2.0% of patients initiating care with chiropractors.

Initial provider specialty was also strongly associated with the types and intensity of therapeutic interventions during the 180-day follow-up period (Table 4). While nearly all patients with chiropractors as initial providers received chiropractic manipulation, only 6.9% of patients presenting to PCPs received chiropractic manipulation within the 180-day follow-up period. Manual therapies, such as massage or trigger point therapies, were commonly received across initial providers, but especially among patients with PT/OT initial providers. An orthopedist initial provider was strongly associated with both therapeutic injection and major surgery within 180-days (6.8% and 3.4%, respectively), compared with patients first seen by chiropractors (0.4% and 0.1%, respectively) or PCPs (1.8% and 0.9%, respectively). For plain radiography, cervical spine CT, MRI, therapeutic injection, and major surgery within 180 days, associations observed in bivariate analyses were robust to multivariate adjustment (Table 5 and Supplemental File, Supplemental Digital Content 1, <http://links.lww.com/BRS/C178>).

DISCUSSION

This descriptive study of a large cohort of patients with new-onset neck pain yields novel insights regarding the pattern and intensity of subsequent diagnostic and therapeutic interventions after initial encounters with different provider types. In this national sample of commercial and MA patients with uniform benefits allowing self-referral to provider specialty of choice, chiropractors were the initial providers for a plurality of patients with new onset neck pain (45.2%). Compared to patients with PCP or specialist physician initial providers, patients with chiropractor initial providers had substantially lower rates of imaging and invasive therapeutic interventions, including injections and surgery, during a 180-day follow-up period.

Our study adds to a sparse literature on the initial and downstream utilization patterns of patients with new-onset neck pain. In a recent analysis of U.S. insured patients with new-onset neck pain, early conservative treatment with either chiropractic care or physical therapy was associated with lower rates of spinal injections and lower total costs during a one-year follow-up.¹³ Within a Utah health system from 2012-2013, neck pain patients who sought initial care from chiropractors had significantly lower rates of advanced imaging and spinal injections than patients who sought initial care from PCPs or specialists.¹⁰ We similarly found that rates of both plain radiography and advanced imaging were substantially lower in patients whose initial provider was a chiropractor as compared to a PCP. As starting with a chiropractor was also associated with lower rates of invasive therapeutic interventions and surgery, our study suggests initial care for new-onset neck pain by chiropractors is likely associated lower longer-term care intensity and costs.

Except for patients who initially saw emergency physicians, most patients with new-onset neck pain received follow-up care from the same provider type as their initial provider. Less than 6% of patients whose initial neck pain visit was with a chiropractor subsequently saw any type of physician for neck pain, and fewer than 6% of patients whose initial neck pain visit was with any type of physician subsequently saw a chiropractor for neck pain. Referrals to PT/OTs occurred with moderate frequency after initial visits with both primary care (12.0%) and specialty physicians (7.2% to 23.3%), and rarely after initial visits with a chiropractor (1.8%). Our findings raise the question whether more frequent referrals from physicians to chiropractors or PT/OTs might enhance the efficiency of care for patients with new onset neck pain.

We observed wide variation across initial provider types in the use of imaging and the types of imaging studies obtained. Patients initially seen by emergency physicians received CTs at much

higher frequency, likely due to the ready availability of CT in emergency settings. Patients initially seen by orthopedic surgeons and neurologists meanwhile received MRI at higher rates. Patients initially seen by chiropractors or physical/occupational therapists, in contrast, received fewer and lower-intensity imaging studies, perhaps because these providers prioritize physical diagnosis and immediate therapeutic intervention. In addition, in most U.S. settings, PT/OTs cannot independently order imaging tests.

Our findings related to therapeutic interventions also suggest that providers in different specialties perceive themselves to have distinct therapeutic roles and, hence, may offer patients a limited range of therapeutic options with widely varying intensity and costs. Even after extensive adjustment for sociodemographic and clinical characteristics, patients who started with an orthopedic surgeon, for example, had substantially higher rates of therapeutic injection and major surgery within 180-days of follow-up than patients who started with a chiropractor. Patients who started with an orthopedist also commonly received physical and manual therapies but rarely chiropractic therapy. While provider factors may drive care selection and intensity, we also recognize that patients may select an entry provider based on the type of intervention that they would prefer or provider availability.¹⁴

Our results may have implications the design of health benefits or systems. While many payors and health systems allow patient self-referral to chiropractors and physical therapists, patients are also often able to self-refer to specialist physicians. For patients with new-onset neck pain, self-referral to specialist physicians may be comparatively inefficient as higher care intensity may not improve the prognosis of acute musculoskeletal pain conditions.⁵ Health systems may seek means of incentivizing initial care for musculoskeletal neck pain with chiropractors or physical/occupational therapists, while implementing protocols or criteria for referral to

physician specialists. Health systems may also seek means of engendering more frequent referrals from primary care or specialist physicians to chiropractors for patients with new-onset neck pain. Health system interventions to facilitate initial neck pain care by chiropractors or physical/occupational therapists warrant careful evaluation to assess impacts on patient outcomes, utilization, and access to care.

Our study has several limitations. First, our sample derived from a national claims database representing commercially insured and MA enrollees. Our results may not generalize to Medicaid, uninsured, or other populations. Second, our analysis focuses on the impact of the initial provider on subsequent care utilization, although we acknowledge that patients may select initial providers based on underlying disease severity or patient preferences may be associated with subsequent care intensity. Third, although unadjusted results for imaging, therapeutic injection, and major surgery were robust to multivariate adjustment, unmeasured patient characteristics may still confound adjusted associations between initial provider and diagnostic and therapeutic outcomes. On the other hand, some multivariate analyses may be overadjusted by including diagnoses that may be found at imaging (e.g., cervical radiculopathy) or events along the causal pathway between the initial visit and the outcome (e.g., recurrent neck pain visits). Fourth, our data derive from claims and lack information to judge the appropriateness of services delivered or to compare patient-level pain or functional outcomes. Fifth, although all patients had no neck pain diagnoses during a baseline year, some may have had had prior neck pain episodes prior to the baseline year without neck pain diagnoses.

In conclusion, within a large, national cohort of patients with new-onset neck pain, we found that chiropractors were the initial provider for a plurality of patients and that patients with chiropractor or PT/OT initial providers received fewer and less costly imaging services and were

less likely to receive invasive therapeutic interventions such as injection or major surgery during follow-up.

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REFERENCES

1. Vos T, Flaxman AD, Naghavi M, et al. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012;380(9859):2163-2196. doi:10.1016/S0140-6736(12)61729-2
2. Cohen SP, Hooten WM. Advances in the diagnosis and management of neck pain. *BMJ*. 2017;358:j3221. doi:10.1136/bmj.j3221
3. Haldeman S, Carroll L, Cassidy JD. Findings from the bone and joint decade 2000 to 2010 task force on neck pain and its associated disorders. *J Occup Environ Med*. 2010;52(4):424-427. doi:10.1097/JOM.0b013e3181d44f3b
4. Hoy DG, Protani M, De R, Buchbinder R. The epidemiology of neck pain. *Best Pract Res Clin Rheumatol*. 2010;24(6):783-792. doi:10.1016/j.berh.2011.01.019
5. Carey TS, Garrett J, Jackman A, McLaughlin C, Fryer J, Smucker DR. The outcomes and costs of care for acute low back pain among patients seen by primary care practitioners, chiropractors, and orthopedic surgeons. The North Carolina Back Pain Project. *N Engl J Med*. 1995;333(14):913-917. doi:10.1056/NEJM199510053331406
6. Frogner BK, Harwood K, Andrilla CHA, Schwartz M, Pines JM. Physical Therapy as the First Point of Care to Treat Low Back Pain: An Instrumental Variables Approach to Estimate Impact on Opioid Prescription, Health Care Utilization, and Costs. *Health Services Research*. 2018;53(6):4629-4646. doi:10.1111/1475-6773.12984
7. Fritz JM, Kim J, Dorius J. Importance of the type of provider seen to begin health care for a new episode low back pain: associations with future utilization and costs. *J Eval Clin Pract*. 2016;22(2):247-252. doi:10.1111/jep.12464
8. Kazis LE, Ameli O, Rothendler J, et al. Observational retrospective study of the association of initial healthcare provider for new-onset low back pain with early and long-term opioid use. *BMJ Open*. 2019;9(9):e028633. doi:10.1136/bmjopen-2018-028633
9. Weeks WB, Leininger B, Whedon JM, et al. The Association Between Use of Chiropractic Care and Costs of Care Among Older Medicare Patients With Chronic Low Back Pain and Multiple Comorbidities. *Journal of Manipulative & Physiological Therapeutics*. 2016;39(2):63-75.e2. doi:10.1016/j.jmpt.2016.01.006
10. Horn ME, George SZ, Fritz JM. Influence of Initial Provider on Health Care Utilization in Patients Seeking Care for Neck Pain. 2017;1(3):226-233. doi:10.1016/j.mayocpiqo.2017.09.001
11. *OptumLabs and OptumLabs Data Warehouse (OLDW) Descriptions and Citation*. Eden Prairie, MN: N.p., July 2020. PDF. Reproduced with Permission from OptumLabs. OptumLabs; 2022.

12. U.S. Department of Agriculture: Economic Research Service. Documentation: 2010 Rural-Urban Commuting Area (RUCA) Codes. Published online 2016. Accessed April 30, 2019. <https://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes/documentation/>
13. Moore BJ, White S, Washington R, Coenen N, Elixhauser A. Identifying Increased Risk of Readmission and In-hospital Mortality Using Hospital Administrative Data: The AHRQ Elixhauser Comorbidity Index. *Medical care*. 2017;55(7):698-705. doi:10.1097/mlr.0000000000000735
14. Jin MC, Jensen M, Zhou Z, et al. Health Care Resource Utilization in Management of Opioid-Naive Patients With Newly Diagnosed Neck Pain. *JAMA Network Open*. 2022;5(7):e2222062. doi:10.1001/jamanetworkopen.2022.22062
15. Davis MA, Mackenzie TA, Coulter ID, Whedon JM, Weeks WB. The United States Chiropractic Workforce: An alternative or complement to primary care? *Chiropr Man Therap*. 2012;20:35. doi:10.1186/2045-709X-20-35

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Figure 1. Flow diagram of cohort identification based on inclusion and exclusion criteria

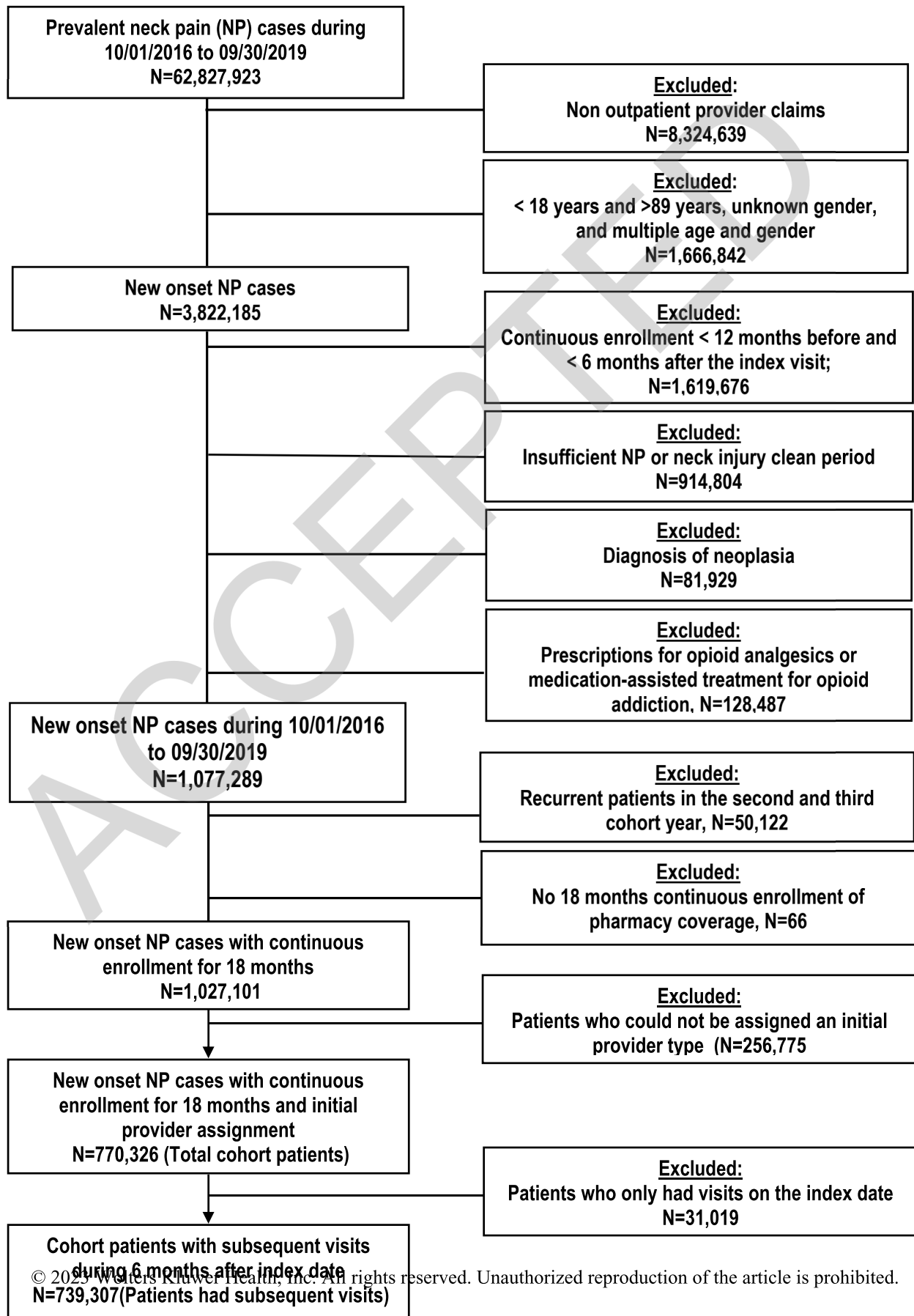


Table 1. Characteristics of patients with new-onset neck pain by initial provider type

Characteristic	Total	Chiropractor	Primary Care	Emergency Medicine	Orthopedic Surgeon	Physical / Occupational Therapist	Neurologist	Rehabilitation Medicine
N (%)	770,326 (100.0)	348,042 (45.2)	256,957 (33.4)	62,072 (8.1)	34,327 (4.5)	24,465 (3.2)	24,297 (3.2)	20,166 (2.6)
Age, y, mean (SD)	51.6 (17.6)	46.5 (16.5)	55.8 (17.2)	53.5 (19.9)	57.8 (15.5)	55.3 (17.7)	57.6 (16.7)	54.7 (16.6)
Female sex (n, column %)	451,685 (58.6)	196,678 (56.5)	153,381 (59.7)	38,021 (61.2)	19,610 (57.1)	16,308 (66.7)	15,695 (64.6)	11,992 (59.5)
Commercial insurance (vs. Medicare Advantage), (n, column %)¹	559,024 (72.5)	294,557 (84.6)	163,189 (63.5)	36,636 (59.0)	21,272 (62.0)	15,981 (65.3)	13,812 (56.9)	13,577 (67.3)
No. of Elixhauser conditions, mean (SD)	1.5 (1.9)	1.1 (1.5)	1.7 (1.9)	2.1 (2.4)	1.9 (2.0)	1.7 (2.0)	2.5 (2.4)	1.7 (1.9)
Rural Urban Commuting Area, RUCA (n, column %)								
Metropolitan	665,128 (86.3)	292,463 (84.0)	225,568 (87.8)	53,682 (86.5)	30,718 (89.5)	22,011 (90.0)	21,799 (89.7)	18,887 (93.7)

Micropolitan	55,018 (7.1)	27,764 (8.0)	16,893 (6.6)	4,954 (8.0)	2,098 (6.1)	1,256 (5.1)	1,387 (5.7)	666 (3.3)
Small town	29,562 (3.8)	15,782 (4.5)	9,051 (3.5)	2,253 (3.6)	840 (2.5)	643 (2.6)	658 (2.7)	335 (1.7)
Rural areas	18,031 (2.3)	10,752 (3.1)	4,840 (1.9)	1,023 (1.7)	488 (1.4)	410 (1.7)	340 (1.4)	178 (0.9)
Unknown/Multiarea	2,587 (0.3)	1,281 (0.3)	605 (0.2)	160 (0.2)	183 (0.5)	145 (0.6)	113 (0.4)	100 (0.4)
Any visits with complicating diagnoses at the index date (n, column %)								
Headache	34,876 (4.5)	13,636 (3.9)	10,167 (4.0)	2,293 (3.7)	101 (0.3)	670 (2.7) ²	7,514 (30.9)	499 (2.5)
Low Back Pain	381,437 (49.5)	300,686 (86.4)	42,322 (16.5)	13,696 (22.1)	7,234 (21.1)	6,290 (25.7) ²	3,807 (15.7)	7,402 (36.7)
Acute Non-Cervical Trauma	1,484 (0.2)	686 (0.2)	242 (0.1)	459 (0.7)	55 (0.2)	**	11 (0.1)	29 (0.1)
Any visits with complicating diagnoses during one year before index date (n, column %)								
Headache	44,561 (5.8)	16,335 (4.7)	14,243 (5.5)	3,438 (5.5)	1,684 (4.9)	2,223 (9.1)	5,389 (22.2)	1,249 (6.2)
Low Back Pain	166,871 (21.7)	79,405 (22.8)	48,751 (19.0)	11,234 (18.1)	8,587 (25.0)	6,773 (27.7)	6,013 (24.8)	6,108 (30.3)
Acute Non-Cervical Trauma	1,695 (0.2)	594 (0.2)	554 (0.2)	192 (0.3)	135 (0.4)	83 (0.3)	78 (0.3)	59 (0.3)

¹<0.1% of patients (n=193 of total) had both commercial and Medicare Advantage insurance on cohort entry.

²Due to fewer than 11 patients with acute non-cervical trauma, numbers rounded to preserve de-identification.

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Table 2. Frequency of Subsequent Neck Pain Visits during the 180-day Follow-Up by Initial Provider and Subsequent Provider Type (N=770,326)

Provider Type for Subsequent Neck Pain Visits During 180 days of follow-up	Initial Provider for Index Neck Pain Visit (n, column %)						
	Chiropractor (N=348,042)	Primary Care (N=256,957)	Emergency Medicine (N=62,072)	Orthopedist (N=34,327)	Physical/Occupational Therapist (N=24,465)	Neurologist (N=24,297)	Rehabilitation Medicine (N=20,166)
Chiropractor	274,056 (78.7)	9,755 (3.8)	1,897 (3.1)	1,206 (3.5)	970 (4.0)	660 (2.7)	1,087 (5.4)
Primary Care	12,693 (3.6)	62,976 (24.5)	9,996 (16.1)	3,893 (11.3)	2,102 (8.6)	2,692 (11.1)	1,951 (9.7)
Emergency Medicine	1,283 (0.4)	3,036 (1.2)	2,475 (4.0)	310 (0.9)	168 (0.7)	215 (0.9)	153 (0.8)
Orthopedist	3,176 (0.9)	9,405 (3.7)	2,354 (3.8)	13,908 (40.5)	720 (2.9)	1,370 (4.0)	1,186 (5.9)
Physical/Occupational Therapist	6,194 (1.8)	30,730 (12.0)	4,495 (7.2)	8,005 (23.3)	20,925 (85.5)	2,866 (11.8)	4,196 (20.8)
Neurologist	1,626 (0.5)	5,443 (2.1)	1,315 (2.1)	1,370 (4.0)	401 (1.6)	9,819 (40.4)	498 (2.5)
Rehabilitation Medicine	3,060 (0.9)	7,267 (2.8)	1,330 (2.1)	2,620 (7.6)	646 (2.6)	597 (2.5)	9,678 (48.0)
Different Provider Type from Initial Neck Pain Visit*	19,281 (5.5)	74,832 (29.1)	36,808 (59.2)	11,184 (32.5)	2,642 (10.8)	8,275 (34.1)	6,325 (31.4)

*Number (%) of patients who saw a different provider type for subsequent neck pain visits than for the initial neck pain visit. The total is less than the sum of subsequent visits across different provider types because some patients may have seen multiple different provider types for subsequent neck pain visits.

Table 3. Diagnostic imaging utilization within 180 days of index neck pain visit by initial provider

Imaging modality by follow-up interval	Initial Provider Type							
	Total (N=770,326)	Chiropractor (N=348,042)	Primary Care (N=256,957)	Emergency Medicine (N=62,072)	Orthopedist (N=34,327)	Physical / Occupational Therapist (N=24,465)	Neurologist (N=24,297)	Rehabilitation Medicine (N=20,166)
Plain Radiography (n, column %)								
30 days	170,713 (22.2)	55,237 (15.9)	68,105 (26.5)	14,802 (23.9)	23,015 (67.1)	783 (3.2)	1,420 (5.8)	7,351 (36.5)
90 days	182,874 (23.7)	58,554 (16.8)	73,913 (28.8)	15,684 (25.3)	23,590 (68.7)	1,386 (5.7)	2,013 (8.3)	7,734 (38.4)
180 days	192,000 (24.9)	61,582 (17.7)	77,780 (30.3)	16,363 (26.4)	23,907 (69.6)	1,894 (7.7)	2,450 (10.1)	8,024 (39.8)
CT of cervical spine (n, column %)								
30 days	31,539 (4.1)	451 (0.1)	5,504 (2.1)	24,520 (39.5)	448 (1.3)	62 (0.3)	383 (1.6)	171 (0.9)
90 days	34,494 (4.5)	1,017 (0.3)	6,894 (2.7)	24,774 (39.9)	763 (2.2)	153 (0.6)	585 (2.4)	308 (1.5)
180 days	37,739 (4.9)	1,788 (0.5)	8,360 (3.3)	25,054 (40.4)	1,049 (3.1)	266 (1.1)	815 (3.4)	407 (2.0)
CT of neck soft tissue (n, column %)								
30 days	2,919 (0.4)	128 (0.0)	1,491 (0.6)	1,196 (1.9)	31 (0.1)	19 (0.1)	37 (0.2)	17 (0.1)
90 days	3,991 (0.5)	374 (0.1)	2,039 (0.8)	1,302 (2.1)	91 (0.3)	51 (0.2)	94 (0.4)	40 (0.2)
180 days	5,166 (0.7)	717 (0.2)	2,562 (1.0)	1,423 (2.3)	158 (0.5)	90 (0.4)	143 (0.6)	73 (0.4)

MRI of cervical spine (n, column %)								
30 days	40,548 (5.3)	2,366 (0.7)	17,350 (6.8)	3,199 (5.2)	8,178 (23.8)	456 (1.9)	5,726 (23.6)	3,273 (16.2)
90 days	55,490 (7.2)	4,813 (1.4)	24,123 (9.4)	4,376 (7.1)	10,135 (29.5)	1,074 (4.4)	6,834 (28.1)	4,135 (20.5)
180 days	64,105 (8.3)	6,807 (2.0)	28,088 (10.9)	4,985 (8.0)	10,858 (31.6)	1,514 (6.2)	7,319 (30.1)	4,534 (22.5)
MRI of neck soft tissue (n, column %)								
30 days	1,071 (0.1)	128 (0.0)	339 (0.1)	288 (0.5)	18 (0.1)	25 (0.1)	257 (1.1)	16 (0.1)
90 days	1,635 (0.2)	251 (0.1)	562 (0.2)	348 (0.6)	44 (0.1)	51 (0.2)	346 (1.4)	33 (0.2)
180 days	2,290 (0.3)	433 (0.1)	812 (0.3)	423 (0.7)	78 (0.2)	77 (0.3)	408 (1.7)	59 (0.3)

Abbreviations: CT=computed tomography, MRI=magnetic resonance imaging

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Table 4. Therapeutic interventions received within 180-days of index neck pain visits by initial provider

Therapeutic intervention by follow-up interval	Initial Provider Type							
	Total (N=770,326)	Chiropractor (N=348,042)	Primary Care (N=256,957)	Emergency Medicine (N=62,072)	Orthopedist (N=34,327)	Physical / Occupational Therapist (N=24,465)	Neurologist (N=24,297)	Rehabilitation Medicine (N=20,166)
Chiropractic manipulative therapy (n, column %)								
30 days	350,691 (45.5)	334,397 (96.1)	11,456 (4.5)	1,339 (2.2)	743 (2.2)	885 (3.6)	376 (1.6)	1,495 (7.4)
90 days	357,022 (46.4)	335,600 (96.4)	14,578 (5.7)	1,909 (3.1)	1,219 (3.6)	1,271 (5.2)	663 (2.7)	1,782 (8.8)
180 days	362,881 (47.1)	336,327 (96.6)	17,598 (6.9)	2,493 (4.0)	1,680 (4.9)	1,723 (7.0)	966 (4.0)	2,094 (10.4)
Physical therapy (n, column %)								
30 days	69,881 (9.1)	6,257 (1.8)	24,062 (9.4)	4,214 (6.8)	8,386 (24.4)	19,914 (81.4)	2,166 (8.9)	4,882 (24.2)
90 days	100,386 (13.0)	15,264 (4.4)	36,424 (14.2)	7,133 (11.5)	11,304 (32.9)	20,130 (82.3)	3,864 (15.9)	6,267 (31.1)
180 days	126,862 (16.5)	25,691 (7.4)	45,859 (17.9)	9,212 (14.8)	13,139 (38.3)	20,461 (83.6)	5,259 (21.6)	7,241 (35.9)
Manual therapy (n, column %)								
30 days	131,938 (17.1)	66,589 (19.1)	26,084 (10.2)	3,137 (5.1)	7,770 (22.6)	19,947 (81.5)	2,029 (8.4)	6,382 (31.7)
90 days	160,017 (20.8)	75,712 (21.8)	37,099 (14.4)	5,509 (8.9)	10,321 (30.1)	20,294 (83.0)	3,392 (14.0)	7,690 (38.1)
180 days	180,954 (23.5)	84,400 (24.3)	44,513 (17.3)	6,917 (11.1)	11,778 (34.3)	20,492 (83.8)	4,396 (18.1)	8,458 (41.9)

Osteopathic manipulative therapy (n, column %)								
30 days	9,603 (1.3)	1,116 (0.3)	7,263 (2.8)	112 (0.2)	71 (0.2)	32 (0.1)	406 (1.7)	603 (3.0)
90 days	10,298 (1.3)	1,349 (0.4)	7,565 (2.9)	155 (0.3)	88 (0.3)	69 (0.3)	430 (1.8)	642 (3.2)
180 days	10,929 (1.4)	1,608 (0.5)	7,798 (3.0)	196 (0.3)	107 (0.3)	97 (0.4)	453 (1.9)	670 (3.3)
Occupational therapy (n, column %)								
30 days	2,821 (0.4)	377 (0.1)	813 (0.3)	704 (1.1)	221 (0.6)	358 (1.5)	197 (0.8)	151 (0.8)
90 days	5,976 (0.8)	1,138 (0.3)	1,885 (0.7)	1,159 (1.9)	551 (1.6)	469 (1.9)	466 (1.9)	308 (1.5)
180 days	9,937 (1.3)	2,292 (0.7)	3,234 (1.3)	1,655 (2.7)	870 (2.5)	632 (2.6)	743 (3.1)	511 (2.5)
Acupuncture (n, column %)								
30 days	7,330 (1.0)	3,911 (1.1)	1,486 (0.6)	66 (0.1)	77 (0.2)	268 (1.1)	125 (0.5)	1,397 (6.9)
90 days	9,241 (1.2)	4,949 (1.4)	1,989 (0.8)	118 (0.2)	127 (0.4)	369 (1.5)	187 (0.8)	1,502 (7.5)
180 days	11,047 (1.4)	5,939 (1.7)	2,458 (1.0)	171 (0.3)	183 (0.5)	446 (1.8)	249 (1.0)	1,601 (7.9)
Therapeutic injection (n, column %)								
180 days	11,263 (1.5)	1,363 (0.4)	4,699 (1.8)	739 (1.2)	2,328 (6.8)	303 (1.2)	464 (1.9)	1,367 (6.8)
Major surgery (n, column %)								
180 days	5,353 (0.7)	306 (0.1)	2,229 (0.9)	565 (0.9)	1,155 (3.4)	577 (2.4)	412 (1.7)	109 (0.5)

Table 5. Adjusted associations between initial provider type and diagnostic or therapeutic interventions received within 180-days of index neck pain visit (N=770,326 patients)

Diagnostic or Therapeutic Intervention (within 180 days of index neck pain visit)	Initial Provider Type						
	Chiropractor	Primary Care	Emergency Medicine	Orthopedist	Physical/Occupational Therapist	Neurologist	Rehabilitation Medicine
Plain Radiography							
Adjusted OR (95% CI) ¹	1.0 (ref)	1.9 (1.9-1.9)	1.6 (1.6-1.6)	9.1 (8.9-9.4)	0.4 (0.4-0.4)	0.4 (0.4-0.5)	2.7 (2.7-2.8)
Adjusted Risk, % (95% CI) ¹	18.1 (18.0-18.1)	29.4 (29.2-29.5)	26.0 (25.8-26.1)	66.8 (66.5-67.1)	7.5 (7.3-7.7)	8.9 (8.7-9.0)	37.7 (37.3-38.0)
CT of Cervical Spine							
Adjusted OR (95% CI) ¹	1.0 (ref)	6.4 (6.1-6.8)	131.9 (124.9-139.2)	5.8 (5.4-6.3)	2.0 (1.7-2.3)	5.4 (5.0-5.9)	3.9 (3.5-4.3)
Adjusted Risk, % (95% CI) ¹	0.5 (0.5-0.5)	3.0 (3.0-3.0)	38.8 (38.5-39.0)	2.7 (2.6-2.8)	0.9 (0.9-1.0)	2.5 (2.4-2.6)	1.8 (1.7-1.9)
MRI of Cervical Spine							

Adjusted OR (95% CI) ¹	1.0 (ref)	5.5 (5.3-5.6)	4.4 (4.3-4.6)	15.4 (14.9-16.0)	2.8 (2.6-3.0)	14.9 (14.3-15.6)	10.3 (9.9-10.8)
Adjusted Risk, % (95% CI) ¹	1.9 (1.8-1.9)	9.4 (9.4-9.5)	7.8 (7.7-7.9)	22.8 (22.5-23.0)	5.1 (4.9-5.2)	22.2 (21.9-22.5)	16.5 (16.2-16.7)
Therapeutic Injection							
Adjusted OR (95% CI) ²	1.0 (ref)	6.1 (5.6-6.5)	5.5 (5.0-6.1)	13.3 (12.3-14.4)	2.1 (1.9-2.4)	3.8 (3.4-4.3)	15.0 (13.8-16.3)
Adjusted risk, % (95% CI) ²	0.1 (0.1-0.1)	0.6 (0.6-0.7)	0.6 (0.6-0.6)	1.4 (1.3-1.4)	0.2 (0.2-0.2)	0.4 (0.4-0.4)	1.6 (1.5-1.6)
Major Surgery							
Adjusted OR (95% CI) ³	1.0 (ref)	6.7 (6.0-7.5)	10.0 (8.8-11.4)	13.1 (11.7-14.8)	2.0 (1.6-2.4)	8.3 (7.2-9.6)	6.4 (5.5-7.5)
Adjusted Risk, % (95% CI) ³	0.02 (0.02-0.02)	0.12 (0.11-0.13)	0.18 (0.16-0.20)	0.24 (0.21-0.26)	0.04 (0.03-0.04)	0.15 (0.13-0.17)	0.12 (0.10-0.13)

Abbreviations: OR=Odds ratio, Ref=reference

¹ Adjusted for age, age², sex, commercial vs. Medical Advantage insurance, rural residence, small town residence, any visits with complications at index date (i.e., cervical radiculopathy, cervical myelopathy, headache, and low back pain), any visits with complications during one year before index date (i.e., headache, low back pain, and acute non-cervical trauma), number of visits with a provider in each specialty (i.e., primary care, emergency medicine, neurologist, orthopedist, rehabilitation medicine, chiropractor, physical or occupational therapist) during one year before index date, and indicators comorbidities in the Elixhauser index.

² Model adjusted for all factors above in addition to any recurrent neck pain visits within 6 months after index date.

³ Model adjusted for all factors above in addition to cervical dislocation injury or cervical fracture diagnoses at index date.