



VARIATIONS IN PATTERNS OF UTILIZATION AND CHARGES FOR THE CARE OF HEADACHE IN NORTH CAROLINA, 2000-2009: A STATEWIDE CLAIMS' DATA ANALYSIS

Eric L. Hurwitz, DC, PhD,^a Maria Vassilaki, MD, MPH, PhD,^b Dongmei Li, PhD,^c Michael J. Schneider, DC, PhD,^d Joel M. Stevans, DC,^e Reed B. Phillips, DC, PhD,^f Shawn P. Phelan, DC,^g Eugene A. Lewis, DC, MPH,^h and Richard C. Armstrong, MS, DCⁱ

ABSTRACT

Objectives: The purpose of the study was to compare patterns of utilization and charges generated by medical doctors (MDs), doctors of chiropractic (DCs), and physical therapists (PTs) for the treatment of headache in North Carolina.

Methods: Retrospective analysis of claims data from the North Carolina State Health Plan for Teachers and State Employees from 2000 to 2009. Data were extracted from Blue Cross Blue Shield of North Carolina for the North Carolina State Health Plan using *International Classification of Diseases, Ninth Revision*, diagnostic codes for headache. The claims were separated by individual provider type, combination of provider types, and referral patterns.

Results: The majority of patients and claims were in the MD-only or MD plus referral patterns. Chiropractic patterns represented less than 10% of patients. Care patterns with single-provider types and no referrals incurred the least charges on average for headache. When care did not include referral providers or services, MD with DC care was generally less expensive than MD care with PT. However, when combined with referral care, MD care with PT was generally less expensive. Compared with MD-only care, risk-adjusted charges (available 2006-2009) for patients in the middle risk quintile were significantly less for DC-only care.

Conclusions: Utilization and expenditures for headache treatment increased from 2000 to 2009 across all provider groups. MD care represented the majority of total allowed charges in this study. MD care and DC care, alone or in combination, were overall the least expensive patterns of headache care. Risk-adjusted charges were significantly less for DC-only care. (*J Manipulative Physiol Ther* 2016;39:229-239)

Key Indexing Terms: *Headache; Chiropractic; Medical Care; Health Services; Utilization; Healthcare Costs*

Headache is one of the most common complaints that cause patients to seek medical care.¹ Almost every adult will experience headache in their lifetime, making it the most prevalent neurological symptom, with up to 47% of the global adult population experiencing an active headache.² It is also one of the most common complaints

in emergency care,³ with the World Health Organization ranking it among the 10 most disabling conditions for men and among the 5 most disabling conditions for women.¹ Migraine's health-related impact, for example, has been compared with that experienced by patients with congestive heart failure, hypertension, or diabetes.⁴

^a Professor, Office of Public Health Studies, University of Hawai'i at Mānoa, Honolulu, HI.

^b Research Associate, Division of Epidemiology, Department of Health Sciences Research, Mayo Clinic, Rochester, MN.

^c Associate Professor, Clinical and Translational Science Institute, University of Rochester School of Medicine and Dentistry, Rochester, NY.

^d Associate Professor, School of Health and Rehabilitation Sciences, University of Pittsburgh, Pittsburgh, PA.

^e Assistant Professor, School of Health and Rehabilitation Sciences, University of Pittsburgh, Pittsburgh, PA.

^f Doctor of Chiropractic, Retired, Pocatello, ID.

^g Doctor of Chiropractic, Private Practice of Chiropractic, Wake Forest, NC.

^h Doctor of Chiropractic, Private Practice of Chiropractic, Greensboro, NC.

ⁱ Doctor of Chiropractic, Private Practice of Chiropractic, Cary, NC.

Submit requests for reprints to: Eric L. Hurwitz, DC, PhD, Professor, Office of Public Health Studies, Department of Public Health Sciences, University of Hawai'i, Mānoa, 1960 East-West Rd, Biomedical Sciences D201, Honolulu, HI 96822. (e-mail: ehurwitz@hawaii.edu).

Paper submitted January 23, 2015; in revised form November 1, 2015; accepted January 1, 2016.

0161-4754

Copyright © 2016 by National University of Health Sciences. <http://dx.doi.org/10.1016/j.jmpt.2016.02.008>

Despite its high prevalence and considerable health-related impact, headache disorders remain underrecognized and undertreated.² In most cases, headache is a benign disorder. However, it can cause significant suffering and disability to patients and their families, leading to decreased quality of life similar to other chronic conditions.² Headache also leads to higher healthcare utilization⁵ and substantial direct and indirect (eg, work absenteeism or reduced efficiency) costs.²

Hu et al⁶ reported that the 1994 annual direct medical costs in the United States were about \$1 billion among migraine sufferers, in addition to \$13 billion in estimated indirect costs to employers. This estimate was considered conservative, as over-the-counter and preventive medications, as well as non-drug-related interventions, were not evaluated.⁴ A more recent report has been published using the 2004 data from the Thomson-Medstat Commercial Claims and Encounters database. This report estimated the medical claims' direct cost burden of migraine as being substantially higher, with a national migraine burden of \$11 billion for those who sought medical treatment. This \$11 billion total cost was divided into these subgroups: \$4.6 billion was attributed to prescription drugs, \$5.2 billion to outpatient costs, \$0.52 billion to emergency room care, and \$0.73 billion to inpatient costs.⁷ They also reported that the average total costs for pharmacy and medical care were \$7007 yearly for a patient with migraine compared with \$4436 for those without migraine.⁷

Researchers from Beth Israel Deaconess Medical Center in Boston identified 9362 visits for headache using data from the National Ambulatory Medical Care Survey and the National Hospital Ambulatory Medical Care Survey. These data represent an estimated 144 million visits from 1999 through 2010. The researchers found substantial increases in the use of low-value, high-cost services.⁸ Figures for the United Kingdom indicated £956 million (equivalent to \$1.60 billion US) due to service costs, probably an underestimation because many patients do not contact their general practitioner for headache.⁹ In the European Union, the total annual cost for headache in adults (18-65 years) has been estimated at €173 billion by the Eurolight project.¹⁰

Given this considerable public health burden, there is a need for detailed study of the economic consequences of all varieties of headache¹¹ and the types of services used, including medical care, chiropractic care, and physical therapy. Although migraine-related costs have been examined more extensively, data on nonmigrainous headaches suggest that costs for this condition also have significant economic consequences.¹²

Headache patients are often seen by medical doctors (MDs), doctors of chiropractic (DCs), physical therapists (PTs), and other medical specialists to whom they are referred. Among headache patients seeking alternative and complementary therapies, chiropractic care is one of the most often selected.^{13,14} In North Carolina, PTs must treat

under the direction of either an MD or a DC; therefore, the MD and/or DC act as the portal of entry provider.¹⁵ Currently, the portal of entry provider combinations (patterns) involved in care (utilization) and the role of specialist referrals as cost drivers are unclear in the literature. There is an increased health insurance industry interest in containing costs by encouraging patients with musculoskeletal pain to pursue care through the primary care "medical home" portal. This raises an important question: Does reducing patient self-selection of providers reduce the cost of care for these conditions, or does it increase cost?

The aim of this study was to assess the utilization and cost of care patterns for headache among patients in the North Carolina State Health Plan (NCSHP) for Teachers and State Employees from 2000 to 2009. We compared the cost of care of these patterns of care: patients who used MDs and DCs alone; MD and DC care in combination with each other; MD or DC care in combination with PT and/or with additional referred provider care.

METHODS

This study was a retrospective closed-claim analysis of the NCSHP. These data included claims generated annually by approximately 660 000 covered beneficiaries (state employees, dependents, and retirees) during the period 2000-2009. An extraction model developed with clinical healthcare analysts from the NCSHP was used to extract data from Blue Cross Blue Shield of North Carolina.

Cohort Identification and Stratification

A headache analytic cohort was constructed for the present analysis by identifying all professional and facility claims for a healthcare event with a primary headache diagnosis using the *International Classification of Diseases, Ninth Revision (ICD-9)*, diagnosis codes (Appendix). The *ICD-9* codes used to select the cohort were identified as the most common codes used across all 3 professions (medical, chiropractic, and physical therapy) and were not meant to represent all possible headache codes. It was not the intent of this study to include every possible *ICD-9* code used by each of the 3 provider types or their specialist referral destinations. It was instead to include the most common codes used by all of the provider types. The codes used by DCs, "Subluxation" *ICD-9* codes, were excluded for a number of reasons. Subluxation codes are rarely used by MD and PT offices when billing third-party payers. These codes are only required when billing traditional Medicare. In these circumstances, Medicare is the primary payer and NCSHP would be secondary. All claims in which NCSHP was the secondary payer were excluded from the analysis.

Secondary, tertiary, and quaternary codes were not used to identify headache patients because substantial utilization

unrelated to the treatment of headache came up in the initial extraction. This would have led to overestimation of headache charges in this study population. Therefore, we chose to use the primary diagnosis to identify cases and subsequent claims. According to *ICD-9* coding guidelines, the primary diagnosis listed on a claim form should reflect the principal reason for the patient's visit on that date of service. By only using the primary diagnosis to identify claims of interest, our analysis provides estimates that are more conservative by eliminating the scatter of cases where headache was only a secondary or tertiary complaint.

"Claim" Defined

Each claim was represented by a unique clinical service (not a visit) as defined by an individual allowed Current Procedural Terminology code. Medicare and non-North Carolina residents were excluded. Each reporting (fiscal) year, starting in July and ending in June, represented a benefit year.

Provider Categorization

The providers were categorized into 4 basic provider categories: (1) Doctor of Chiropractic (DC), (2) Medical/Osteopathic Doctor (MD), (3) Physical Therapist (PT), and (4) Referral providers. The MD category also included additional provider types: General Practice, Internal Medicine, Neurology, Neurosurgery, Obstetrics-Gynecology, Orthopedic Surgery, Osteopathy, Pediatrics, Physical Medicine, General Surgery, Family Practice, or Geriatric Medicine; Nurse Practitioner; Podiatry; Public Health; University/College Infirmary; Urgent Care; and VA/Military Hospital Professional Staff. Referral providers were hospitals, surgical centers, emergency medicine, and other specialty referral services and providers.

Of note is the inclusion of Podiatry in the MD category. This specialty finds inclusion because the current headache analysis is 1 in a series of 3 analyses using the NCSHP database to evaluate the patterns of care and costs for common conditions (ie, low back pain, neck pain, and headache). Podiatrists were included in the MD category because they may use a primary diagnosis of a lumbar radiculopathy when seeing a patient for foot pain or numbness and are therefore a possible portal of entry for low back patients. Podiatrists would be far less likely to treat neck pain or headache patients. However, they were included in all 3 analyses to maintain consistent methodology across the 3 studies.

In North Carolina, patients must be referred from an MD or a DC to receive PT care. This places the primary management decisions with the referring MD or DC, and the PTs work under the treatment direction of these providers. Therefore, the PT category does not stand alone in this analysis.

Provider Utilization Patterns

Although much interest has developed in the efficacy of the "medical home," where patients are encouraged to seek care

from their primary care doctors first, not all patients choose this path. Many patients choose to seek care (self-refer) directly from various specialist and nonspecialist healthcare professionals. Therefore, this model was intended to reflect how the system currently functions, and primary care "medical home" was not selected as a provider category.

Tracking of healthcare use and costs becomes very complicated once one begins to follow longitudinally patient treatment through different provider patterns. This is due to the utilization of multiple sets of tests and interventions (eg, advanced imaging, radiography, medication, surgery) delivered within heterogeneous settings (eg, office, in- and out-patient facilities). Consequently, patients were classified into care patterns based on their use of each of these provider types: MD-only, DC-only, MD-DC, MD-PT, MD-referral, DC-referral, MD-DC-referral, and MD-PT-referral.

Care Endpoint

Once *ICD-9* codes were selected and the patterns of care identified, the endpoint for care became the next question. Ideally, this would have been done within the parameters of an "episode." However, we chose not to do an "episodes of care" analysis because it would have required arbitrary definitions of (a) episode length, (b) time lapse between visits, and (c) time to recurrence (eg, reoccur in 1 week, 1 month, or 1 year), none of which have been validated in the literature. For this reason, we tracked the cost of care for headache using the primary *ICD-9* code through care according to the provider patterns described above, using a fiscal year as the endpoint for all diagnostic codes. Each fiscal year was analyzed separately so that the date range for any diagnosis within each analysis could be no longer than 1 year. For a diagnosis that spanned more than 1 fiscal year or that incurred charges over several months in different years, the diagnosis was included in both but would be reported in separate analyses reflecting those years.

Tracking of Costs

The aggregate costs attributed to the various patterns of care for patients with headache were as follows: If a patient presented with the primary diagnosis of "Migraine with aura, without mention of intractable migraine without mention of status migrainous" (346.00) in a primary care doctor's office, the cost of the care under that code would accumulate under the MD only pattern. This would include all diagnostic and treatment services prescribed, as long as the patient did not receive DC, PT, or referral care services. If that same patient sought care in a DC's office or PT, all costs would accumulate under the MD-DC or MD-PT pattern, respectively. This is how a primary *ICD-9* code would track utilization and costs through provider patterns.

Cost Reference Points

Reference points of average (mean and median) numbers of claims, charges per claim, and total allowed charges per

patient were used to analyze costs. The total allowed charges were calculated by summing the payments made by both the patient and insurer for a medical service. This dollar amount represents the total amount paid to the provider. Costs were not adjusted for inflation. It was not the purpose of this study to estimate absolute differences in costs over time from 2000 to 2009 but instead to compare within-year relative differences in costs between patterns of care.

For each fiscal year, pharmaceutical claims data were linked with medical claims data based on each patient's unique identity. The major claim types were professional office visit (eg, MD, DC); advanced imaging (magnetic resonance imaging, computerized tomography, or similar services); radiology (diagnostic radiography, arthrography, or similar services); physical therapy (provider specialty is physical therapy or a physical therapy facility with service types belonging to physical therapy); and surgical (services provided by neurosurgeon or orthopedic or general surgeon).

The University of Hawaii Human Studies Program approved this study as exempt from federal regulations pertaining to the protection of human research participants, as documented in the Code of Federal Regulations at 45CFR 46.101(b) (Exempt Category 4).

Statistics

Frequency distributions of claims and patients were generated for each pattern of care by year. The number of claims in each provider group for each care pattern was identified by cross-tabulation of care pattern and provider type. Within each of the service claim types, care pattern and provider type were cross-tabulated to identify the number of claims in each provider group for each care pattern. The total allowed and charges per claim for medical, pharmaceutical, and combined expenses were then summarized for each patient. We also calculated patient-based and claim-based means and medians of medical, pharmaceutical, and combined medical and pharmaceutical expenses associated with each care pattern.

Scores reflecting risk of expected healthcare cost and utilization relative to that of the overall population were available in years 2006-2009. Risk scores take into account patient-specific factors that may affect utilization and charges, including age, sex, primary diagnosis, comorbidities, and use of prescription drugs. Essentially, risk scores help define the difficulty in treatment level for a particular patient.

For patients in the middle quintile of risk, linear regression models were used to fit log₁₀-transformed total allowed charges per patient to examine pairwise differences across the 8 most relevant patterns of care, adjusting for risk score as a continuous variable in the models. Patterns that contained very little utilization were excluded. The log₁₀-based transformation was used because the transformed costs are closer to normal distributions than natural log-transformed cost data. Examining patients in the middle

quintile (40th-60th percentiles) removes those at lowest and highest risk and offers apples-to-apples between-pattern comparisons of the typical patient. Linear orthogonal contrasts (ratios) were used to compare differences in charges between DC- and MD-related care patterns. Residual diagnostics were conducted, and the normality assumptions of residuals were satisfied. The homoscedasticity assumption was also satisfied for the log-transformed cost data. *P* values, standard errors, and 95% confidence intervals were computed. SAS 9.2 (SAS Institute, Cary, NC)¹⁶ was used for data management and statistical analyses.

RESULTS

Utilization

There were no significant sociodemographic differences in patients by provider type. Consistent with the epidemiology of headache and headache-related care-seeking, approximately 80% of patients were female and on average about 40 years old.

Overall Utilization and Charges

There were 910 778 claims that met our inclusion criteria for headache. The number of patients with at least 1 claim for primary diagnosis of headache increased from 9587 in 2000 to 22 780 in 2009 (138% increase), and the total number of claims increased from 50 781 in 2000 to 118 992 in 2009 (134% increase). In addition, the total allowed yearly charges (ie, the sum of patient and payer financial responsibility) tripled from \$15 187 791 in 2000 to \$46 446 882 in 2009 (206% increase) (Fig 1).

Total headache-related charges in North Carolina almost tripled from 2000 through 2005 and then declined in 2006 and 2007 before rising again in 2008 and 2009. Over the decade, average total allowed charges for headache increased by 28%, and average total charges for all care patterns combined increased from \$1612 in 2000 to a decade high of \$2527 in 2005 (57% increase) before declining in the decade's latter years (Fig 2).

Pattern-Specific Utilization and Charges

This section reports the cost analysis of patterns of provider care or paths through which patients may have been provided care through the system. We also report the average (mean and median) number of claims, charges per claim, and overall allowed charges per patient for each of these patterns. This section concludes with a presentation of risk adjusted averages for the years 2006-2009.

The number of patients in care patterns with MDs, with or without referral to PT or other providers (but without DC care), increased from 6116 in 2000 to 16 006 in 2009 (162% increase). This is in contrast with the number of patients in care patterns with DCs, with or without MDs or

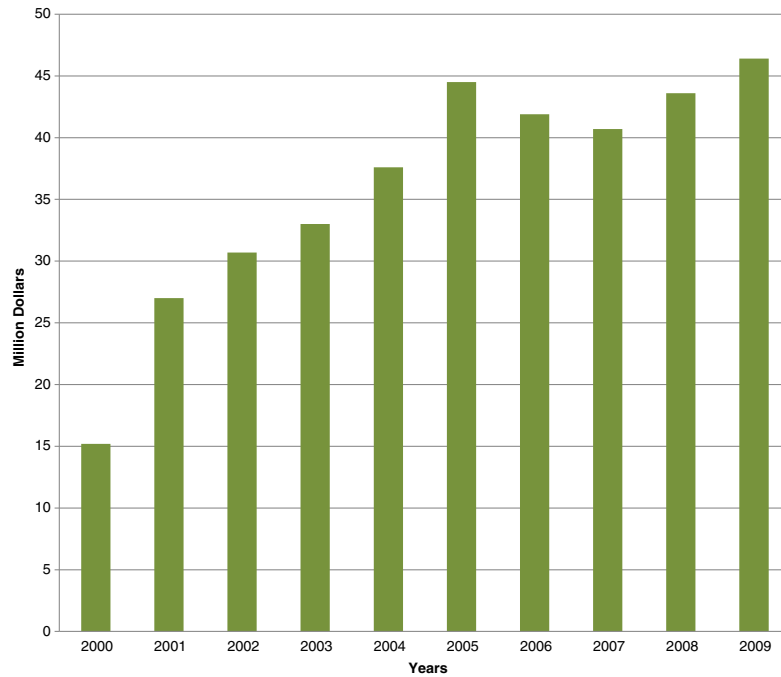


Fig 1. Sum of total allowed charges for all care patterns combined for headache, by year: North Carolina State Health Plan for Teachers and State Employees, 2000-2009.

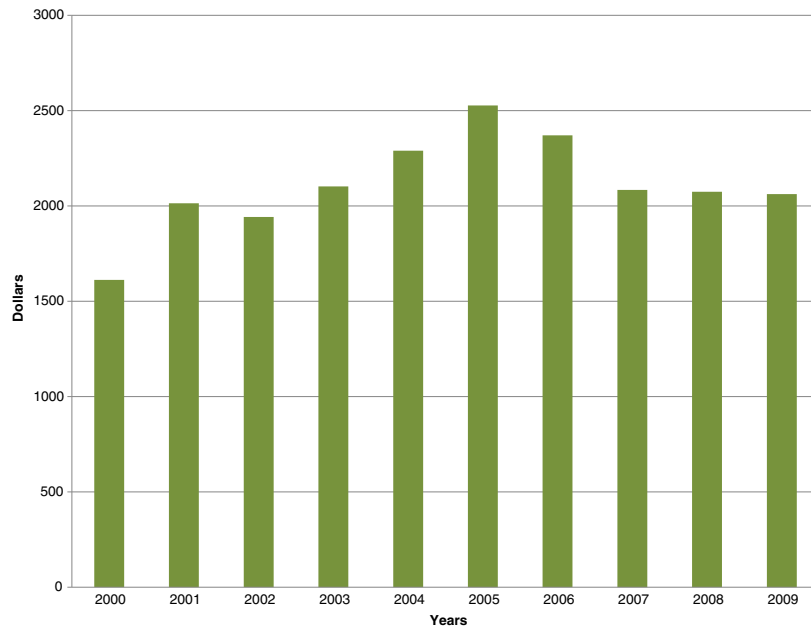


Fig 2. Per-patient mean total allowed charges for all care patterns combined for headache, by year: North Carolina State Health Plan for Teachers and State Employees, 2000-2009.

referral care (but without PT care), which only increased from 1092 in 2000 to 1393 in 2009 (28% increase). Medical claims increased from 30 481 in 2000 to 80 562 in 2009 (164% increase), whereas chiropractic claims only in-

creased from 11 163 in 2000 to 16 068 (44% increase). The numbers of patients in care patterns with PTs (with either MD or DC care) increased from 219 in 2000 to 673 in 2009 (207% increase).

Table 1. Number of Patients and Mean (Median) Total Allowed Charges per Patient for Headache, by Care Pattern and Year: North Carolina State Health Plan for Teachers and State Employees, 2000-2009

Year	Care Pattern							
	DC-only		MD-only		MD-DC		MD-PT	
	No.	Charges	No.	Charges	No.	Charges	No.	Charges
2000	292	1213 (230)	3558	850 (121)	304	1408 (158)	42	1724 (456)
2001	362	1813 (350)	4941	1077 (144)	449	1014 (184)	69	1974 (318)
2002	449	1599 (374)	5761	1201 (148)	499	2052 (166)	84	2096 (260)
2003	375	2026 (347)	5630	1189 (170)	521	1242 (202)	84	1216 (205)
2004	405	2364 (401)	5784	1222 (175)	506	1450 (222)	90	1707 (222)
2005	404	2603 (479)	6013	1238 (173)	529	1313 (186)	92	3199 (250)
2006	433	2074 (462)	6017	1271 (183)	559	1584 (216)	98	1510 (265)
2007	557	1921 (285)	7586	1012 (173)	433	1323 (187)	112	852 (197)
2008	453	1840 (275)	8334	1209 (182)	452	1531 (209)	141	1171 (252)
2009	462	1737 (284)	9126	1232 (180)	351	1522 (166)	143	1552 (235)

Year	DC-referral		MD-referral		MD-DC-referral		MD-PT-referral	
	No.	Charges	No.	Charges	No.	Charges	No.	Charges
2000	167	1766 (322)	2405	2606 (844)	329	2734 (771)	111	2539 (629)
2001	253	1863 (346)	3658	3159 (903)	493	4656 (874)	192	2628 (535)
2002	264	1591 (338)	4566	2884 (820)	562	2870 (731)	219	2886 (763)
2003	276	1709 (378)	4666	3132 (935)	525	3135 (796)	259	3937 (676)
2004	228	2222 (550)	4937	3420 (994)	566	3248 (865)	324	3000 (526)
2005	308	3128 (410)	5460	3699 (1050)	657	3512 (947)	335	3770 (854)
2006	281	2428 (445)	5491	3371 (942)	697	4093 (1116)	314	2883 (614)
2007	257	2491 (382)	5311	3343 (890)	438	3915 (933)	288	2880 (541)
2008	230	1979 (457)	5977	3199 (874)	461	3132 (927)	390	3037 (634)
2009	204	1876 (380)	6325	3108 (850)	376	4255 (790)	412	3158 (675)

DC, doctor of chiropractic; MD, medical doctor; PT, physical therapist

The majority of patients and claims were found in the MD-only or MD plus referral patterns, representing 70% of patients and 65% of claims in 2009. Chiropractic patterns represented less than 10% of patients and total allowed charges. Specialty referral services and providers, including emergency care and hospitalization, accounted for about 20% of all headache patients and total allowed charges. Pharmaceutical charges accounted for more than a third of total allowed charges for all care patterns combined.

Average numbers of claims per patient are generally higher for care patterns that included chiropractic compared with patterns involving medical care; however, charges per medical claim were much greater on average than charges per chiropractic claim. For all years, care patterns involving referral services in combination with MD or DC care resulted in appreciably greater average charges per patient than care patterns without referrals.

When looking at the average overall allowed charges per patient for care patterns with at least 50 patients, MD-only care, DC-only care, and MD-DC care were consistently the 3 least expensive patterns of care, with mean (median) total allowed charges in 2009 of \$1232 (\$180), \$1737 (\$284), and \$1522 (\$166), respectively. In all years 2000-2009, *without calculation of risk-adjusted averages*, patterns that included MDs alone incurred fewer charges than care patterns that included DCs alone. When care did not include referral providers or services, MD-DC care was generally less

expensive than MD-PT care. However, when care involved referral providers or services, MD-PT care was generally less expensive than medical care with chiropractic care (Table 1).

Total allowed charges of MD care with referrals were substantially larger on average than total allowed charges of DC care with referrals. In 2009, MD care with referrals resulted in an average of \$1737 greater total charges as compared with DC care with referrals. MD-DC care plus referrals was on average \$1127 more expensive than MD-PT care plus referrals in 2009 (MD-DC referrals added \$2733 to total charges, on average, compared with \$1606 for MD-PT referrals).

Risk-Adjusted Charges, 2006-2009

Risk scores take into account patient-specific factors that may affect utilization and charges, including age, sex, primary diagnosis, comorbidities, and use of prescription drugs. Essentially, risk scores help define the difficulty of treating a particular patient. Examining the subgroup of patients in the middle quintile of risk, that is, patients with risk scores within 40-60 percentiles, removes those at lowest and highest risk of high use and charges and provides opportunity for between-pattern comparisons of the more typical patient. These risk scores were available only for the years 2006-2009.

During this period, risk-adjusted mean charges were significantly greater for MD-only vs DC-only care and for

Table 2. Risk-Adjusted Mean (Standard Error) of Headache Total Allowed Charges and Cost Ratios With 95% Confidence Intervals Among Patients in the Middle Quintile of Risk, by Pattern of Care and Year: North Carolina State Health Plan for Teachers and State Employees, 2006-2009

Pattern of Care	Year			
	2006	2007	2008	2009
DC only	\$191.22 (\$43.62)	\$263.03 (\$41.69)	\$586.57 (\$84.26)	\$594.15 (\$61.34)
MD only	\$454.22 (\$25.90)	\$1246.20 (\$50.90)	\$1791.73 (\$58.08)	\$2097.38 (\$52.61)
Cost ratio	0.42 (0.27, 0.66)	0.21 (0.15, 0.29)	0.33 (0.25, 0.44)	0.28 (0.23, 0.35)
P	P = .0002	P < .0001	P < .0001	P < .0001
MD-DC	\$249.27 (\$87.36)	\$454.99 (\$122.08)	\$615.08 (\$138.61)	\$1807.57 (\$330.93)
MD-PT	\$903.14 (\$639.30)	\$705.09 (\$325.75)	\$1700.07 (\$575.05)	\$2013.43 (\$546.15)
Cost ratio	0.28 (0.08, 1.01)	0.65 (0.25, 1.68)	0.36 (0.17, 0.77)	0.90 (0.48, 1.67)
P	P = .0523	P = .3694	P = .0083	P = .7325
DC-referral	\$633.58 (\$286.85)	\$1299.20 (\$538.34)	\$1505.95 (\$633.26)	\$3770.40 (\$994.67)
MD-referral	\$550.54 (\$42.62)	\$987.08 (\$62.40)	\$1692.51 (\$84.94)	\$1956.04 (\$73.72)
Cost ratio	1.15 (0.51, 2.60)	1.32 (0.62, 2.79)	0.89 (0.42, 1.90)	1.93 (1.17, 3.18)
P	P = .7349	P = .4740	P = .7625	P = .0104
MD-DC-referral	\$440.20 (\$139.84)	\$516.59 (\$201.26)	\$861.91 (\$222.52)	\$1860.49 (\$519.69)
MD-PT-referral	\$411.38 (\$159.59)	\$1541.59 (\$568.62)	\$1361.03 (\$334.56)	\$1592.62 (\$327.53)
Cost ratio	1.07 (0.43, 2.67)	0.34 (0.13, 0.89)	0.63 (0.32, 1.24)	1.17 (0.61, 2.25)
P	P = .8845	P = .0276	P = .1833	P = .6415

DC, doctor of chiropractic; MD, medical doctor; PT, physical therapist

Means adjusted for between-pattern differences in risk scores that reflect measure of risk of expected healthcare cost and utilization relative to that of the overall population taking into account age, sex, primary diagnosis, comorbidities, use of prescription drugs, and risk scores; risk scores available 2006-2009 only.

MD-PT vs MD-DC care in all years, with the exception of 2007 for MD-PT vs MD-DC care in 2007. The cost ratios ranged from 0.21 to 0.90; that is, among headache patients with risk scores between the 40th and 60th percentiles, total allowed charges are on average 10%-79% less for DC patients (Table 2). Risk-adjusted mean charges for DC with referral care and MD with referral care are statistically similar, except in the year 2009. MD-DC care with referrals and MD-PT care with referrals also incurred statistically similar risk-adjusted mean charges, except in the year 2007.

DISCUSSION

Although the prevalence of headache disorders such as migraine has not changed since the 1990s, rates of physician consultation have increased.¹⁷ Even though consultation rates have increased, approximately half of those with headache do not use medication or are not under the care of a physician.^{17,18} In any given year, it is estimated that only 48% of migraineurs will see a doctor, usually those having the most severe cases of headache (compared with nonconsulters).¹⁷ Despite the fact that a substantial portion of those with headache do not seek treatment, our analysis is consistent with previous research⁸ that has shown large increases in utilization and expenditures throughout the 2000-2009 decade for the management of headache.

The present study found that utilization by patients with headache increased most dramatically for care involving MDs, PTs, and referral providers or services. The majority of patients and claims were in the MD-only or MD plus referral patterns, representing 65% of claims in 2009. Chiropractic care showed

the least gain in the number of patients and claims over the decade. These findings are similar to those of Adams et al.¹⁴ In their critical review on complementary and alternative medicine (CAM) use for migraine and headache, they reported that DC care was among the most commonly used CAM therapies. However, they also found that CAM therapies were primarily used concurrently or following a general practitioner visit, with fewer patients reporting the use of CAM therapies (including chiropractic care) before their MD visit.

Previous reports of costs in patients with migraine suggest that primary care and specialty physician office visits account for about 60% of all costs.⁶ Pharmaceutical charges account for a large proportion of the total charges associated with medical care. In our study, pharmaceutical charges accounted for more than a third of total allowed charges for all care patterns combined. This compares well with the migraine cost findings in Hu et al,⁶ who reported that expenses related to prescription medication accounted for nearly 30% of the total direct costs, whereas Latinovic et al¹⁹ reported that antimigraine medication was prescribed in 33.9% of the headache consultations.

In 2009, our unadjusted analysis showed that MD-care patterns with or without referral to PT or other providers (but without DC care) were on average 15% less expensive than DC care. Although charges per claim were less for DC-associated services, patients in DC-care patterns had many more claims on average than patients in MD-care patterns. This may simply be a reflection of the nature of DC treatment, which typically involves a series of manual therapy visits over time leading to multiple claims for their professional services.

In care patterns where additional referral care was provided, the combination of MD-DC-referral care was

somewhat more expensive (\$483 per patient) than the combination of MD-PT-referral care. On average, referrals associated with MD-only care were much more expensive (\$1856 per patient) than referrals associated with DC-only care. Investigators in the United Kingdom have reported that mean service costs were higher for those patients receiving referrals compared with those attending only their general practitioner.⁹ However, higher costs were also associated with the intensity of pain.⁹ We did not have clinical information available in our claims database, although, beginning in 2006, the NCSHP database did carry a risk score. The risk score allowed us to control for some patient characteristics (ie, age, sex, primary diagnosis, comorbidities, and use of prescription drugs) that influence both utilization and charges.

We conducted a subgroup analysis using patients in the middle quintile of risk to determine the utilization and charges for the typical patient. We chose this approach because the distribution of patient risk scores was heterogeneous across MD and DC patterns of care. The subgroup analysis favored DC patterns of care, showing that DC-only and MD-DC care patterns were less costly on average than MD-only and MD-PT care. However, charges for DC with referral care and MD with referral care were statistically similar in most years.

In the United States, the use of high-cost, low-value ambulatory medical services for headache increased dramatically from 1999 to 2010.⁸ For example, referrals to other physicians almost doubled from 6.9% to 13.2%, and use of advanced imaging more than doubled from 6.7% of visits in 1999-2000 to 13.9% in 2009-2010.⁸ Therefore, creating policies to encourage the use of lower-cost services, such as chiropractic care, may be a mechanism to mitigate the escalating costs associated with headache management.

One potential policy lever to achieve this aim would be to reduce patient copayments for these lower-cost services. This is necessary because previous studies have shown DC care to be very sensitive to patient out-of-pocket payments.^{20,21} The RAND Health Insurance Experiment found that use of chiropractic care was reduced by 50% when patient cost-share was 25% or more of the visit cost.²⁰ Therefore, we suggest that it might be possible that the current trend toward higher patient cost-sharing may have unintended consequences in that it discourages the use of lower-cost chiropractic services and may inadvertently steer patients into more expensive patterns of care. This hypothesis would require confirmation in future prospective research studies.

The North Carolina legislature reversed a mandate in 2007 that required insurers to maintain copayment equity between primary medical care and chiropractic care. As a result of the legislative change, the NCSHP implemented a new policy treating DC care as a specialty service. This new policy increased the copayments for DC visits by 20% to 100%, thereby creating a substantial barrier to the use of DC

services. Interestingly, there were noticeable changes in the total costs for managing the headache population around this time.

Over the decade, there was a clear upward trend in total allowed charges for all care patterns over time. The combined charges for headache in 2000 were \$15.2 million, which had escalated to \$44.5 million by 2005. However, there was a noticeable break in this trend the following year when total allowed charges dropped to \$40.7 million. That flattening of the trend may reflect changes in the NCSHP benefit plan options that were introduced in October of 2006. The downward trend then reversed following the copayment policy change which became effective on October 1, 2007.

Following the copayment increase for DC services, the total allowed charges resumed an upward trend in 2008 to \$43.6 million and eventually to \$46.4 million in 2009 (Fig 1). The temporal association between the hike in DC copays and the escalating costs may be important because the change in chiropractic copayments may have shifted the utilization patterns and may partially account for the dramatic increase in costs for the North Carolina NCSHP population. Exploring this association of the policy decision and its economic consequences is necessary but was beyond the scope of this current analysis and will be the focus of our future work.

Investigators have suggested that patients with chronic headache should receive interdisciplinary care.²² This becomes especially important as more information on headaches and their association with future sequelae become available. Recent reports suggest that migraine might be a progressive disease with cardiovascular, cerebrovascular, and longer-term neurologic effects and that repeated headache episodes may result in permanent central nervous system changes.⁴ This can have important implications on quality of life and productivity, as well as total healthcare costs. For example, the economic impact of migraine includes both direct healthcare costs and indirect costs due to lost workplace productivity or absenteeism.^{18,23}

For migraine, several studies have presented annual direct and indirect cost estimates ranging from \$127 to \$7089 and from \$709 to \$4453, respectively, per patient with migraine.²³ It is also noteworthy that among survey-ascertained patients with migraine, those who already had a formal migraine diagnosis (ie, using claims data for *ICD-9*) seemed to incur higher 12-month medical care costs compared with those ascertained by survey only (\$4597 vs \$2520 respectively).²⁴ Previous reports indicate that adults with headache are more likely to have physical and mental comorbidities,^{11,25} and estimates of migraine often include costs of these comorbid conditions.²⁶ As such, it is important to report estimates and variations in patterns of utilization and charges for the care of headache. These estimates can be used to assess and plan accordingly for future healthcare services.

Limitations

There are methodologic challenges inherent in the analysis of health insurance databases. For this study, these challenges arise in the form of inability to control for tiering, possible inaccuracy of diagnostic, management and treatment codes, as well as the lack of availability of risk factors for a portion of the analysis. All of these factors could have influenced our analysis of comparability across provider groups and may have created the potential for provider underrepresentation.

Another limitation of the study was capturing data only from those patients who sought care and being restricted to the information available in the claims database. For example, we did not have access to any clinical data, outcomes, or additional factors such as patient or disease characteristics that could have affected choice of provider or number of claims.⁷ However, the objective of our study was to estimate and compare overall charges and utilization across patterns of care for primary headache diagnoses, not to estimate effectiveness of headache treatment by pattern of care, undeniably an important aim but not our focus here. Another limitation is that secondary, tertiary, and quaternary codes were not used to identify headache cases, but doing so would have led to an overestimation of headache charges in our cohort.

Study Strengths

This is a large study with claims generated by approximately 660 000 persons (state employees, dependents, and retirees) that accrued 910 778 claims for headache in multiple and combined healthcare pathways over the 2000-2009 decade in North Carolina.

The series of articles it has generated on the treatment of low back pain,²⁷ neck pain,²⁸ and headache provides an opportunity to healthcare policy makers and legislators for a unique economic examination. It was also an opportunity to view costs using a lateral vs vertical analysis. When accumulating provider costs are viewed vertically (as if in “silos”), increasing utilization of one particular provider or another can be seen as a simple net cost increase in that particular silo (“vertical view”). However, when costs are viewed across the silos, as this study has done, an increase in the utilization of one provider group might result in a net cost decrease in the total costs across silos (“lateral view”).

CONCLUSION

Overall utilization and average charges for the treatment of headache increased considerably from 2000 to 2005 and then decreased in each subsequent year. Policy changes that took place between 2005 and 2007 may have affected utilization rates of certain providers and their associated

charges. MD care accounted for the majority of total allowed charges throughout the decade. In general, patterns of care involving multiple providers and referral care incurred the largest charges, whereas patterns of care involving single or nonreferral providers incurred the least charges. MD-only, DC-only, and MD-DC care were the least expensive patterns of headache care; however, risk-adjusted charges (available 2006-2009) were significantly lower for DC-only care compared with MD-only care.

Practical Applications

- This study found that MD care accounted for the majority of total allowed charges throughout the decade 2000-2009.
- Patterns of care involving multiple providers and referral care incurred the largest charges, whereas patterns of care involving single or nonreferral providers incurred the least charges.
- Not accounting for patients' differences in risk, MD care with no referral care was the least expensive pattern of headache care.
- Compared with MD-only care, risk-adjusted charges (available 2006-2009) for patients in the middle quintile of risk are significantly lower for DC-only care.

ACKNOWLEDGMENT

We gratefully acknowledge the assistance of Anthony W. Hamm, DC, FACO, and Marc S. Gottlieb, DC. Dr Hamm assisted with the classification of conditions according to *ICD-9* codes, and Dr Gottlieb helped with design of the data extraction models.

FUNDING SOURCES AND POTENTIAL CONFLICTS OF INTEREST

This study was made possible by the North Carolina General Assembly and with grants from NCMIC Research Foundation and Health Network Solutions. Conflicts of interest reported included the following: ELH: financial (personal fees from [a] escrow account managed by Dr Phelan, [b] the RAND Corporation). SPP: institutional (self-managed escrow account); financial (personal fees from self-managed escrow account). RCA: institutional (board member of Health Network Solutions that provided some financial support for the study).

RBP: financial (personal fees from NCMIC Foundation). MJS: financial (personal fees from NCMIC for expert testimony and lectures). JMS: financial (personal fees from Landmark Healthcare). DL: financial (personal consulting fees).

CONTRIBUTORSHIP INFORMATION

Concept development (provided idea for the research): E.L.H., S.P.P., R.C.A.

Design (planned the methods to generate the results): E.L.H., S.P.P., R.C.A.

Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): E.L.H., S.P.P., R.B.P., E.A.L.

Data collection/processing (responsible for experiments, patient management, organization, or reporting data): E.L.H., S.P.P., R.B.P.

Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): E.L.H., S.P., D.L., M.J.S., J.M.S., R.B.P.

Literature search (performed the literature search): E.L.H., M.V., J.M.S.

Writing (responsible for writing a substantive part of the manuscript): E.L.H., S.P.P., M.V., M.J.S., J.M.S., R.B.P.

Critical review (revised manuscript for intellectual content; this does not relate to spelling and grammar checking): E.L.H., D.L., M.J.S., J.M.S., R.B.P., S.P.P., E.A.L., R.C.A., M.V.

REFERENCES

1. Stovner L, Hagen K, Jensen R, et al. The global burden of headache: a documentation of headache prevalence and disability worldwide. *Cephalalgia* 2007;27:193-210.
2. Jensen R, Stovner LJ. Epidemiology and comorbidity of headache. *Lancet Neurol* 2008;7:354-61.
3. Gilbert JW, Johnson KM, Larkin GL, Moore CL. Atraumatic headache in US emergency departments: recent trends in CT/MRI utilisation and factors associated with severe intracranial pathology. *Emerg Med J* 2012;29:576-81.
4. Hazard E, Munakata J, Bigal ME, Rupnow MF, Lipton RB. The burden of migraine in the United States: current and emerging perspectives on disease management and economic analysis. *Value Health* 2009;12:55-64.
5. Lyngberg AC, Rasmussen BK, Jorgensen T, Jensen R. Secular changes in healthcare utilization and work absence for migraine and tension-type headache: a population based study. *Eur J Epidemiol* 2005;20:1007-14.
6. Hu XH, Markson LE, Lipton RB, Stewart WF, Berger ML. Burden of migraine in the United States: disability and economic costs. *Arch Intern Med* 1999;159:813-8.
7. Hawkins K, Wang S, Rupnow M. Direct cost burden among insured US employees with migraine. *Headache* 2008;48:553-63.
8. Mafi JN, Edwards ST, Pedersen NP, Davis RB, McCarthy EP, Landon BE. Trends in the ambulatory management of headache: analysis of NAMCS and NHAMCS data 1999-2010. *J Gen Intern Med* 2015;30:548-55.
9. McCrone P, Seed PT, Dowson AJ, et al. Service use and costs for people with headache: a UK primary care study. *J Headache Pain* 2011;12:617-23.
10. Linde M, Gustavsson A, Stovner LJ, et al. The cost of headache disorders in Europe: the EuroLight project. *Eur J Neurol* 2012;19:703-11.
11. Gaul C, Finken J, Biermann J, et al. Treatment costs and indirect costs of cluster headache: a health economics analysis. *Cephalalgia* 2011;31:1664-72.
12. Stovner LJ, Hagen K. Prevalence, burden, and cost of headache disorders. *Curr Opin Neurol* 2006;19:281-5.
13. Eisenberg DM, Davis RB, Ettner SL, et al. Trends in alternative medicine use in the United States, 1990-1997—results of a follow-up national survey. *JAMA J Am Med Assoc* 1998;280:1569-75.
14. Adams J, Barbary G, Lui CW. Complementary and alternative medicine use for headache and migraine: a critical review of the literature. *Headache* 2013;53:459-73.
15. Physical Therapy Act. North Carolina General Statute 90-270.24. available from: www.ncleg.net/gascripts/statutes/Statutes.asp.
16. SAS Institute. SAS (release 9.2). Cary, NC: Statistical Software; 2012.
17. Lipton RB, Scher AI, Kolodner K, Liberman J, Steiner TJ, Stewart WF. Migraine in the United States—epidemiology and patterns of healthcare use. *Neurology* 2002;58:885-94.
18. Blumenfeld AM, Varon SF, Wilcox TK, et al. Disability, HRQoL and resource use among chronic and episodic migraineurs: results from the International Burden of Migraine Study (IBMS). *Cephalalgia* 2011;31:301-15.
19. Latinovic R, Gulliford M, Ridsdale L. Headache and migraine in primary care: consultation, prescription, and referral rates in a large population. *J Neurol Neurosurg Psychiatry* 2006;77:385-7.
20. Shekelle PG, Rogers WH, Newhouse JP. The effect of cost sharing on the use of chiropractic services. *Med Care* 1996;34:863-72.
21. Stevans JM, Zodet MW. Clinical, demographic, and geographic determinants of variation in chiropractic episodes of care for adults using the 2005-2008 Medical Expenditure Panel Survey. *J Manipulative Physiol Ther* 2012;35:589-99.
22. Nicol Andrea L, Hammond Nancy, Doran Shamsa Velani. Interdisciplinary management of headache disorders. *Tech Reg Anesth Pain Manage* 2013;17:174-87.
23. Munakata J, Hazard E, Serrano D, et al. Economic burden of transformed migraine: results from the American Migraine Prevalence and Prevention (AMPP) Study. *Headache* 2009;49:498-508.
24. Elston Lafata J, Moon C, Leotta C, Kolodner K, Poisson L, Lipton RB. The medical care utilization and costs associated with migraine headache. *J Gen Intern Med* 2004;19:1005-12.
25. Kalaydjian A, Merikangas K. Physical and mental comorbidity of headache in a nationally representative sample of US adults. *Psychosom Med* 2008;70:773-80.
26. Scher AI, Bigal ME, Lipton RB. Comorbidity of migraine. *Curr Opin Neurol* 2005;18:305-10.
27. Hurwitz EL, Li D, Schneider MJ, et al. Variations in patterns of utilization and charges for the care of low back pain in North Carolina, 2000-2009: a statewide claims' data analysis. *J Manipulative Physiol Ther* 2016;39:252-62.
28. Hurwitz EL, Li D, Schneider MJ, et al. Variations in patterns of utilization and charges for the care of neck pain in North Carolina, 2000-2009: a statewide claims' data analysis. *J Manipulative Physiol Ther* 2016;39:240-51.

APPENDIX A. HEADACHE PRIMARY DIAGNOSES (ICD-9 CODES)

Primary Diagnoses (ICD-9 Codes) of Headache

Tension headache (307.81), Cluster headache syndrome unspecified (339.00), Episodic cluster headache (339.01), Chronic cluster headache (339.02), Episodic paroxysmal hemicrania (339.03), Chronic paroxysmal hemicrania (339.04), Tension type headache, unspecified (339.10), Episodic tension type headache (339.11), Chronic tension type headache (339.12), Post-traumatic headache, unspecified (339.20), Acute post-traumatic headache (339.21), Chronic post-traumatic headache (339.22), Drug induced headache, not elsewhere classified (339.3), New daily persistent headache (339.42), Primary thunderclap headache (339.43), Other complicated headache syndrome (339.44), Primary exertional headache (339.84), Primary stabbing headache (339.85), Other headache syndromes (339.89), Migraine with aura, without mention of intractable migraine w/o mention of status migrainosus (346.00), Migraine with aura, with intractable migraine, so stated, without mention of status migrainosus (346.01), Migraine with aura, without mention of intractable migraine with status migrainosus (346.02), Migraine with aura, with intractable migraine, so stated, with status migrainosus (346.03), Migraine without aura, without mention of intractable migraine w/o mention of status migrainosus (346.10), Migraine without aura, with intractable migraine, so stated, without mention of status migrainosus (346.11), Migraine without aura, without mention of intractable migraine with status migrainosus (346.12), Migraine without aura, with intractable migraine, so stated, with status migrainosus (346.13), Variants of migraine, nec (not elsewhere classified), w/o mention of intractable migraine w/o mention of status migrainosus (346.20), Variants of migraine, nec, with intractable migraine, so stated, w/o mention of status migrainosus (346.21), Variants of migraine, nec, without mention of intractable migraine with status migrainosus (346.22), Variants of migraine, nec, with intractable migraine, so stated, with status migrainosus (346.23), Hemiplegic migraine, without mention of intractable migraine w/o mention of status migrainosus (346.30), Hemiplegic migraine, with intractable migraine, so stated, without mention of status migrainosus (346.31), Hemiplegic migraine, without mention of intractable migraine with status migrainosus (346.32), Hemiplegic migraine, with intractable migraine, so stated, with status migrainosus (346.33), Chronic migraine w/o aura, w/o mention of intractable migraine w/o mention of status migrainosus (346.70), Chronic migraine w/o aura, with intractable migraine, so stated, w/o mention of status migrainosus (346.71), Chronic migraine without aura, without mention of intractable migraine with status migrainosus (346.72), Chronic migraine without aura, with intractable migraine, so stated, with status migrainosus (346.73), Other forms of migraine, w/o mention of intractable migraine w/o mention of status migrainosus (346.80), Other forms of migraine, with intractable migraine, so stated, w/o mention of status migrainosus (346.81), Other forms of migraine, without mention of intractable migraine with status migrainosus (346.82), Other forms of migraine, with intractable migraine, so stated, with status migrainosus (346.83), Migraine, unspecified, without mention of intractable migraine w/o mention of status migrainosus (346.90), Migraine, unspecified, with intractable migraine, so stated, without mention of status migrainosus (346.91), Migraine, unspecified, without mention of intractable migraine with status migrainosus (346.92), Migraine, unspecified, with intractable migraine, so stated, with status migrainosus (346.93), Nonallopathic lesions, head region (739.0), and Headache (784.0).
