The Medical Care Utilization and Costs Associated with Migraine Headache

Jennifer Elston Lafata, PhD, Christina Moon, MA, Carol Leotta, PhD, Ken Kolodner, PhD, Laila Poisson, MS, Richard B. Lipton, MD

OBJECTIVE: To describe the medical care use and costs associated with migraine.

DESIGN: Retrospective case-control design in which migraine case status was ascertained via validated telephone interview and linked with comprehensive claims data. Unadjusted and adjusted use and cost differences by migraine status were evaluated using exponential score tests and generalized estimating equations.

SETTING AND PATIENTS: We interviewed 8,579 individuals to identify migraine cases ($N = 1,265$) and a random sample of nonmigraine controls ($N = 1,178$) among eligible health plan enrollees aged 18 to 55.

MEASURES: Survey responses were used to categorize individuals meeting the International Headache Society's diagnostic criteria for migraine with or without aura as migraine cases and to collect information on comorbid psychiatric symptoms. Claims data were used to compile annual medical and pharmaceutical use and costs, presence of migraine diagnosis, and other diagnosed comorbidities.

RESULTS: Interview-ascertained migraine cases used more outpatient visits (9.1 vs 6.8; $P < .01$), were more likely to be seen in the emergency department (20.7% vs 17.6%; $P < .05$), and were admitted to the hospital more (4.5% vs 2.8%; $P < .05$) compared to nonmigraine controls. Cases incurred significantly higher medical care costs (\$2,761 vs \$2,064; $P < .01$). Multivariable model results indicate that much of this increase in costs is due to the presence of major depressive symptoms as well as other diagnosed comorbidities that are more common among those with migraine.

CONCLUSIONS: By combining validated telephone survey information to identify migraine cases and controls with comprehensive claims data, we found migraine cases incur higher medical care costs compared to controls. These increased costs are associated with the presence of psychiatric symptoms and other comorbidities.

KEY WORDS: migraine; migraine headache; medical care cost; utilization; claims data.

J GEN INTERN MED 2004;19:1005-1012.

Migraine is a highly prevalent and disabling disorder. Approximately 18% of women and 6% of men between

the ages of 12 and 80 years suffer from migraines in the United States.¹⁻³ Migraine headache is characterized by recurrent episodes of headache pain that are often severe, and may include other manifestations such as photophobia, nausea, and vomiting. Although the indirect costs (e.g., lost and underproductivity) associated with migraine are known to be substantial,⁴ relatively less is known about medical care utilization and costs among individuals with migraine headaches.

As we and others have shown, many migraine sufferers do not consult health care professionals explicitly for headache^{2,5-7} and those seeking care often do not receive a diagnosis of or treatment for migraine headache,^{5,7,8} thereby leading to the underascertainment of cases via claims data. This in turn may make it inappropriate to use claims data alone to describe the medical care use and costs associated with the condition. This is because some costs that are inherently due to the underlying condition may be omitted from consideration by inappropriately labeling individuals as disease free. Instead, both cases and controls should be identified by another source. For symptom-based conditions for which validated survey instruments exist, such as migraine, direct interview can provide a relatively inexpensive means to fully ascertain cases and controls from among a population for whom comprehensive claims data are also available. Such a design enables the linking of valid case-control status to comprehensive information on medical care utilization and costs.

In this paper, we use such an approach to describe and estimate differences in total medical care use and costs between a cohort of migraine cases and a random sample of nonmigraine controls. We also compare the use and costs between those cases that have and have not received a medical diagnosis for migraine headache. We focus on total medical care use and costs, as opposed to migraine-related use and costs, due to the inherent difficulty in using claims data to discern use and costs associated with a particular condition or disease—particularly one for which diagnostic codes are known to be underused. Understanding the extent to which migraine sufferers are disproportionate users of medical care is important, for if they are, knowledge of this may help motivate health plans, employers, providers, and other policy makers to direct resources toward migraine diagnosis and treatment.

METHODS

Study Setting and Population

Eligible study subjects were identified from among the approximately 250,000 group model enrollees in a

Received from the Henry Ford Health System (JEL, CM, LP), Detroit, Mich; IMR, An AdvancePCS Company (CL, KK), Hunt Valley, Md; and Departments of Epidemiology and Social Medicine, and Neurology (RBL), Albert Einstein College of Medicine, New York, NY.

Address correspondence and requests for reprints to Dr. Elston Lafata: Center for Health Services Research, Henry Ford Health System, One Ford Place, Suite 3A, Detroit, MI 48202 (e-mail: jlafata1@hfhs.org).

nonprofit, mixed-model HMO located in southeast Michigan. These individuals receive care from an 800-member multi-specialty medical group. Both the health plan and medical group are affiliated with an integrated health system, facilitating linkage of patient-level data across the two institutions.

Health plan enrollees were identified as eligible for inclusion if they were between the ages of 18 and 55; incurred at least one encounter to a medical group provider between June 1, 2000 and May 31, 2001; and were continuously enrolled in the health plan between June 1, 1999 and May 31, 2001. For purposes of this research, an encounter or visit was defined as any care delivered by a medical group provider, regardless of setting (i.e., outpatient, emergency department, or inpatient care). A total of 23,299 enrollees met the criteria. (We required at least one visit because an additional research aim of interest was to use claims data to develop a migraine risk model.⁶)

Participant Recruitment

Eligible enrollees were mailed letters of study introduction between June 4, 2001 and September 10, 2001, and given an opportunity to opt out of the study. A total of 633 individuals exercised this option, leaving 22,666 individuals eligible for telephone interview participation. Interview call attempts were made between June 2001 and November 2001. We attempted to contact individuals no fewer than 10 times, varying the time of day and day of week. A total of 14,108 enrollees were contacted: 8,579 completed the interview; 997 partially completed the interview; 1,728 were not eligible for participation (i.e., did not meet eligibility criteria, could not complete the survey due to a language, scheduling, physical, or mental barrier, or were deceased); and 2,804 refused to participate. The overall participation rate was 80.1% (participation rate = $[CI + PI]/[CI + PI + RF * (1 - [NE]/[NE + CI + PI])]$ where CI = completed interview = 8579; PI = partial interview = 997; RF = refused = 2804; NE = not eligible = 1728). Compared to nonrespondents (nonrespondents = total eligible population who did not complete interview [22,666] – completed interviews [8,579]), survey respondents were more likely to be female (64.8% vs 60.3%) and older (64.9% over 40 years of age vs 46.6%). The study was approved by the medical group's Human Rights Committee (Institutional Review Board).

Survey Data

Based on interview responses and a validated diagnostic algorithm, individuals were categorized as those with and without migraine.⁹ The interview, described in detail elsewhere,⁹ is designed to collect information concerning headache type, characteristics (i.e., age of onset, frequency, duration, and disability), and features (i.e., location and quality of pain, effect of headaches on physical activity, and the occurrence of nausea, vomiting, photophobia, phono-

phobia, and visual or sensorimotor aura). Validation studies indicate the interview has a sensitivity of approximately 85% and specificity of approximately 97% using a clinical assessment to assign a diagnosis based on the International Headache Society (IHS) criteria as the gold standard.^{1,9}

Respondents were categorized as a migraine case if they met the IHS diagnostic criteria for migraine with or without aura based on computer-assisted telephone interview (CATI) responses.^{9,10} To create a control group approximately equal in size, we randomly sampled approximately one sixth of respondents not meeting the case definition. Of the 8,579 survey respondents, 1,265 were categorized as cases and 1,178 were selected as controls.

In addition to completing the headache diagnostic interview, respondents also completed the Migraine Disability Assessment Scale,^{11,12} a standardized quality-of-life assessment, the SF-12,¹³ a screen for major depression and anxiety, the PRIME-MD,¹⁴ and health plan coverage and sociodemographic questions. Participants provided verbal consent before completing the survey.

Analytical Variables

Survey responses were linked to automated medical and pharmacy claims records from the 12-month period immediately preceding date of interview. The primary outcomes of interest were claims-based total annual medical care utilization and costs. Available claims data included all services (regardless of diagnosis) delivered by the medical group and those services reimbursed by the health plan but not delivered by the medical group. We constructed continuous measures of the total number of physician office visits, emergency department visits, and hospital admissions and days incurred, and prescription medications dispensed in the 12-month period immediately preceding interview completion.

We also constructed a measure of the total medical care costs (including prescription drug costs) incurred in the 12-month period immediately preceding interview completion. Cost estimates were derived using institutional cost-to-charge ratios for those services delivered by the medical group. For prescription drugs and those services delivered by other organizations, but paid for by the health plan, the amount paid by the health plan was used. Thus, "cost" reflects the perspective of an integrated health system that is at risk for externally delivered services.

Using self-reported (i.e., interview) data, we constructed variables reflective of age, gender, and race. Similarly, we were able to construct measures of education, marital status, and employment status. We used the PRIME-MD to construct two variables reflective of the common psychiatric comorbidities associated with migraine. The first reflected whether or not the individual expressed major depressive symptoms, and the second reflected whether or not the individual expressed symptoms suggestive of major anxiety. Both of these conditions are known to be under-ascertained via claims data.^{15–17} We used medical claims

Table 1. Sample Characteristics by Migraine Status*

	Controls (n = 1,178)	Interview- ascertained Migraine Cases (n = 1,265)	Claims-diagnosed Migraine Cases (n = 147)
Sociodemographics			
Mean age, y (SD) [‡]	42.0 (10.1)	40.7 (9.7)	41.4 (10.3)
Gender, % [‡]			
Female	59.3	84.4	83.0
Race, % [§]			
African American /other	32.6	31.9	21.8
White	67.4	68.1	78.2
Education, % [‡]			
High school or less	23.3	23.0	27.9
Some college	33.8	41.9	42.9
Four-year degree	23.3	20.3	18.4
Graduate school	19.6	14.8	10.9
Marital status, %			
Married	63.8	64.1	63.3
Not married	36.2	35.9	36.7
Employment status, % [‡]			
Currently working for pay	81.9	76.9	82.3
Sick/disabled	2.4	4.6	1.4
Not currently working for pay	13.0	14.8	11.6
Unemployed	2.7	3.7	4.8
Comorbidities			
Charlson Comorbidity Score ^{‡,§} (SD)	0.4 (0.9)	0.5 (1.2)	0.9 (1.4)
Major depressive symptoms, % [‡]	11.6	28.1	32.7
Major anxiety symptoms, % [‡]	1.8	7.9	9.5
Health insurance coverage, %			
HMO is primary [‡]	96.8	94.6	94.5
Rx drug coverage	94.9	93.8	91.2
Continuously enrolled [†]	97.4	95.7	95.2

* Wilcoxon rank sum tests used for continuous constructs and χ^2 tests for categorical constructs.

[†] P < .05; [‡] P < .01 for overall comparisons between interview-ascertained migraine cases and controls.

[§] P < .01 for overall comparisons between claims-diagnosed migraine cases and undiagnosed cases (not shown).
SD, standard deviation.

data to construct the Deyo adaptation of the Charlson Comorbidity Index.¹⁸ This index, which is based on 19 conditions (each of which is assigned a weight from 1 to 6) has been shown to be associated with physician expenditures, as well as other medical care use and costs.¹⁹

Among interview-ascertained migraine cases, we also used claims data to construct a variable reflective of whether or not the individual had a formal migraine medical diagnosis (International Classification of Diseases, Ninth Revision [ICD-9] = 346.xx) in the 24-month period preceding interview. Finally, survey responses were used to construct an indicator variable reflective of whether or not the individual reported using another insurance carrier as their primary carrier, while information in health plan administrative records were used to control for the presence or absence of prescription drug coverage and whether or not the individual was continuously enrolled in the 12-month period immediately preceding their telephone interview date.

Statistical Methods

To determine statistical significance in patient characteristics by migraine status, we used Wilcoxon rank sum tests for continuous constructs and χ^2 tests for categorical variables (Table 1). We used statistical approaches that account for the nonindependence among sample members receiving care from the same physician to test for differences in medical care utilization and costs (Tables 2 and 3). We used a majority use rule to assign patients to the physician they saw most often in the 24-month period preceding interview administration. Those patients with a visit to a primary care physician (PCP) (n = 2,100) were aligned to the PCP they saw most often, while those not seeing a PCP (n = 289) were aligned to the physician they saw most often, regardless of specialty. We also constructed one additional cluster for patients not seeing any physician (n = 54) during the 24-month period immediately preceding their survey administration.

Table 2. Twelve-month Medical Care Utilization and Costs by Migraine Status*

Outpatient, mean % visits (SD) [†]	Controls (n = 1,178)	Interview-ascertained Migraine Cases (n = 1,265)	Claims-diagnosed Migraine Cases (n = 147)
	90.5	92.3	99.3 [¶]
Emergency, %	6.8 (7.3) [§]	9.1 (10.1)	13.4 (11.7) [¶]
Mean department visits (SD) [†]	17.6 [‡]	20.7	24.5
Hospitalizations, %	1.8 (1.4)	1.9 (1.7)	2.2 (1.9)
Mean admits (SD) [†]	2.8 [‡]	4.5	8.2 [¶]
Mean days (SD) [†]	1.2 (0.6)	1.3 (1.0)	1.7 (2.0)
Prescription drug, %	5.9 (8.6)	4.3 (6.6)	5.8 (12.5)
Mean dispensings (SD) [†]	76.8	78.5	78.9
Total costs Mean (SD)	13.4 (14.5)	18.3 (20.7)	26.9 (26.5) [¶]
Median	\$2,064 (\$4,176) [§]	\$2,761 (\$4,624)	\$4,597 (\$6,175) [¶]
IQ range	\$983	\$1,291	\$2,691
	\$381 to \$2,097	\$517 to \$3,161	\$996 to \$5,381

* GEE logistic regression models used for categorical constructs and exponential scores tests used for continuous constructs.

[†] Mean among those with visit/admit/dispensing.

[‡] P < .05; [§] P < .01 for pairwise comparisons between interview-ascertained migraine cases and controls.

[¶] P < .05; [¶] P < .01 for pairwise comparisons between undiagnosed cases (not shown) and claims-diagnosed migraine cases.

IQ range, interquartile range; SD, standard deviation.

Table 3. GEE Regression Coefficients: Log of 12-month Medical Care Costs*

	Unadjusted Model (n = 2,443)		Model with Sociodemographics (n = 2,394)		Model with Comorbidities (n = 2,352)	
	Beta	Standard Error	Beta	Standard Error	Beta	Standard Error
Migraine case (per survey)	0.31 [§]	0.08	0.20 [‡]	0.09	0.14	0.09
Age			0.01	0.01	0.02 [§]	0.00
Female			0.46 [§]	0.11	0.46 [§]	0.10
White race			-0.05	0.09	-0.01	0.09
Education						
High school or less [†]				—	0.00	—
Some college			-0.03	0.10	-0.03	0.10
Four-year degree			-0.14	0.12	-0.03	0.11
Graduate school			-0.16	0.12	-0.04	0.12
Married			0.08	0.20	0.02	0.09
Employment status						
Currently working			0.07	0.28	0.20	0.27
Sick/disabled			0.84 ^{**}	0.37	0.72 [§]	0.32
Not currently working			0.09	0.31	0.21	0.28
Unemployed [†]				—	0.00	—
HMO as primary carrier			0.22	0.29	0.29	0.30
Rx drug coverage			0.31	0.17	0.29	0.17
Continuous enrollment			0.66	0.33	0.65 [‡]	0.32
Charlson Comorbidity Score					0.47 [§]	0.04
Major depressive symptoms (yes vs no)					0.23 [‡]	0.10
Major anxiety symptoms (yes vs no)					0.18	0.20

* When the first 2 models are fit on the observations for whom complete sociodemographic and comorbidity information is available (n = 2,352), results and conclusions do not change.

[†] Reference group.

[‡] P < .05.

[§] P < .01.

GEE, generalized estimating equation.

Generalized estimating equation (GEE) logistic regression models (Proc Genmod, SAS v. 8.2, SAS Institute, Cary, NC) were used to test for differences in proportions of medical care utilization. A semiparametric exponential scores test (Proc PHREG, SAS v. 8.2) was used for analysis of continuous constructs.²⁰ Unadjusted and adjusted differences in medical care costs by migraine status were modeled with GEE linear regression models. Given the nonnormal distribution of costs, a natural log transformation was used. To avoid the bias associated with retransformation on a nonlinear scale, we retransformed predicted cost estimates using the smearing estimator.²¹ The appropriateness of these approaches was confirmed via evaluation of model residuals on the log scale.²²

RESULTS

Patient Characteristics

The prevalence of migraine headache in the population using the interview-ascertained migraine case definition was 19.2% among women and 6.5% among men. Only 11.6% of these interview-ascertained migraine cases had been diagnosed in claims data. Relative to controls, interview-ascertained cases were slightly younger, more likely to be female, and less likely to be educated or to be currently working for pay (Table 1). There were no differences in race and marital status between interview-ascertained migraine cases and controls. Migraine cases scored significantly higher on the Charlson Comorbidity Index and were significantly more likely to express major depressive and anxiety symptoms. In terms of health plan coverage, we found no differences in prescription drug coverage by migraine status, but we did find that migraine cases were significantly less likely to report that the health plan was their primary health insurance carrier and to have been continuously enrolled in the 12-month period immediately preceding interview date.

Among survey-ascertained migraine cases, those with a medical claims diagnosis for migraine ($N = 147$) were significantly more likely to be of white race and to suffer from more comorbidities as reflected by their Charlson Comorbidity Index than those individuals who had not received a medical diagnosis for migraine (Table 1). No other statistically significant differences were found between cases with and without a medical diagnosis for migraine.

Medical Care Utilization and Costs by Migraine Status

Table 2 describes the medical care utilization and unadjusted cost differences in the 12-month period preceding interview by migraine status. Regardless of the type of utilization, interview-ascertained migraine cases always used more medical care than controls. For example, migraine cases used on average 2.3 more physician office visits than controls (9.1 vs 6.8, respectively), and were

significantly more likely to have been seen in an emergency department (20.7% vs 17.6%) or admitted to a hospital (4.5% vs 2.8%). Corresponding to this increased utilization, we found migraine cases (as identified via the telephone interview) incurred on average \$697 more in medical care costs during the year when compared to those without migraine (\$2,761 vs \$2,064).

Among the migraine cases, those with a claims-based diagnosis of migraine tended to use more care compared to those without such a diagnosis. For example, diagnosed migraine cases used on average 5.1 more physician office visits than controls (13.4 vs 8.5), were admitted to the hospital more often (8.2% vs 4.0%), and were dispensed more medications (26.9 vs 17.1). Corresponding to this increased utilization, we found migraine cases who had received a claims diagnosis for migraine incurred on average \$2,078 more in medical care costs during the year when compared to those not diagnosed with migraine (\$4,597 vs \$2,520).

Model-predicted Medical Care Costs by Migraine Status

Table 3 presents results from the regression models evaluating the association of interview-ascertained migraine status on 12-month total medical care costs. Prior to controlling for any patient characteristics, for a patient with interview-ascertained migraine status, the expected cost is 1.37 times the expected cost of a patient without migraine. Specifically, prior to adjusting for any patient characteristics, we found that migraine cases, on average, incurred \$750 more in medical care costs during the year when compared to those not suffering from migraine (\$2,793 vs \$2,043).

The second column in Table 3 presents model results once differences in patient sociodemographic characteristics and health insurance coverage are controlled. Once these are controlled, interview migraine case status continues to be associated with significantly higher medical care expenditures, albeit to a lesser extent. Using results from this model, the average migraine case is expected to incur annual medical expenditures of \$2,636, while on average those not suffering from migraine (i.e., controls) are expected to incur annual medical expenditures of \$2,148.

The final column in Table 3 presents model results once differences in patient sociodemographic characteristics, health insurance coverage, and comorbidities are controlled. This model enables additional insight into the factors that are contributing to the additional medical care spending. As can be seen from the table, once comorbidities are included in the model, migraine status is no longer statistically associated with medical care costs. However, results from this saturated model find that patient factors known to be associated with migraines are associated with increased medical care expenditures. In particular, model findings indicate that increased medical care spending is significantly greater among those reporting major depressive symptoms—a characteristic that is almost three times

as likely to be found among migraine cases as controls and for which there is an established bidirectional causal relationship.²³

DISCUSSION

Consistent with previous studies,¹⁻³ we found migraine headaches to be highly prevalent among a population of health plan enrollees aged 18 to 55 who had recently sought care. In our sample, 19.2% of women and 6.5% of men met the IHS criteria for migraine headache with or without aura. Despite the known disabling effects of and effective treatment for migraine headache, less than 12% of these individuals received a medical diagnosis for migraine within the past 24 months.^{2,5-7} This suggests that the overwhelming majority of individuals with migraine who interact with the health care system are missing out on the known benefits of available therapies.

Also consistent with other studies, we found migraine headache is associated with a number of concomitant conditions that contribute to the total burden of disease.²⁴ In our population we found that individuals meeting the IHS's criteria for migraine were significantly more likely to report both major depressive and anxiety symptoms and to score higher on the Charlson Comorbidity Index. Although this burden of concomitant conditions was significantly greater among migraine cases who had received a medical diagnosis for migraine, it was far from negligible among those not receiving such a diagnosis.

The few prior investigations that have evaluated medical care use and costs associated with migraine headaches have consistently found that patients with migraine use more medical care services and incur more medical care costs compared to their counterparts without migraine.^{4,25,26} These prior investigations, however, are hindered by their reliance on claims data alone to identify migraine cases and controls,²⁵ their reliance on self-reported migraine status and medical care use,²⁶ or the application of interview data from one population source to utilization estimates from another population source.⁴ As many individuals with migraines do not seek medical care for their headaches,^{5,6,8} studies that rely on claims data to ascertain cases underestimate the number of migraine sufferers. Further, those who seek care often suffer from more severe migraine.^{2,7,27-34} The reliance on claims data alone, therefore, is likely to dramatically underestimate disease prevalence and overestimate disease severity, making it difficult to accurately measure differences in average medical care costs due to migraine. Prior studies relying solely on self-reported information may also be flawed, as many individuals do not know that the headaches they incur are migraine^{2,7} and because of the inherent difficulty of accurately recalling medical care use. Thus, to understand the differences in medical care utilization and costs associated with migraine it is important to identify both migraine cases and controls by direct interview from a population for which comprehensive medical and pharmacy claims data are available.

Using a population-based case-control design that relied on a validated interview screen to identify migraine cases and controls as well as the presence of comorbid psychiatric symptoms and claims data to compile information on medical care use and costs, we found that migraine sufferers consistently incur more medical care use and costs than those without migraine. Prior to adjusting for differences in patient characteristics, migraine cases incurred approximately \$700 on average (or 1.36 times) more per year in total medical care costs. After adjusting for patient sociodemographic and health insurance coverage characteristics, migraine cases continued to incur 1.23 times higher costs than their counterparts without migraine. Yet, after controlling for interview-ascertained psychiatric symptoms commonly associated with migraine (anxiety and depression) and an overall claims database measure of case-mix (Charlson Comorbidity Index), we no longer found migraine status to be significantly associated with medical care costs. Instead, we found the presence of comorbidities and psychiatric symptoms to be significantly associated with increased medical care costs. We found medical care costs to increase significantly with increasing Charlson Comorbidity Scores (1.6 times higher with each point increment) and to be 1.3 times greater among individuals reporting major depressive symptoms—implying that comorbid conditions, some of which have been repeatedly found to be associated with migraine headache, are the primary factors associated with the increased medical care costs observed among migraine cases.

Prior longitudinal studies clearly indicate the bidirectional association between migraine and major depression, with each disorder increasing the risk for the subsequent first onset of the other.²³ Such bidirectional findings are consistent with the explanation that the disorders share common etiologies.²⁴ In clinical practice, it is customary in individuals with both migraine and depression to identify and treat each condition.²³ The available evidence and treatment guidelines suggest that treating each disorder is the key to improving outcomes.³⁵

Given the cross-sectional nature of the data used in the current analyses, we can only speculate as to whether successfully treating migraine among those patients with depression and vice versa would lead to reductions in overall medical care expenditures. What is perhaps more important is the selection of migraine therapy based on comorbidities,^{36,37} which may be exacerbated by migraine therapy. For example, analgesic overuse may exacerbate both migraine and depression in clinic-based studies.^{36,37} Conversely, comorbidities sometimes create opportunities to treat more than one condition with a single drug. For example, when hypertension and migraine co-occur, both disorders can be treated with a beta-blocker. When migraine and depression occur together, an antidepressant may ameliorate both disorders.

This study has several notable strengths. First, both migraine status and psychiatric symptoms were ascertained by direct interview. Second, costs were estimated

for the same population using a comprehensive claims database. Finally, the study sample was large, health plan based, and sociodemographically diverse.

However, our study is not without limitations. Primary among them is that the study population and data are derived in a single health plan, and within that health plan, patients received care from one large medical group. Thus, whether our findings generalize to other settings or patients is not known. It should be noted, however, that the age, gender, and race distribution of the population seen by this medical group is consistent with the population residing in the larger community. Furthermore, we required that eligible study subjects incur at least one visit to a medical group provider in the 12-month period preceding sample identification. This latter requirement may lead us to underestimate differences in medical use and costs if those individuals with migraine are more likely to have such an occurrence compared to those without migraine. Finally, while our results clearly point to the fact that medically diagnosed migraine sufferers use more medical care resources, we can not determine whether a medical diagnosis leads to an overall increase in use or those who make extensive use of health care resources are more likely to receive a migraine diagnosis.

Conclusions

Migraine continues to be a problem that is largely ignored by the medical community. Yet, some 12% of patients seeking care meet the IHS criteria for migraine, and these patients disproportionately suffer from symptoms of anxiety and depression as well as other diagnosed comorbidities. Although findings here do not support the notion that diagnosing and treating undiagnosed and untreated migraine would result in reduced overall medical care expenditures, there is ample evidence that effective treatments exist for these patients.³⁸⁻⁴⁰ As prior work suggests that indirect costs account for over 80% of the total cost of migraine,⁴ the economic argument for better migraine treatment has been based on the extensive evidence that effective migraine therapy can reduce absenteeism and improve productivity among working individuals.^{41,42} Thus, in addition to benefiting patient well-being, migraine treatment programs may reduce the total economic cost of illness by decreasing indirect costs. Finally, our findings suggest that addressing the comorbidities commonly found among migraine patients, particularly depressive symptoms, may afford additional advantages. Given the large numbers of individuals who suffer from migraine headaches and the existence of effective therapy to address both their migraine pain as well as their common comorbidities, it seems imperative that barriers to improve the care we deliver to these individuals be addressed.

REFERENCES

1. Stewart WF, Lipton RB, Liberman J. Variation in migraine prevalence by race. *Neurology*. 1996;47:52-9.
2. Lipton RB, Stewart WF, Diamond S, Diamond ML, Reed M. Prevalence and burden of migraine in the United States: data from the American Migraine Study II. *Headache*. 2001;41:646-57.
3. Lipton RB, Stewart WF, Kolodner KB, Liberman JN. Epidemiology and patterns of health care use for migraine in the United States. *Headache*. 1999;39:65-6.
4. 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.
5. Stang PE, Osterhaus JT, Celentano DD. Migraine. Patterns of healthcare use. *Neurology*. 1994;44(6 suppl 4):S47-S55.
6. Kolodner K, Lipton RB, Elston Lafata J, et al. Pharmacy and medical claims data identified migraine sufferers with high specificity but modest sensitivity. *J Clin Epidemiol*. 2004. In press.
7. Lipton RB, Diamond S, Reed M, Diamond ML, Stewart WF. Migraine diagnosis and treatment: results from the American Migraine Study II. *Headache*. 2001;47:638-45.
8. Celentano DD, Stewart WF, Lipton RB, Reed ML. Medication use and disability among migraineurs: a national probability sample survey. *Headache*. 1992;32:223-8.
9. Stewart WF, Lipton RB, Whyte J, et al. An international study to assess reliability of the Migraine Disability Assessment (MIDAS) score. *Neurology*. 1999;53:988-94.
10. Headache Classification Committee of the International Headache Society. Classification and diagnostic criteria for headache disorders: cranial neuralgias and facial pain. *Cephalalgia*. 1998;8:19-28.
11. Stewart WF, Lipton RB, Kolodner KB, Sawyer J, Lee C, Liberman JN. Validity of the Migraine Disability Assessment (MIDAS) score in comparison to a diary-based measure in a population sample of migraine sufferers. *Pain*. 2000;88:41-52.
12. Stewart WF, Lipton RB, Sawyer J. A multi-national study to assess the reliability of the migraine disability assessment (MIDAS) score. *Headache*. 1998;38:407.
13. Ware JE, Gandek B. The SF-36 health survey: development and use in mental health and the IQOLA Project. *Int J Ment Health*. 1994;23:49-73.
14. Spitzer RL, Kroenke K, Williams JB. Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. Primary Care Evaluation of Mental Disorders. Patient Health Questionnaire. *JAMA*. 1999;282:1737-44.
15. Melfi CA, Croghan TW. Use of claims data for research on treatment and outcomes of depression care. *Med Care*. 1999;37(4 suppl):AS77-AS80.
16. Simon G, Ormel J, VonKorff M, Barlow W. Health care costs associated with depressive and anxiety disorders in primary care. *Am J Psychiatry*. 1995;152:352-7.
17. Harman JS, Rollman BL, Hanusa BH, Lenze EJ, Shear MK. Physician office visits of adults for anxiety disorders in the United States, 1985-1998. *J Gen Intern Med*. 2002;17:165-72.
18. Deyo RA, Taylor VM, Diehr P, et al. Analysis of automated administrative and survey databases to study patterns and outcomes of care. *Spine*. 1994;19(suppl 18):2083S-2091S.
19. Schneeweiss S, Seeger JD, Maclure M, Wang PS, Avorn J, Glynn RJ. Performance of comorbidity scores to control for confounding in epidemiologic studies using claims data. *Am J Epidemiol*. 2001;154:854-64.
20. Savage IR. Contributions to the theory of rank order statistics—the two sample case. *Ann Math Stat*. 1956;27:590-615.
21. Duan N, Manning WG, Morris CN, Newhouse JP. A comparison of alternative models for the demand for medical care. *J Bus Econ Stat*. 1983;1:115-26.
22. Manning WG, Mullahy J. Estimating log models: to transform or not to transform? *J Health Econ*. 2001;20:461-94.

23. Breslau N, Schultz LR, Stewart WF, Lipton RB, Lucia VC, Welch KM. Headache and major depression: is the association specific to migraine? *Neurology*. 2000;54:308–13.
24. Breslau N. Migraine comorbidity with stroke, epilepsy and major depression. In Olesen J, Steiner TJ, Lipton RB, eds. *Reducing the Burden of Headache*. Oxford: Oxford University Press; 2003:164–72.
25. Clouse JC, Osterhaus JT. Healthcare resource use and costs associated with migraine in a managed healthcare setting. *Ann Pharmacother*. 1994;28:659–64.
26. Edmeads J, Mackell JA. The economic impact of migraine: an analysis of direct and indirect costs. *Headache*. 2002;42:501–9.
27. Linet MS, Celentano DD, Stewart WF. Headache characteristics associated with physician consultation: a population-based survey. *Am J Prev Med*. 1991;7:40–6.
28. Lipton RB, Stewart WF, Sawyer J, Edmeads JG. Clinical utility of an instrument assessing migraine disability: the Migraine Disability Assessment (MIDAS) questionnaire. *Headache*. 2001;41:854–61.
29. Lipton RB, Stewart WF, Celentano DD, Reed ML. Undiagnosed migraine headaches. A comparison of symptom-based and reported physician diagnosis. *Arch Intern Med*. 1992;152:1273–8.
30. Von Korff M, Wagner EH, Dworkin SF, Saunders KW. Chronic pain and use of ambulatory health care. *Psychosom Med*. 1991;53:61–79.
31. Stewart WF, Lipton RB. Migraine headache: epidemiology and health care utilization. *Cephalalgia*. 1993;13(suppl 12):41–6.
32. Rasmussen BK, Olesen J. Migraine with aura and migraine without aura: an epidemiological study. *Cephalalgia*. 1992;12:221–8.
33. Lipton RB, Stewart WF, Von Korff M. The burden of migraine. A review of cost to society. *Pharmacoeconomics*. 1994;6:215–21.
34. Von Korff M, Stewart WF, Lipton RB. Assessing headache severity. New directions. *Neurology*. 1994;44(6 suppl 4):S40–S46.
35. Ramadan NM, Silberstein S, Freitag F, Gilbert TT, Frishberg BM. Evidence based guidelines for migraine headache in the primary care setting: pharmacological management for prevention of migraine. Available at: <http://www.neurology.org>. Accessed March 1, 2003.
36. Lipton RB, Silberstein S. Why study the comorbidity of migraine? *Neurology*. 1994;44:28–32.
37. Silberstein S, Lipton RB. Chronic daily headache, including transformed migraine, chronic tension type headache and medication overuse. In: Silberstein S, Lipton RB, Dalessio DJ, eds. *Wolff's Headache and other Head Pain*. New York, NY: Oxford University Press; 2001:247–82.
38. Centers for Disease Control and Prevention. Colorectal cancer test use among persons aged ≥ 50 years—United States, 2001. *MMWR*. 2003;52:193–6.
39. Davies GM, Santanello N, Lipton R. Determinants of patient satisfaction with migraine therapy. *Cephalalgia*. 2000;20:554–60.
40. Dasbach EJ, Carides GW, Gerth WC, Santanello NC, Pigeon JG, Kramer M. Work and productivity loss in the rizatriptan multiple attack study. *Cephalalgia*. 2000;29:830–4.
41. Cady RK, Sheftell F, Lipton RB, Kwong WJ, O'Quinn S. Economic implications of early treatment of migraine with sumatriptan tablets. *Clin Ther*. 2001;23:284–91.
42. Stang P, Cady R, Batenhorst A, Hoffman L. Workplace productivity. A review of the impact of migraine and its treatment. *Pharmacoeconomics*. 2001;19:231–44.