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Research Submissions

The Predictive Value of Abbreviated Migraine Diagnostic Criteria

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Objective.—To determine the operating characteristics and predictive value of abbreviated criteria for the diagnosis of migraine headache.

Background.—The International Headache Society (IHS) diagnostic criteria for migraine have been adopted in limited fashion in clinical practice. Primary care physicians in particular deal with innumerable conditions and diagnostic algorithms. Unless the IHS criteria are simplified the recognition of migraine headache in primary care settings will not be apt to improve.

Methods.—This study was a retrospective analysis of four discrete research databases: headache clinic patients (N = 390), private practice neurology patients (N = 290), college students (N = 99), and community-based patients (N = 784). Physicians and psychologists expert in the diagnostic criteria for migraine headache syndromes conducted a standardized diagnostic interview in all patients (N = 1524). Each was later assigned an IHS headache diagnosis by a previously validated computer-based algorithm. The sensitivity, specificity, positive and negative predictive values, and accuracy were calculated for single- and multiple-variable models of migraine predictors. Optimal models were defined as those with positive likelihood ratios (+LRs) of >4.5 and negative likelihood ratios (−LRs) of <0.25 for the combined population.

Results.—The only optimal single-variable model was nausea, which had an overall +LR of 4.8 and −LR of 0.23. None of the two-variable models met criteria for an optimal model. The best of the optimal three-variable models were nausea/photophobia/pulsating (+LR 6.7, −LR 0.23) and nausea/photophobia/worsening with physical activity (+LR 5.9, −LR 0.21). These three models maintained positive predictive values >0.80 in all 4 patient populations and negative predictive values >0.70 in the majority of populations.

Conclusion.—The single-variable model of nausea and the three-variable models of nausea/photophobia/worse with exertion and nausea/phonophobia/pulsating can effectively predict migraine in diverse clinical settings. These models however, should only be applied after a careful exclusion of secondary headache disorders.

Key words: migraine, diagnosis, headache, nausea, primary care, symptoms, abbreviated criteria

Abbreviations: IHS International Headache Society, LR likelihood ratios, PPV positive predictive value, NNV negative predictive valued, PA worsening with physical activity, MS moderate to severe, AUC-ROC area under the curve of the receiver operating curve, CI confidence intervals

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Migraine headache is a common disorder that affects 28 million Americans including 15% to 18% of women, 6% of men, and 5% of children.[1] It is more prevalent than diabetes (17 million, 6.5%), asthma (15 million, 10.5%), and osteoarthritis (20.7 million, 12%).[2,3] The prevalence of migraine headache is even higher within primary care practice sites approaching 29% in nonselected patients from primary care waiting rooms[4] and 57% to 73% in those presenting to their primary care physicians with a complaint of "headache."[5,6] Despite being a common disorder that is frequently encountered by primary care and specialist physicians, migraine is frequently under-diagnosed and misdiagnosed.[1,5,7]

Multiple studies have documented that less than 50% of migraineurs have received a diagnosis of migraine headache by a physician.[1,8] Migraine headache is often misdiagnosed in patients who complain of headache to their primary care physicians. A study from a Seattle based health maintenance organization reported that primary care physicians correctly diagnosed <50% of migraineurs.[5] An international study found that primary care physicians misdiagnosed 24% of those patients later diagnosed with migraine headache by review of headache diaries by headache experts.[7]

Many factors may contribute to the under diagnosis and misdiagnosis of headache in primary care settings.[9] Primary care physicians may have limited time during an office visit to establish a diagnosis of headache. The average time of an office visit is 8 to 15 minutes in the United Kingdom and 11 to 15 minutes in the United States.[10,11] Multiple medical problems are often addressed in a single office visit, which further reduces the time devoted to the headache complaint. In addition, the presence of two or more coexisting headache disorders in the same patient (eg, tension-type and migraine headaches), which may occur in up to 51% of patients, also makes it less likely that migraine will be diagnosed.[5]

The diagnostic criteria may represent another barrier to the diagnosis of migraine headache within primary care. The International Headache Society (IHS) developed its initial diagnostic criteria for headache disorders in 1988 and they were later updated in 2004.[12] These criteria were primarily developed to standardize the diagnosis of migraine headache within clinical research trials, but have experienced poor uptake by primary care physicians as a diagnostic tool. Expecting primary care physicians to ask seven questions to establish a diagnosis of migraine without aura and at least four additional questions for a diagnosis of migraine with aura is at least challenging. The number of these criteria may represent a significant barrier to their use by primary care physicians.

We believe that a simplification of the diagnostic criteria might improve recognition of migraine headache. Therefore, this study was conducted to determine if abbreviated diagnostic criteria could accurately predict patients with an IHS diagnosis of migraine in 4 different adult patient populations. We hypothesized that abbreviated diagnostic criteria would have high sensitivity, specificity, positive/negative predictive values, and accuracies in these populations.

MATERIALS AND METHODS

This research was conducted under the auspices of the Institutional Review Boards of both the University of Cincinnati College of Medicine and the University of Mississippi Medical Center. The study was a retrospective analysis of four discrete research databases. All patients within each database completed the same structured diagnostic interview and were later assigned an IHS headache diagnosis (based on 1988 criteria) by a computer-based algorithm. The algorithm had been previously validated in the diagnosis of headache disorders based on criteria developed by the IHS.[13] Trained physicians or psychologists at each site conducted the verbal diagnostic interviews. Multiple diagnoses were formulated for patients with more than one type of headache (eg, one patient could be diagnosed "migraine without aura" as well as "episodic tension-type headache," reflecting two distinct headache patterns). Those with more than one headache were asked to first describe their most severe or disabling headache and then to describe their second most severe or disabling headache.

The patient populations from the four databases were derived from the following sites:

1. Headache Clinic—consecutive headache clinic patients (N = 390) with a chief complaint of

headache presenting to the Head Pain Center at the University of Mississippi Medical Center from March 1990 to February 1994,

2. Neurology Practice—consecutive private practice neurology patients (N = 290) with a chief complaint of headache presenting to a private practice neurologist in Tampa, Florida from December 1991 to April 1992,
3. College Student—students (N = 99) enrolled in psychology classes at the Illinois Institute of Technology (September 1998 to May 1999) and Texas A&M (August 1989 to March 1990), and
4. Community-Based Population—patients (N = 784) were recruited from newspaper advertisements and television news stories to participate in a "headache diagnostic interview" at the Pain and Rehabilitation Clinic of Chicago (September 1996 to August 1998).

Inclusion and exclusion criteria varied depending on the research database. For the headache clinic and neurology practice databases the inclusion criteria were: (1) ability to speak English and (2) >18 years of age. For the college student database the inclusion criteria were the presence of "frequent and bothersome" headaches as judged by the participant. The community-based database included all patients that responded to local advertisement offering "free headache diagnostic information" and agreed to participate in a diagnostic interview, but excluded those that were <18 years of age.

Statistical Analysis.—"Migraine headache" was defined as all participants with a diagnostic category of 1.1 to 1.7 from the IHS 1988 diagnostic criteria, which included both migraine with and without aura as well as migrainous headache (met all but one of diagnostic criteria for migraine with and without aura). The migraine headache group included patients with episodic and chronic migraine (≥15 days with migraine per month). "Nonmigraine headache" was defined as all other headache diagnoses. If participants experienced migraine as well as another headache disorder (eg, tension-type or medication overuse headaches), they were placed in the migraine group. Migraine predictors were selected on the basis of the IHS criteria and included aura, nausea, vomiting, photophobia, phonophobia, unilateral, worse with physical activity, throbbing or pulsating, and moderate to severe intensity. Migraine predictors were elicited by specific questions from the structured diagnostic interview. Nausea was defined as the presence of "nausea" accompanying the headaches. Photophobia was defined as a headache worsened by normal light and phonophobia as headache worsened by conversational noise. Aura symptoms were defined as visual, sensory or motor symptoms that developed over >4 minutes, lasted <60 minutes and the headache followed the aura symptoms in <60 minutes. Worse with physical activity was defined as headache pain worse with routine physical activities (eg, walking, lifting, bending).

Two-by-two tables were constructed of the univariate migraine predictors (present vs. not) and a diagnosis of migraine headache (migraine vs. nonmigraine headache). The sensitivity, specificity, and positive/negative likelihood ratios (+LR and −LR, respectively) were determined for each of the predictors using the combined data set. Data analyses were performed using STATA version 7 (Stata Corp 2001. Stata Statistical Software Release 7.0. College Station, TX: Stata Corporation).

Receiver operating curves (ROC) were then generated for these single-variable models. The area under the curve (AUC) of the ROC curve was to ascertain which single variables were most predictive of a diagnosis of migraine headache. Since the single-variable models were binary the ROC curve was composed of two lines as described by Cantor.[14] The first line connected the origin (sensitivity = 0, specificity = 1) with the point of the binary test and the second line connected the point of the binary test with the point in the far right-hand corner (sensitivity = 1, specificity = 0). The AUC of the ROC was obtained using a simple geometric approach since the data are not inherently continuous. The ROC curves were calculated using the STATA ROC analysis ROCTAB command, which computes the AUC using the trapezoidal rule for numerical integration. (Stata Version 7 Reference Manual Volume 3, pp. 131-151, Stata Corp.).

Those single variables with the five highest AUCs were then used to create the various combinations of two- and three-variable models. These models were binary with a single cutpoint defining a positive result. Two-variable models had two separate cutpoints for analysis (1/2 and 2/2 variables present for a positive result) and three-variable models had three separate cutpoints (1/3, 2/3, and 3/3 variable present for a positive result). Migraine predictors were all weighted equally within our models. The sensitivity, specificity, +LRs and −LRs were then determined for all combinations and cutpoints of two- and three-variable models using the combined data set to determine the optimal models.

Optimal models were defined as having +LRs >4.5 and −LRs <0.25 (both required). These thresholds were chosen to provide good positive and negative predictive values in patient populations with an intermediate pretest probability of migraine headache (eg, 40% to 60%), which would represent a conservative estimate of the probability of migraine in patients presenting to their physicians with a complaint of headache. For example, a positive test result with these LRs would increase the positive predictive value of migraine headache to >75% and a negative result would provide a negative predicative value >70%. Optimal models were selected from each grouping of one-, two-, and three-variable models. If a group had more than one optimal model, then only the two with the most favorable operating characteristics were reported.

Positive and negative predictive values (PPVs and NPVs, respectively), LRs, and accuracies of the optimal models were then calculated separately in the 4 patient samples. Similar operating characteristics within all four samples would suggest cross-validation of the model (eg, this would be equivalent to use one of the populations as the training set and the other three as the cross-validating sets).

Chi square statistics were used to determine if the sensitivity and specificity of the optimal models differed with age and gender within the combined population. Age was subdivided into groupings of <30, 40 to 50, 50 to 60, and >60 years of age for the analysis. A separate analysis was also performed to determine how the models performed in the subgroup of those with and without chronic daily headache (CDH) (≥15 days per month with headache).

RESULTS

Patient Characteristics.—The patient characteristics are summarized in Table 1 and the specific headache diagnoses from each population are listed in Table 2. The study populations at all four sites were primarily women (67% to 81%). Migraine prevalence varied from 33% in the college student population to 71% in the private neurology practice population. Although a high prevalence of CDH was found in the combined population (37%), as would be expected, CDH was highest in the headache clinic. At the private neurology practice and the headache clinic, a large proportion of patients had medication overuse contributing to their headache syndrome.

One-Variable Models.—Nausea was the only one-variable model that met criteria for an optimal model and had a sensitivity of 0.81, specificity of 0.83, +LR of 4.8 and −LR of 0.23 for the combined population. The one-variable models of aura and vomiting maintained excellent +LRs (>4.5), but had poor −LRs. Others such as moderate to severe intensity had excellent −LRs (<0.25), but poor +LRs. The models with

Table 1.—Patient Characteristics

Characteristics	Headache Clinic (n = 390)	Neurology Practice (n = 253)	College Student (n = 99)	Community (n = 784)	Combined Population (n = 1529)
Mean age (years)	37.7	40.7	27.8	40.3	39.0
Women	77%	81%	67%	78%	77%
Mean headache days per month	16	14	8	15	14
>1 Headache diagnosis*	15%	20%	12%	18%	18%

*Refers to >1 headache diagnosis in the same patient.

Table 2.—Specific Headache Diagnoses in the Four Patient Populations

Headache Diagnoses*	Headache Clinic	Neurology Practice	College Student	Community	Combined Population
Migraine headache	63%	71%	33%	66%	64%
Tension-type headache	46%	40%	70%	44%	45%
Cluster headache	9%	11%	1%	4%	5%
Medication overuse	46%	45%	19%	29%	36%
Chronic daily headache	43%	33%	21%	38%	37%
Post traumatic headache	4%	2%	1%	5%	5%
Chronic migraine	27%	25%	11%	23%	23%

*Migraine headache = 1998 IHS diagnoses 1.1 to 1.7, tension type headache = 1998 IHS diagnoses 2.1 to 1.3, cluster headache = 1998 IHS diagnoses 3.1 to 3.3; Medication overuse was defined as typical consumption ≥4 tabs per day of dose of aspirin or acetaminophen, ≥2 tabs per day of sedatives or analgesics, or use of ergotamine ≥3 days per week (or 10 mg per week); chronic daily headache is ≥15 days per month with headache (includes those with chronic migraine) and chronic migraine is ≥15 days with migraine per month; more than one headache diagnosis could coexist in the same patient.

the five highest AUCs included nausea, photophobia, phonophobia, pulsating, and worse with exertion (Table 3).

Two- and Three-Variable Models.—None of the two-variable models met criteria for an optimal model. The most predictive two-variable models were nausea/photophobia and nausea/moderate to severe intensity (both variables present for a positive result). They provided excellent +LRs of 8.0 and 6.2, respectively, for the combined population, but their −LRs were poor at 0.39 and 0.29. Therefore, the addition of a second predictor increased their +LRs compared with the one-variable model of nausea, but significantly worsened their −LRs.

Several of the three-variable models met the criteria for an optimal model. The two most predictive of the three-variable models were nausea/photophobia/worse with physical exertion and nausea/photophobia/pulsating (2/3 variables required for a positive response) with +LRs of 5.9 and 6.7, respectively, as well as −LRs of 0.21 and 0.23. The sensitivity and specificity of the nausea/photophobia/worse with exertion model was 0.82 and 0.86, respectively, while that of the nausea/photophobia/pulsating model was 0.80 and 0.88.

Operating Characteristics Within Individual Patient Populations.—The LRs, PPVs, NPVs, and accuracies of the optimal models for all 4 patient populations and the combined data set are presented in Table 4.

Table 3.—Operating Characteristics of Single-Variable Models for the Combined Population

Single Variables	Sensitivity (95% CI)	Specificity (95% CI)	+LR (95% CI)	−LR (95% CI)	AUC of ROC (95% CI)
Nausea	0.81 (0.79, 0.83)	0.83 (0.80, 0.86)	4.8 (3.9, 5.7)	0.23 (0.20, 0.26)	0.82 (0.80, 0.84)
Photophobia	0.79 (0.76, 0.82)	0.78 (0.75, 0.82)	3.6 (3.1, 4.2)	0.27 (0.24, 0.31)	0.79 (0.76, 0.81)
Phonophobia	0.76 (0.73, 0.78)	0.75 (0.71, 0.79)	3.0 (2.6, 3.5)	0.32 (0.28, 0.36)	0.76 (0.74, 0.78)
Pulsating	0.62 (0.59, 0.65)	0.76 (0.72, 0.80)	2.6 (2.4, 2.8)	0.50 (0.46, 0.55)	0.76 (0.74, 0.78)
Physical activity	0.66 (0.63, 0.69)	0.75 (0.71, 0.79)	2.6 (2.2, 3.0)	0.45 (0.41, 0.50)	0.69 (0.67, 0.72)
Unilateral	0.52 (0.49, 0.55)	0.74 (0.70, 0.78)	2.0 (1.7, 2.3)	0.65 (0.60, 0.70)	0.66 (0.63, 0.68)
Moderate to severe	0.91 (0.89, 0.92)	0.41 (0.37, 0.45)	1.5 (1.4, 1.7)	0.22 (0.18, 0.27)	0.63 (0.60, 0.65)
Vomiting	0.45 (0.42, 0.48)	0.92 (0.90, 0.94)	5.6 (4.2, 7.5)	0.50 (0.56, 0.64)	0.68 (0.67, 0.71)
Aura symptoms	0.05 (0.04, 0.06)	0.98 (0.97, 0.99)	4.0 (2.0, 7.8)	0.94 (0.92, 0.96)	0.53 (0.52, 0.54)

LR = likelihood ratios; CI = confidence intervals; AUC of ROC = area under the curve for the receiver operating curves.

Table 4.—Likelihood Ratios and Predictive Values of the Optimal Models Within Individual Patient Populations

Optimal Models	+LR (95% CI)	−LR (95% CI)	PPV (95% CI)	NPV (95% CI)	Accuracy (95% CI)
Nausea					
Headache clinic	4.1 (2.9, 5.6)	0.24 (0.18, 0.31)	0.87 (0.82, 0.91)	0.73 (0.67, 0.80)	0.81 (0.77, 0.85)
Neurology practice	5.1 (3.1, 8.3)	0.10 (0.06, 0.16)	0.93 (0.89, 0.97)	0.80 (0.71, 0.89)	0.89 (0.85, 0.93)
College student	11.2 (4.2, 29.7)	0.35 (0.21, 0.58)	0.85 (0.71, 0.98)	0.85 (0.76, 0.93)	0.85 (0.78, 0.92)
Community-based	4.5 (3.5, 5.9)	0.28 (0.23, 0.33)	0.90 (0.87, 0.93)	0.65 (0.60, 0.70)	0.79 (0.76, 0.82)
Combined	4.8 (3.9, 5.7)	0.23 (0.20, 0.26)	0.89 (0.89, 0.91)	0.71 (0.68, 0.75)	0.82 (0.80, 0.84)
Nausea, photophobia, PA					
Headache clinic	4.6 (3.3, 6.5)	0.21 (0.15, 0.28)	0.88 (0.84, 0.92)	0.75 (0.68, 0.82)	0.83 (0.79, 0.86)
Neurology practice	6.5 (3.5, 11.7)	0.18 (0.13, 0.26)	0.94 (0.91, 0.98)	0.69 (0.60, 0.79)	0.85 (0.81, 0.90)
College student	9.1 (3.8, 21.1)	0.30 (0.17, 0.53)	0.83 (0.69, 0.97)	0.87 (0.79, 0.95)	0.86 (0.79, 0.93)
Community-based	5.9 (4.3, 7.9)	0.21 (0.17, 0.25)	0.92 (0.89, 0.94)	0.71 (0.67, 0.76)	0.84 (0.82, 0.86)
Combined	5.9 (4.8, 7.2)	0.21 (0.18, 0.24)	0.91 (0.89, 0.93)	0.74 (0.70, 0.77)	0.84 (0.82, 0.86)
Nausea, photophobia, pulsating					
Headache clinic	4.9 (3.4, 7.1)	0.25 (0.19, 0.32)	0.89 (0.85, 0.93)	0.71 (0.64, 0.78)	0.81 (0.77, 0.85)
Neurology practice	6.4 (3.5, 11.6)	0.19 (0.14, 0.27)	0.94 (0.91, 0.98)	0.67 (0.58, 0.77)	0.84 (0.80, 0.89)
College student	22.3 (5.5, 90.8)	0.34 (0.21, 0.55)	0.92 (0.81, 1.0)	0.85 (0.77, 0.93)	0.87 (0.80, 0.93)
Community-based	7.3 (5.1, 10.3)	0.22 (0.19, 0.27)	0.94 (0.91, 0.96)	0.70 (0.65, 0.75)	0.83 (0.81, 0.86)
Combined	6.7 (5.3, 8.4)	0.23 (0.20, 0.26)	0.93 (0.91, 0.94)	0.71 (0.68, 0.75)	0.83 (0.81, 0.85)

LR = likelihood ratio; PPV = positive predictive value; NPV = negative predictive value; CI = confidence intervals; PA = worse with physical activity; MS = moderate to severe.

PPVs and accuracies of >0.80 were attained by each of the three models for all 4 patient populations. NPVs ranged from 0.65 to 0.85 in the nausea model, 0.67 to 0.85 in the nausea/photophobia/pulsating model, and 0.69 to 0.87 in the nausea/photophobia/worse with exertion model.

Performance of Optimal Models Within Subgroups of Patients.—The single-variable model of nausea maintained similar sensitivities and specificities within different age groups ($P = .76$ and .42, respectively). The specificity of this model did not differ between women and men (0.83 vs. 0.84, $P = .66$), but the sensitivity was higher in females (0.82 vs. 0.74, $P = .014$). The +LRs and −LRs were 4.8/0.22, respectively, in women and 4.6/0.31 in men.

Similarly the sensitivities and specificities of the three-variable models did not differ within different age groups (all P values >.40). The specificities of the three-variable models were not influenced by gender (P values >.50), but the sensitivities were lower in men. The sensitivity was 0.72 in men and 0.85 in women for the nausea/photophobia/worse with exertion model and 0.70 in men and 0.82 in women in the nausea/photophobia/pulsating model (all P values <.001). The +LRs and −LRs of the former model were 5.7/0.18 and 5.5/0.32 in women and men, respectively, 6.8/0.20 and 7.0/0.33 in the later model.

The sensitivity and specificity were minimally affected in patients with CDH in our three models. The sensitivity was not significantly different for the single-variable model nausea in those with and without CDH (0.78 vs. 0.82, $P = .23$), but the specificity was slightly less in the CDH group (0.79 vs. 0.86, $P = .03$). This yielded +LRs and −LRs of 3.7/.28, respectively, in the CDH group and 5.9/.21 in the episodic headache group. The sensitivities and specificities were not significantly different in those with and without CDH in both of the three-variable models. (P values >.23)

COMMENTS

To our knowledge this study is the largest to date investigating the predictive value of abbreviated IHS criteria in the diagnosis of migraine headache (n = 1529). Our three best models were the single-variable model of nausea and the three-variable models of nausea/photophobia/worse with exertion and nausea/

photophobia/pulsating. All three models maintained +LRs >4.5 and −LRs <0.25 for the combined population, which would provide very good positive and negative predictive value in those with an intermediate pretest probability of migraine headache in the 40% to 60% range.

The operating characteristics of the three models were also evaluated within 4 discrete patient populations. The prevalence of migraine headache within these populations ranged from 33% in the college student group to 71% in the neurology practice. All three models maintained very good positive predictive values and accuracies, which approached or exceeded 80% in the 4 patient populations. The NPV was slightly less predictive, but remained >70% in the majority of the populations for all three models.

We used 1988 IHS criteria as the gold standard for diagnosis of migraine headache, but the criteria were revised in 2004. Since the criteria for migraine have only slightly changed from 1988 to 2004, we would expect similar results if the study was repeated with the newer criteria. We defined migraine headaches as diagnoses 1.1 to 1.7 from the 1988 criteria, which includes migraine with aura, migraine without aura and migrainous headache and would correspond to diagnoses 1.1, 1.2, and 1.6 in the 2004 criteria.

Multiple studies over the past decade have attempted to identify abbreviated migraine diagnostic criteria. Most were developed within specialty clinics, which could affect their generalization to the primary care setting.[15-17] Some[15,16,18] used verbal interviews to identify migraine predictors while others[17,19] have used verbal or written questionnaires. The ascertainment of clinical predictors may differ between verbal interviews and questionnaires.[20] Clinical predictors were not clearly defined in most of the past studies. For example, nausea could be defined in any of the following ways: (1) sick to your stomach, (2) queasiness, (3) a sensation of nausea, or (4) a feeling you want to vomit. The definition of nonmigraine headache also varied among past studies. Most[15,17,19] considered "all other headaches" as nonmigraine, while some[16,18] considered only tension-type headaches as nonmigraine. Only two past studies[17,19] using IHS diagnostic criteria have been validated in separate patient samples and none have been applied to a variety of patient populations to assess their transportability.

Our study has several strengths compared with past studies. Our models were not developed in a primary care population, but were tested in several diverse populations including specialty, college student, and population based samples with a wide range of prevalences. We used a verbal structured diagnostic interview, which allowed us to capture more complete information than written questionnaires and more accurately reflected what is actually done in clinical practice. The structured interview also ensured that clinical variables were collected similarly and that all variables were uniformly defined. Our definition of nonmigraine headache included a vast number of headache syndromes such as medication overuse, cluster headache, tension-type headache, and CDH, which would be representative of the diseases that need to be differentiated from migraine. Our models performed similarly at four separate sites throughout the United States suggesting transportability and cross validation of the models within separate patient populations.

Three past studies using IHS diagnostic criteria have reported the operating characteristics of single-variable models. Two of these studies used a structured verbal diagnostic interview[16,18] and one used a written questionnaire[19] to identify migraine predictors. The highest +LRs were reported for the single variables of nausea, vomiting, and photophobia and the lowest −LRs were reported for photophobia and nausea. The +LRs ranged from 2.5 to 21, 3.4 to 5.6, and 2.9 to 7.6 in these studies for nausea, vomiting, and photophobia, respectively, and the −LRs ranged from 0.18 to 0.34 and 0.14 to 0.49 for photophobia and nausea, respectively. Our study yielded similar results identifying nausea, vomiting, photophobia, and aura as those single variables with the highest +LRs and moderate to severe intensity, photophobia and nausea as those with the lowest LRs.

The single variable of "disability" (eg, headache is "severe/disabling" or "limits your ability to work, study or do what you need to do") has been purported by headache specialists to be a good univariate predictor of those with migraine headache. Studies, however, have failed to demonstrate sufficiently high +LRs with this single variable (+LRs range from 1.8 to 2.4 in two past studies) to "rule in" a diagnosis in those with an intermediate pretest likelihood of migraine.[19,21] The −LRs however, would be sufficiently low (−LRs range from 0.24 to 0.25 from two past studies) to "rule out" a diagnosis of migraine.

There have been three past studies of multivariate abbreviated models using IHS criteria as the gold standard for the diagnosis of migraine.[15,17,19] All were three-variable models and required 2/3 variables to be present for a positive test result. The +LRs from these studies ranged from 2.6 to 3.2 and the −LRs from 0.02 to 0.25. Therefore, these models would have only moderate positive predictive value in those with an intermediate pretest likelihood of migraine, but would have very good negative predictive value.

Liptons's "ID Migraine" screener is probably the best studied of the multivariate models and is the only one both developed and validated within a primary care population.[19] He enrolled patients from primary care waiting rooms that "wanted to speak to a health care professional about their headaches" or "had headaches that limited their ability to work, study or enjoy life." A 3-item written questionnaire was then developed and nausea, photophobia, and disability were identified as his three clinical predictors (2/3 answered affirmatively constituted a positive test result). His model demonstrated a +LR of 3.2 and −LR of 0.25. Interestingly the single question regarding nausea yielded the same +LR as the 3-item questionnaire (+LR = 3.2), but the −LR was higher at 0.49. This study was designed to screen for migraine in patients in an early symptomatic phase of migraine prior to their presentation to their primary physician. It is unknown how this model would perform in patients presenting to their physician with a complaint of headache. Also, it is uncertain whether the operating characteristics would change if the two screening questions were not asked prior to administration of the 3-item questionnaire nor how this questionnaire would perform verbally.

All three of our optimal models have maintained higher +LRs than have been reported by past studies of univariate and multivariate models. The slightly lower +LRs reported in most past studies might be explained by the fact that migrainous headaches were not included as part of their "gold standard" definition of migraine headache. In fact, the +LR for the combined population would decrease to 2.6 to 3.0 for the three models in the present study if migrainous headaches had been excluded from the definition of migraine. Also, past studies have not reliably separated out different headache types coexisting within the same patient, which could confound the identification of migraine predictors. For example, a patient with frequent tension-type headaches and infrequent migraine might not report nausea if it only occurs with one headache per month. Our structured diagnostic interview was specifically designed to identify more than one headache type within the same patient.

The predictive value of our models is very dependent on the prevalence of migraine headache in a given population. Our study was designed to predict migraine in populations with a similar prevalence to those presenting to physicians with a complaint of headache. Studies have reported a prevalence of migraine of 57% to 73% in primary care patients with a complaint of headache[5,6] and 63% to 71% in subspecialty patients (data derived from this study). A positive result to models with +LRs >4.5 would increase the probability of migraine to >80% in patients with prevalences in this range. Thus the univariate predictors of nausea, vomiting, and aura symptoms as well as both three-variable models would be very predictive of migraine headache in these populations. A negative result to models with −LRs <0.25 would decrease the probability of migraine to <30% in populations with prevalences <60%. Models with LRs <0.25 include the univariate predictors of nausea and moderate to severe and both three-variable models. Therefore, these models would have good negative predictive value in populations with prevalences <60%, but poor negative predictive value in those >60%.

The performance of our three models was not influenced by the age of the patients, but was affected by gender. All three of our models performed less well in a male population. The +LRs remained excellent in men ranging from 4.6 to 7.0 in the three models, but the negative LRs increased to 0.31 to 0.33. Therefore, the positive predictive value of our models would not be significantly affected by gender in those with an intermediate pretest probability of migraine, but the negative predictive value would be lower in men than women.

The operating characteristics of the single-variable model nausea were minimally affected by the presence of CDH, while the three-variable models were unaffected. The +LR of the single-variable model decreased to 3.7 in those with CDH and the −LR ratio increased to 0.28. This would slightly reduce the positive and negative predictive value of this model in those with CDH and an intermediate probability of migraine headache (eg, 40% to 60%). The presence of nausea however, would still have a positive predictive value of >75% to identify migraine in populations with a prevalence of migraine >50%. Since the prevalence of migraine headaches was >50% in those with CDH in all 4 patient populations, the single-variable model nausea would have very good positive predictive value in this subgroup.

There are several limitations to our study. First, these models were developed within specialty, population-based, and college student samples and their generalization to primary care patients has not been established. Second, the models perform the best in those with an intermediate pretest likelihood of migraine. Third, the operating characteristics of the models can only be assured through use of the same questions asked within the structured diagnostic interview. Fourth, as mentioned above the negative predictive value of the model may be less in men. Fifth, the inter- and intra-observer agreement of the structured diagnostic interview has not been determined in past studies.

Our two best three-variable models were marginally superior predictors of migraine when compared with the single-variable model of nausea, but these small differences were not considered to be clinically relevant. Therefore, nausea was considered our best model overall because a single-variable model would be the easiest to use within a clinical setting. But can the presence of a single predictor "diagnose" migraine headache? The authors maintain that the only absolute way to diagnose migraine is through use of the IHS diagnostic criteria. However, our data would suggest that the presence of nausea would increase the probability of migraine to >75% in populations with a prevalence of migraine >50%. We contend that a PPV >75% is sufficiently high to start therapies that are specific for the treatment of migraine headaches (eg, abortives such as the triptans/ergots and preventatives such as the anticonvulsants/β-blockers in those patients with a high enough migraine burden to warrant preventatives).

One should not conclude that all headaches with nausea are migraine headache since secondary headache disorders (eg, subarachnoid hemorrhage, meningitis, etc.) may present with nausea as a symptom. Therefore, abbreviated criteria should be applied only after an appropriate history and physical examination to exclude red flags of a secondary headache disorder. Nausea could also represent a side effect to abortive medications such as narcotics and anti-inflammatories; thus nausea associated with medication use should not be considered a positive predictor for migraine.

A logical sequence of steps must be followed to use abbreviated migraine diagnostic criteria in a patient presenting with a complaint of headache. First, secondary headache disorders must be excluded. Patients with a "red flag" for a secondary headache disorder should receive appropriate diagnostic testing (eg, appropriate neuroimaging and sometimes a lumbar puncture). The red flags for a secondary headache disorder include: (1) new onset headache in patients >40 years of age, (2) "worst or first" headache, (3) headaches reaching peak intensity within <60 seconds (thunderclap headaches), (4) change in the frequency, duration, or quality of headaches in those with existing headache disorders, (5) headache in those with systemic symptoms or disease (eg, unexplained weight loss or fever; history of malignancy, HIV, or immunosuppression), and (6) headache in those with neurologic signs (hemiparesis, hemisensory loss, cranial nerve abnormalities, etc.). Some consideration to neuroimaging might also be given to those with CDH. Second, abbreviated migraine diagnostic criteria can be used in the patient. The patient would have a likelihood >75% of migraine headaches if the criteria are positive. Third, migraine specific therapies can be considered if the abbreviated criteria are positive. A response to migraine specific therapies should not be used, however, to establish a diagnosis of migraine headache since secondary headache disorders have

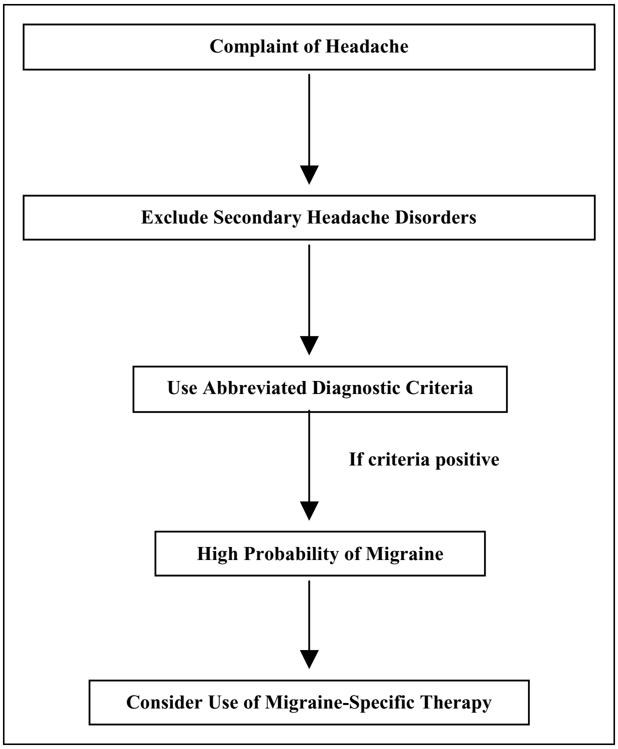

Fig.—Use of abbreviated migraine diagnostic criteria in clinical practice. Adapted with permission from Martin, V. Simplifying the diagnosis of migraine headache. Adv Stud Med. 2004;4:200-209.

been reported to respond to the triptans (eg, subarachnoid hemorrhage, low pressure headache syndromes, etc.). The authors recognize that the management of chronic migraine may differ from episodic migraine. For example, migraine specific therapies should be limited to ≤2 days per week particularly within those with chronic migraine to prevent medication overuse headaches. Also, it may be necessary to combine two or more preventatives to treat patients with chronic migraine (Figure).

CONCLUSIONS

The single model of nausea and the three-variable models of nausea/photophobia/worse with exertion and nausea/photophobia/pulsating were identified as our most predictive models for the recognition of migraine headache. They provided very good PPV and moderate NNV in those with an intermediate prevalence of migraine headache. These models also performed similarly within 4 different patient samples suggesting transportability and cross validation of the models. The three-variable models are marginally superior predictors of migraine, but not enough to warrant their recommendation over the one-variable model of nausea. Therefore, nausea was chosen as our best abbreviated model. The single-variable model of nausea may represent a useful tool for the recognition of migraine headache if confirmed in future prospective studies within primary care populations. These models, however, should only be applied after a careful exclusion of secondary headache disorders.

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