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Utility of an Abbreviated Dizziness Questionnaire to Differentiate between Causes of Vertigo and Guide Appropriate Referral: A Multicenter Prospective Blinded Study

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Abstract

Objective—Test performance of a focused dizziness questionnaire’s ability to discriminate between peripheral and non-peripheral causes of vertigo.

Study Design—Prospective multi-center

Setting—Four academic centers with experienced balance specialists

Patients—New dizzy patients

Interventions—A 32-question survey was given to participants. Balance specialists were blinded and a diagnosis was established for all participating patients within 6 months.

Main outcomes—Multinomial logistic regression was used to evaluate questionnaire performance in predicting final diagnosis and differentiating between peripheral and non-peripheral vertigo. Univariate and multivariable stepwise logistic regression were used to identify questions as significant predictors of the ultimate diagnosis. C-index was used to evaluate performance and discriminative power of the multivariable models.

Results—437 patients participated in the study. Eight participants without confirmed diagnoses were excluded and 429 were included in the analysis. Multinomial regression revealed that the model had good overall predictive accuracy of 78.5% for the final diagnosis and 75.5% for differentiating between peripheral and non-peripheral vertigo. Univariate logistic regression identified significant predictors of three main categories of vertigo: peripheral, central and other. Predictors were entered into forward stepwise multivariable logistic regression. The discriminative

power of the final models for peripheral, central and other causes were considered good as measured by c-indices of 0.75, 0.7 and 0.78, respectively.

Conclusions—This multicenter study demonstrates a focused dizziness questionnaire can accurately predict diagnosis for patients with chronic/relapsing dizziness referred to outpatient clinics. Additionally, this survey has significant capability to differentiate peripheral from non-peripheral causes of vertigo and may, in the future, serve as a screening tool for specialty referral. Clinical utility of this questionnaire to guide specialty referral is discussed.

Introduction

Dizziness is a common problem seen in general otolaryngology and primary care offices. Patients of all age ranges are affected and the prevalence of dizziness increases with age.¹ A recent screening study reported a lifetime prevalence of 7% for women and 3% for men requiring a medical consultation for vertigo.¹ Although dizziness is common and problematic, diagnosis remains difficult, especially for those in the primary care setting.

While there are multiple questionnaires in use to describe the emotional, physical and functional effects of vestibular disease and dizziness, including the Dizziness Handicap Inventory² and The UCLA Dizziness Questionnaire,³ a good tool to quickly differentiate between causes of vertigo is still lacking. Arguably, a timely, efficient diagnosis and early treatment of dizziness would improve quality of life for patients, and decrease work-loss days. A recent review of the evaluation of vertiginous patients supports a decrease in enthusiasm for unnecessary expensive vestibular testing and an emphasis on the use of patient history when diagnosing dizzy patients.⁴ Grill et al.⁵ reports an overuse of expensive neuroimaging studies with an estimated 71% of BPPV patients undergoing an MRI during their work-up for vertigo. In order to make appropriate referrals and avoid delay of diagnosis and unnecessary tests, a short, inexpensive questionnaire would be useful to differentiate between common causes of dizziness. Specifically, differentiating between peripheral and non-peripheral vertigo would be pivotal to save time and efficiently initiate treatment with the appropriate specialist.

Prior work by Zhao et al. has supported the use of a historical questionnaire as a vital tool for initial assessment of dizziness patients. Previously, a subset of 32 questions regarding dizziness symptoms was identified, which performed very well, with an overall predictive accuracy of 71%.⁶ This instrument was developed by a single neurotologist using questionnaire and diagnosis data from patients at a single institution. In the present study, the questionnaire tested previously has been slightly modified and the investigation has been expanded to 4 specialty balance centers around the country in order to increase generalizability of the application of a focused historical instrument. Additionally, the ability of this instrument to differentiate between major categories of vertigo - peripheral, central and other causes - was assessed. The main objective of this study was to test the performance of a modified version of a previously developed dizziness assessment tool. As a secondary outcome, the utility of this questionnaire to differentiate between the broad categories of vertigo was explored.

Materials and methods

This was a multicenter prospective blinded cohort study. Four experienced balance specialists (three neurotologists and one PhD balance specialist) from separate dizziness and balance centers participated in the study. These institutions are all well-established and well-recognized balance centers. All clinics included neurotology, neurology and psychiatric consultation and input as needed. The study population consisted of patients scheduled to see one of the participating specialists for a new dizziness complaint. At the time of their visit, prior to seeing the physician, all patients with dizziness complaints were approached, and interested participants were consented by staff and given a 32-question survey assessing symptoms, timeline, and exacerbating factors of dizziness (Figure 1). This questionnaire was slightly modified from the 32-question version tested previously⁶ and developed based on three considerations, 1. statistical significance of questions, 2. clinical relevance and experience and 3. discussion among experts in the field. For questions left blank on the questionnaire, an answer of “No” was presumed. The questionnaire was collected prior to the patient seeing the specialist as to keep the specialist blinded. Each physician performed routine history and physical exams as well as vestibular testing / imaging / further work-up as determined necessary. Participating specialists provided the final diagnosis 6 months after the initial visit based on a consensus decision made by all participating specialists. All involved specialists were granted input regarding final diagnoses. There was no prescribed algorithm for diagnosis, rather, all input from involved specialists was considered in making a decision based on clinical judgement from a 6 month time period. Any developments outside of the 6 month period were outside of the scope of this study. Multiple diagnoses were accepted. Diagnoses were categorized as previously reported,⁶ with the final diagnosis groups consisting of BPPV, vestibular migraine, Meniere’s Disease, vestibular neuritis, “Other peripheral vestibular,” “Other CNS,” and “Other miscellaneous.” “Other peripheral vestibular” included canal dehiscence, hypoactive labyrinth, SNHL, eustachian tube dysfunction and otosclerosis. “Other CNS” included anxiety, central cause, motion sickness, multiple sclerosis, neoplasm, trauma, Parkinson’s, NPH, abnormal gait, and epilepsy. “Other miscellaneous” included autonomic/orthostasis, cerebrovascular, dizziness NOS, conversion disorder, neuropathy, lupus, sinusitis, hypoglycemia and tinnitus. In this study, “cerebrovascular” referred to chronic small vessel disease and imbalance and not a focal or acute stroke. If patients had 2 of any of the following - BPPV, vestibular neuritis, Meniere’s or vestibular migraine - they were considered to have 2 final diagnoses and were not included in the analysis. However, BPPV, vestibular neuritis, Meniere’s and migraine were considered to “trump” other CNS, other peripheral vestibular and other miscellaneous diagnoses. Therefore, if a patient had BPPV and anxiety, they would have been analyzed as a BPPV patient. Similarly, if a patient had both BPPV and hypoactive labyrinth, which was considered an “Other peripheral vestibular” cause, the patient would have been analyzed as a BPPV patient in this study.

A second, more broad categorization group included the diagnoses of “Peripheral causes,” “Central causes” and “Other causes.” “Peripheral causes” included BPPV, Meniere’s, vestibular neuritis and Other peripheral vestibular. “Central causes” included vestibular migraine and other CNS. “Other causes” included “Other Miscellaneous” as defined above.

The “Other causes” category was reserved for patients without a peripheral or central explanation for dizziness.

This study was reviewed and approved by the respective Institutional Review Boards at each participating center. All surveys were completed on paper and were entered into REDCap Software (Version 5.11.1) for organization and data manipulation.

Standard descriptive statistics were used to describe the study population and explore distribution of diagnoses. Primary diagnosis of vertigo with mutually exclusive categories was the dependent variable of multinomial logistic regression used to test the predictive power of the 32-question survey for the correct vertigo diagnosis. If participants received a final diagnosis (BPPV, vestibular migraine, Meniere’s or vestibular neuritis), this diagnosis was considered the primary diagnosis in analysis. If participants received two final peripheral diagnoses, they were excluded from the multinomial regression testing accuracy for final diagnosis. The percent correctly classified was determined based on the highest likelihood diagnosis, compared to the baseline category, which was BPPV, the most common diagnosis. Additionally, multinomial logistic regression was used to test the predictive power of the instrument for broad category diagnoses. Broad category diagnoses consisted of peripheral, central and other causes. Patients with both central and peripheral vertigo diagnoses were excluded from the analysis exploring predictive abilities of the instrument to differentiate between peripheral, central and other causes. Percent correctly classified was used to evaluate model performance.

To further interrogate the 32-question survey, univariate analysis was used to identify questions as significant predictors of the three major categories. Statistically significant variables ($p < 0.05$) from univariate analyses were included in a multivariable forward stepwise logistic regression. C-index was used to evaluate performance and discriminative power of the final multivariable models. All statistical analyses were performed using the SPSS software package.

Results

Descriptive characteristics

A total of 437 patients agreed to participate in the study. Eight participants without confirmed diagnoses were excluded from the final analysis, leaving 429 analyzable cases. The mean age of the population was 54 years ($SD=14$) with 62.5% female and 34.5% male (3% not declared). The distribution of final diagnoses and baseline characteristics of patients from each medical center are shown in Table 1. A total of 43 patients received both peripheral and central diagnoses of vertigo; 28 of these had a central diagnosis of vestibular migraine. The most common co-existing diseases were BPPV and vestibular migraine ($n=13$) and BPPV and vestibular neuritis ($n=17$).

Final Vertigo Diagnoses

Using multinomial regression, the instrument revealed high predictive power ($>80\%$ sensitivity) for BPPV, vestibular migraine, Meniere’s and vestibular neuritis and fair predictive power ($>60\%$) for “Other CNS” and “Other miscellaneous” diagnoses. The

biggest weakness of the instrument was misclassification of participants with “Other peripheral vestibular” diagnoses as vestibular migraine or Meniere’s patients. The overall predictive capability of the instrument was 78.5% for the final diagnosis (Table 2).

Broad category diagnoses

When evaluating the model for accuracy using three major diagnosis categories of peripheral, central, and other causes, the overall sensitivity of the instrument was 75.5% with high predictive power (>80%) for peripheral diagnoses and fair predictive power (>60%) for central and other causes (Table 3). Univariate analysis identified symptoms that were negative or positively correlated to the three main diagnosis categories of vertigo: peripheral causes, central causes and other causes (Table 4). Symptoms and complaints which were identified as significant in the univariate analyses were entered into a multivariable analysis using forward stepwise logistic regression. The results of these analyses are shown in Table 5. Using the final models developed in the multivariable analysis, the areas under the ROC curves, or c-indices, were shown to have good discriminatory power with a c-index of 0.75, 0.70 and 0.78 for peripheral, central and other causes of vertigo, respectively (Table 5).

Discussion

The results of this multi-institutional, blinded, prospective study show that a short, focused dizziness questionnaire has good predictive power for determining final diagnoses in the outpatient vertigo clinic population for care of patients presenting with non-acute, chronic or remitting vertigo. Additionally, this instrument is potentially able to direct referrals and specialty treatment by discriminating between peripheral, central and other causes of vertigo in more than three-fourths of cases. By further interrogating the questionnaire through multivariable analysis, specific questions which may be the most informative regarding diagnosis have been identified. By considering the associated odds ratios for each answer choice, this subset of questions may further guide the evaluating physician towards a working diagnosis and subsequent work-up and referral.

This instrument performed with slightly improved accuracy to the 32-question survey used in the Zhao et al. study (overall predictive capability of 75.5% vs 71.4%)⁶ with improved sensitivity at predicting BPPV, vestibular migraine, Meniere’s, vestibular neuritis, “Other CNS” and “Other miscellaneous” diagnoses, suggesting that the modifications made to the instrument were helpful in distinguishing between final diagnoses. Interestingly the current study, although with a smaller sample size, had dramatic improvement with prediction of vestibular neuritis and decreased accuracy with predicting “Other vestibular” causes of vertigo. This was due to the misclassification of patients with “Other vestibular” causes to predicted diagnoses of vestibular migraine, Meniere’s and miscellaneous causes, however no “Other vestibular” patients were predicted to have “Other CNS” diagnoses. In general, patients were very rarely misclassified to the “Other CNS” category, suggesting that this instrument would not mistakenly lead a physician to refer for central neurologic workup or order unnecessary brain imaging. As seen in the Zhao et al. study,⁶ the current instrument performed very well with the prediction of the most common diagnoses seen in specialty

otolaryngology clinics with available neurologic consultation - BPPV, Meniere's Disease, vestibular neuritis and vestibular migraine. This is likely due to the development of a questionnaire which contains relevant questions to distinguish between these common diagnoses.

The ability of this instrument to accurately predict peripheral, central and other causes is promising as a potential tool for physicians interested in referring patients for neurologic or otoneurologic consultation. The current survey revealed an overall predictive capability of 75.5% accuracy in discriminating between these broad categories of dizziness. The model was the most sensitive in detecting peripheral causes, most likely due to the patient population that was tested as well as the focus of the survey on pertinent vestibular questions. Of note, this instrument was the least sensitive for classification into the broad category of central causes. The 40 misclassified central patients who were thought to have either peripheral or other causes of vertigo were predominantly vestibular migraine patients (53%), followed by abnormal gait patients (20%). Six (15%) of the central misclassified patients were given a diagnosis of "central vertigo," however, unfortunately, no further specifics were available. The subset of questions identified as particularly useful for differentiating between broad categories of dizziness are all consistent with known symptoms associated with either peripheral or central diagnoses. These particular questions may hold extra weight when considering a patient for referral for further work-up.

Clinically, it appears that utilization of a short survey may improve efficiency of diagnosis and appropriate referral and may decrease the use of unnecessary expensive work-up. The ability for this instrument to perform well in both diagnosing common types of vertigo as well as differentiating between broad categories of causes of dizziness makes it potentially universally useful and applicable to a large number of specialties. While further validation in the primary care setting needs to be done, the hope is that this instrument can both guide the general otolaryngologist in making a final diagnosis or help a general otolaryngologist or primary care physician determine whether the patient should be referred to a neurologist or a neurologist. Arguably, those identified as likely to be in the "other" category would warrant further work up with an internist or cardiologist.

There are several limitations of this study. A major limitation is external generalizability to patient populations seen in the general otolaryngology and primary care clinic. The instrument has been developed and tested in patients who were referred to balance specialists, and thus the population is potentially skewed towards patients with peripheral, and confusing or ambiguous central causes of vertigo. Likely, a primary care office would include more patients with ischemic and other neurologic diseases contributing to dizziness. Of note, in our patient population we had only 5 patients with diagnosed neoplasms, and 3 patients with cerebrovascular / cerebral artery occlusion issues thought to be related to dizziness. Patients diagnosed with central causes of vertigo were predominantly vestibular migraine patients. Due to overlap of symptoms of vestibular migraine patients with peripheral vestibular patients, the sensitivity for classifying these patients with central disease was only fair (>60%). Further work to validate the performance of this instrument in the general otolaryngology and primary care patient population is warranted. A second limitation is sample size. While this study is multi-institutional and included over 400

patients, sample size did not allow for evaluation of the performance of the survey for less commonly diagnosed causes of vertigo. A third limitation is the predetermined length of follow-up time of 6 months. This time period was chosen as an appropriate and reasonable length of time to allow for adequate consults, work-up and evolution of any potentially dangerous etiologies of vertigo. However, consideration of events occurring outside of this 6 month time period would not have been included in the results. Additionally, the nature of our study did not allow collection of data of patients who did not consent to our study. While all patients with vertigo complaints were approached and invited to participate, demographic and diagnostic information for patients who declined to participate were not obtained. Lastly, the nature of the analysis and sample size does not allow categorization of patients with more than one diagnosis for which we are not able to create a hierarchy.

In the future, evaluation of the performance of this questionnaire in the general otolaryngology and primary care setting would be the next logical step. Through a multi-institutional, blinded, prospective study design, the predictive capabilities of this short, simple survey at predicting vertigo diagnoses can be validated. The ultimate long-term goal of this project is the development of a simple computer based application or program in which a physician could answer a subset of questions and receive a statistically supported list of probabilities of possible vertigo diagnoses. Further work with increased sample size is warranted to meet this goal. Using the clinical history and reported symptoms of the patients' vertiginous episodes is extremely important for decreasing unnecessary diagnostic work-up costs and increasing the rate at which patients are seen by the appropriate specialist, ultimately leading to improved quality of life.

Conclusion

This study demonstrates the ability of a focused dizziness instrument to accurately predict diagnosis in specialty outpatient balance clinics. Further work is warranted to test the performance of this tool in the primary care setting to differentiate peripheral from non-peripheral causes of vertigo and potential use as a screening tool for referral.

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References

1. Neuhauser, Hannelore K. Epidemiology of vertigo. *Current Opinion in Neurology*. 2007; 20:40–6. [PubMed: 17215687]
2. Jacobson G, Newman C. The development of the Dizziness Handicap Inventory. *Archives of Otolaryngology - Head and Neck Surgery*. 1990; 116:424–7. [PubMed: 2317323]
3. Zur O, Carmeli E. The University of California Los Angeles Dizziness Questionnaire: Advantages and Disadvantages. *Journal of Vestibular Research*. 2014; 23:279–83. [PubMed: 24447967]
4. Phillips JS, Mallison A, Hamid MA. Cost-effective evaluation of the vestibular patient. *Current opinion in Otolaryngology & Head and Neck Surgery*. 2011; 19:403–9. [PubMed: 21849898]
5. Grill E, Strupp M, Muller M, Jahn K. Health Services Utilization of Patients with Vertigo in Primary Care: A Retrospective Cohort Study. *J Neurol*. 2014; 261:1492–8. [PubMed: 24817192]
6. Zhao J, Piccirillo J, Spitznagel E, Kallogjeri D, Goebel J. Predictive Capability of Historical Data for Diagnosis of Dizziness. *Otol Neurotol*. 2011; 32:284–90. [PubMed: 21178804]

Please complete ALL sections of this questionnaire. Thank you.

Participant ID #: _____ Age: _____ Date: _____

Gender: Male ☐ Female ☐

Is your dizziness constant or does it come in spells?

It is constant.....☐

It comes in spells.....☐

During your dizziness, do you feel like...

	Yes	No
You are spinning around in circles.....	☐	☐
The world is spinning around you.....	☐	☐
You are nauseated.....	☐	☐
Your head is swimming.....	☐	☐
You are very sensitive to light, or changes in lighting.....	☐	☐
You are very sensitive to sounds, or changes in sound	☐	☐

If yes,

Do you sounds make you dizzy ☐

Do sounds make your world jiggle ☐

My hearing...

	One ear	Both ears	Neither
Changed for the better recently.....	☐	☐	☐
Changed for the worse recently.....	☐	☐	☐
Changed during a dizziness attack.....	☐	☐	☐

My ears...

Ring when I am dizzy.....	☐	☐	☐
Feel full or bursting when I am dizzy.....	☐	☐	☐
Feel painful when I am dizzy.....	☐	☐	☐

Have you ...

	Yes	No
Lost consciousness, "blackout," or fainted.....	☐	☐
Had severe prolonged headaches with nausea and/or light sensitivity	☐	☐
Or a family member ever been diagnosed with migraines.....	☐	☐
Had trouble walking in the dark.....	☐	☐

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See Other Side

If your dizziness comes in spells, please answer the following questions:

My typical dizzy attack lasts... (pick ONE)

- Less than 3 mins.....☐
 More than 3 but less than 15 mins.....☐
 More than 15 but less than 59 mins...☐
 More than 1 but less than 12 hours....☐
 More than 12 hrs but less than 1 week ☐
 Weeks to months.....☐
 They vary greatly.....☐

Usually, a dizzy attack happens...(pick ONE)

- Less than once a month.....☐
 At least once a month, but less than weekly ☐
 At least once a week, but not daily.....☐
 Daily.....☐
 It varies greatly.....☐

Which of the following describe your symptoms?

	Yes	No
Dizzy in sudden spells, with breaks in between.....	☐	☐
Dizzy when sitting or standing still.....	☐	☐
Dizzy when rolling over in bed.....	☐	☐
Dizzy when turning or moving your head.....	☐	☐
Dizzy when bent over or reaching down.....	☐	☐
Dizziness lasts for a few seconds when you get up quickly from a chair or bed	☐	☐

Please indicate whether your dizziness changes...

	More	Less	No Change
In certain positions.....	☐	☐	☐
For women, during your menstrual period.....	☐	☐	☐
When you sit or stand still.....	☐	☐	☐
When you rapidly move your head	☐	☐	☐

Figure 1.
 Focused Dizziness Questionnaire

Table 1**Characteristics of the Study Population**

	Total
Number of participants	429
Age, mean (SD)	54 (14)
Sex, n(%)	
Male	148(34.5)
Female	268(62.5)
Not specified	13(3)
Final Diagnoses *	
BPPV	108
Vestibular Migraine	108
Meniere's	83
Vestibular neuritis	40
Other Peripheral Vestibular	42
Other CNS	66
Other miscellaneous	47
Multiple final diagnoses	
BPPV and Vestibular neuritis	17
BPPV and Vestibular Migraine	13
Vestibular Migraine and Meniere's	8
Vestibular neuritis and Vestibular Migraine	3
Broad Category Vertigo Diagnoses **	
Peripheral	210
Central	129
Other	47
Multiple broad category diagnoses	
Peripheral and Central	43
Multiple peripheral diagnoses	41

* Some participants had more than one of the diagnoses listed. Participants with multiple final diagnoses (BPPV, Vestibular Migraine, Meniere's and Vestibular neuritis) were excluded from multinomial logistic regression testing prediction of final diagnosis.

** For broad category diagnoses, patients were classified as either peripheral, central, other, or peripheral and central (total N=429). Participants with both peripheral and central diagnoses were excluded from multinomial logistic regression testing prediction of broad category diagnosis.

Table 2

Predicted diagnosis by multinomial logistic regression versus final diagnosis

	Predicted						95% CI for % correctly classified
	BPPV	Vestibular Migraine	Meniere's	Vestibular neuritis	Other Vestibular	Other CNS	
Diagnosed (n=303)							
BPPV (n=67)	57	4	3	0	1	1	85.1 0.74-0.92
Vestibular Migraine (n=72)	3	60	2	0	0	3	83.3 0.73-0.90
Meniere's (n=63)	1	5	54	0	0	3	85.7 0.75-0.93
Vestibular Neuritis (n=10)	0	0	0	10	0	0	100 0.68-1.00
Other Peripheral Vestibular (n=22)	0	4	2	0	12	0	54 0.35-0.73
Other CNS (n=34)	4	4	2	0	0	21	61 0.45-0.76
Other misc. (n=35)	3	4	1	0	0	3	68 0.52-0.82
Overall percentage (%)	22.4	26.7	21.1	3.3	4.3	10.2	78.5

Table 3
Predicted diagnosis by multinomial logistic regression versus broad category diagnosis

Diagnosed (n=319)	Predicted				95% CI for % correctly classified
	Unknown / Other	Central Causes	Peripheral Causes	Correctly classified (%)	
Other (n=35)	24	5	6	68.6	0.52–0.82
Central causes (n=106)	6	66	34	62.3	0.53–0.71
Peripheral causes (n=178)	6	21	151	84.8	0.79–0.89
Overall percentage	11.3	28.8	59.9	75.5	

Table 4
Significant variables for each diagnostic category from binary logistic regression

Diagnostic Category	Variable	OR	95% CI for OR Lower, Higher	P value
Peripheral				
Positive predictors				
	<i>Hearing improved in one ear recently</i>	4.66	1.53 14.17	0.007
	<i>Dizzy rolling in bed</i>	3.0	1.57 3.75	<0.001
	<i>Sensation of world spinning</i>	2.27	1.55 3.34	<0.001
	<i>Ear rings when dizzy</i>	2.14	1.29 3.54	0.003
	<i>Dizziness spells</i>	1.96	1.28 3.00	0.002
	<i>Hearing worsened in one ear recently</i>	1.84	1.12 3.03	0.016
	<i>Sensation of spinning in circles</i>	1.81	1.23 2.67	0.003
	<i>Age</i>	1.02	1.004 1.032	0.010
Negative predictors				
	<i>Attack frequency - daily</i>	0.22	0.98 0.504	<0.001
	<i>Prolonged headaches</i>	0.499	0.334 0.746	0.001
	<i>Trouble in Dark</i>	0.61	0.413 0.997	0.010
	<i>Sensitive to Light</i>	0.618	0.421 0.905	0.013
	<i>Family history of migraines</i>	0.659	0.438 0.990	0.045
Central				
Positive predictors				
	<i>Prolonged headaches</i>	3.02	1.97 4.62	<0.001
	<i>Sensitive to light</i>	1.97	1.3 2.98	0.001
Negative predictors				
	<i>Ear feels full when dizzy</i>	0.55	0.300 0.996	0.049
	<i>Dizzy rolling in bed</i>	0.60	0.37 0.85	0.006
	<i>Age</i>	0.977	0.963 0.992	0.003
Other				
Negative predictors				
	<i>Prolonged headaches</i>	0.193	0.075 0.498	0.001

Diagnostic Category	Variable	OR	95% CI for OR Lower, Higher		P value
	<i>Nauseated</i>	0.22	0.114	0.424	<0.001
	<i>Decrease in dizziness when standing/sitting still</i>	0.244	0.093	0.643	0.004
	<i>Dizzy rolling in bed</i>	0.288	0.145	0.571	<0.001
	<i>Sensation of spinning in circles</i>	0.295	0.134	0.648	0.002
	<i>Increase in dizziness when moving head</i>	0.398	0.213	0.743	0.004
	<i>Dizzy when bend over</i>	0.419	0.227	0.775	0.006
	<i>Sensation of world spinning</i>	0.42	0.223	0.793	0.007
	<i>Sensitive to sound</i>	0.457	0.22	0.946	0.035
	<i>Dizzy when getting up quickly</i>	0.475	0.255	0.883	0.019

Table 5

Significant variables for each diagnostic category from multivariate logistic regression

Diagnostic Category	Variable	OR	95% CI for OR	Lower, Higher	P value
Peripheral					
	<i>Hearing improved in one ear recently</i>	3.72	1.030	13.41	0.045
	<i>Sensation of world spinning</i>	2.65	1.67	4.19	<0.001
	<i>Dizzy rolling in bed</i>	2.53	1.60	4.003	<0.001
	<i>Ear rings when dizzy</i>	2.020	1.098	3.715	0.024
	<i>Age</i>	1.024	1.007	1.042	0.005
	<i>Sensation of spinning in circles</i>	0.576	0.361	0.919	0.021
	<i>Family history of migraines</i>	0.57	0.347	0.939	0.027
	<i>Prolonged headaches</i>	0.397	0.240	0.655	<0.001
C-Index of final model = 0.75					
Central					
	<i>Prolonged headaches</i>	3.01	1.91	4.74	<0.001
	<i>Age</i>	0.98	0.97	0.99	0.026
	<i>Dizzy rolling in bed</i>	0.48	0.31	0.75	0.001
	<i>Ear full when dizzy</i>	0.47	0.25	0.89	0.019
C-Index of final model = 0.70					
Other					
	<i>Prolonged headaches</i>	0.279	0.105	0.743	0.011
	<i>Nauseated</i>	0.346	0.173	0.690	0.003
	<i>Dizzy rolling in bed</i>	0.369	0.181	0.752	0.006
	<i>Sensation of spinning in circles</i>	0.433	0.191	0.982	0.045
C-Index of final model = 0.78					