Sensitivity and specificity of the Amer dizziness diagnostic scale (ADDS) for patients with vestibular disorders

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Abstract. [Purpose] To investigate the sensitivity and specificity of a newly developed diagnostic tool, the Amer Dizziness Diagnostic Scale (ADDS), to evaluate and differentially diagnose vestibular disorder and to identify the strengths and weaknesses of the scale and its usefulness in clinical practice. [Subjects and Methods] Two hundred subjects of both genders (72 males, 128 females) aged between 18 to 60 (49.5±7.8) who had a history of vertigo and/or dizziness symptoms for this previous two weeks or less were recruited for the study. All subjects were referred by otolaryngologists, neurologists or family physicians in and around Jeddah, Kingdom of Saudi Arabia. On the first clinic visit, all the patients were evaluated once using the ADDS, following which they underwent routine testing of clinical signs and symptoms, audiometry, and a neurological examination, coupled with tests of Vestibulo-Ocular Reflex function, which often serves as the "gold standard" for determining the probability of a vestibular deficit. [Results] The results show that the ADDS strongly correlated with "true-positive" and "true-negative" responses for determining the probability of a vestibular disorder (r =0.95). A stepwise linear regression was conducted and the results indicate that the ADDS was a significant predictor of "true-positive" and "true-negative" responses in vestibular disorders (R² =0.90). Approximately 90% of the variability in the vestibular gold standard test was explained by its relationship to the ADDS. Moreover, the ADDS was found to have a sensitivity of 96% and a specificity of 96%. [Conclusion] This study showed that the Amer Dizziness Diagnostic Scale has high sensitivity and specificity and that it can be used as a method of differential diagnosis for patients with vestibular disorders.

Key words: Dizziness, Vestibular, Balance

INTRODUCTION

Dizziness is one of the most common complaints in medicine and encompasses various abnormal sensations relating to perceptions of the body's relationship to space. The prevalence of dizziness in the general population ranges from 20 to 30%1). Typically, dizziness is divided into four subtypes: vertigo, lightheadedness, disequilibrium and oscill_checkpoint...
which is used to quantify balance disorders, somatic anxiety, and autonomic severity symptoms\textsuperscript{14}. The VSS consists of two subscales: the Vertigo scale (VSS-VER), which assesses symptoms mainly associated with disorders of the vestibular system, and the Anxiety and Autonomic symptom scale (VSS-AA) for the assessment of a group of generic symptoms which may be associated with autonomic arousal or somatic expressions of anxiety\textsuperscript{15, 16}. Also, in 1990, Jacobson and Newman designed and validated a specific questionnaire for dizziness, the Dizziness Handicap Inventory (DHI), which evaluate the self-perception of the incapacitating effects on quality of life caused by dizziness. The DHI is a useful tool for physiotherapists and professional rehabilitation teams, enabling them to list patients' problems, define intervention goals, and plan and evaluate treatment and/or rehabilitation programs\textsuperscript{17}. Even though both these scales are used assess dizziness patients, they are primarily used for those who have been diagnosed, to establish the intensity of dizziness and the functional impact of dizziness on their lives. However, before using any of these tests and scales, it is always preferable to provide direction for the clinician as to how to proceed with further assessment and examination of a patient who presents with a complaint of dizziness so that unnecessary diagnostic procedures can be avoided.

The wide variation in patient symptoms and the lack of knowledge about the natural history of some vestibular impairments compound the selection of patients who might be good candidates for vestibular rehabilitation. There is a need for sensitive and specific methods for identifying patients with vestibular impairment so as to enable a clinician or rehabilitation professional to direct them to the right treatment. For diagnosing peripheral vestibular dysfunction, the first step in the procedure is the patients' report of symptoms, form which the presence of a vestibular deficit can be inferred. If the questions are not articulated properly, the outcome of the diagnosis may vary. For this reason, there is frequently a lack of association between symptoms and the actual detection of vestibular abnormalities\textsuperscript{18}. The vestibular tests, however, do not characterize the vestibular deficit in terms of the patient's functional deficit, and thus have limited value in the identification of balance deficits related to vestibular dysfunction\textsuperscript{19}. The selection of tests for a dizziness patient will depend on a number of factors. To choose an ideal test, the clinician must consider the tests' measurement properties, the characteristics of the subjects being tested, the expertise needed by the clinician to administer the test, cost and equipment requirements, as well as the space and time required for the test. Although there are multiple tests in existence for documenting vestibular dysfunction, the cost and the time required to perform these tests often preclude their use in general clinics. Therefore, the need arises for a simple scale for screening dizzy patients which can differentially diagnose them on their first visit to a clinic and direct them to an appropriate mode of investigative procedures and management. As discussed earlier, since the causes of dizziness are multi-factorial, it may be difficult for general physicians to diagnose a patient with dizziness.

Thus, the main aim of the current study was to investigate the feasibility of using ADDS as a first line of evaluation in general clinics, so that even those who are not specialized in this area can effectively screen a patient who complains of dizziness and refer him or her to the appropriate specialty for further diagnosis and management. Considering these factors, the aim of the present study was to evaluate the sensitivity and specificity of the ADDS, a newly developed diagnostic tool for evaluating and differentially diagnosing vestibular disorders, in people with vestibular disorders, and to identify the strengths and weaknesses of its usefulness in clinical practice.

**SUBJECTS AND METHODS**

**Subjects**

Two hundred subjects aged between 18 and 60 years old (49.5±7.8) including both male and female patients who had a history of vertigo and/or dizziness symptoms in the previous two weeks or less were recruited for this study. After explaining the objectives and procedures of the study to subjects, informed consent for this study was obtained. The study was approved by the Institutional Review Board of King Abdulaziz University. All subjects were referred by otorhinolaryngologists, neurologists or family physicians in and around Jeddah, Kingdom of Saudi Arabia and the study was conducted over a period of 11 months.

**Procedure: Amer Dizziness Diagnostic Scale (ADDS)**

The Amer Dizziness Diagnostic Scale (ADDS) is administered as a structured interview in which participants are asked seventeen specific questions which cover different aspects of dizziness or vertigo, such as the type of dizziness, symptoms, tempo, circumstances, history etc. The specific questions in the scale are arranged in a hierarchical decision tree and each question is aimed at one behavior and evokes a "yes" or "no" answer. The presence and severity of dizziness symptoms are rated on a scale based on the category or section. Thus, possible scores vary from 0 to 113, with each category of scores indicating a different diagnosis (Fig. 1). The ADDS's seventeen questions are divided into five categories. The first seven questions are general information questions. The patients are asked about their gender, age, and their history of hypertension, diabetes mellitus, and balance problems, and also whether they have experienced partial hearing loss associated with dizziness. These general questions are intended for statistical and future research purposes. The next three questions are specific to Unilateral Vestibular Hypofunction (UVH). First, they ask whether the patient has been diagnosed with a viral or bacterial infection in the last two weeks, such as a common cold or flu, and then whether they have experienced blurred vision with or without vomiting. The third question in this set asks whether patients drift to one side when walking. The third set of questions contains two questions critical for evaluating Benign Paroxysmal Positional Vertigo (BPPV). These questions ask about the experience of dizziness while moving the head, and also whether the subjects experience dizziness with different body movements, such as bending.
### AMER Dizziness Diagnostic Scale (ADDS)

#### Question

| Question | YES | NO |
|----------|-----|----|
| **Section 1 (no score)** |     |    |
| 1 Gender? | [M] | [F] |
| 2 Age? | Above 50 | Below 50 |
| 3 Are you Hypertensive? |     |    |
| 4 Are you Diabetic? |     |    |
| 5 Do you have a balance problem? |     |    |
| 6 Do you experience double vision or blurred vision that cause vomiting? |     |    |
| 7 Have you experienced partial hearing loss associated with dizziness? |     |    |
| **Section 2 (yes = 1, no = 0)** |     |    |
| 8 Have you been diagnosed with a viral or bacterial infection in the last 2 weeks (cold, flu)? |     |    |
| 9 Do you experience double vision or blurred vision? |     |    |
| 10 Do you drift to one side when walking? |     |    |
| **Section 3 (yes = 5, no = 0)** |     |    |
| 11 Do you experience dizziness while moving your head? |     |    |
| 12 Do you experience dizziness with different body movements, like bending forward or sleeping on your side? |     |    |
| **Section 4 (yes = 20, no = 0)** |     |    |
| 13 Have you been diagnosed with any neurological disorder (Stroke, MS)? |     |    |
| 14 Have you had a head Concussion before experiencing dizziness? |     |    |
| 15 Do you experience lightheadedness or fainting when moving from a sitting to a standing position? |     |    |
| 16 Do you have ear Tinnitus? |     |    |
| **Section 5 (No = 0, S = 1, M = 5 & H = 20)** |     |    |
| 17 How long does your dizziness last? | No | S | M | H |

**Total** (max 113) =

#### Diagnosis:
- [ ] CGD
- [ ] UVH
- [ ] BPPV
- [ ] CM

Fig. 1. AMER Dizziness Diagnostic Scale (ADDS)

forward or sleeping on one side. The fourth group of questions is related to Central Mediated Problem (CM), and has only four questions. These questions ask whether patients have been diagnosed with any neurological disorders, such as stroke or multiple sclerosis. The next question asks the patient whether they had experienced a head concussion before experiencing dizziness, and whether they experience lightheadedness or fainting while moving from sitting to standing, and whether they have ear tinnitus. The last question, which relates to all previous vestibular disorders, in addition to Cervicogenic Dizziness (CGD), is about the dizziness episodes.

Questions 1 to 16 are in YES or NO format, but question 17 is designated only for dizziness episodes. The scoring criteria of the seventeen questions are as follows. NO always SCORS ZERO. Questions 1 through 7 have no score, whereas Questions 8–10, are given one point for every YES answer. Questions 11–12 are given five points for every YES answer, and questions from 13–16 are given twenty points for every YES answer. For the final question, if the dizziness lasts seconds it is given 1 point, if it lasts minutes it is given 5 points, and if it lasts hours it is given 20 points. The interpretation of the ADDS total score is as follows: if the total score is 0, the diagnosis is probably a Cervicogenic Dizziness problem (CGD). Dizziness can be diagnosed as Unilateral Vestibular Hypofunction (UVH) if the total score lies between 1 and 4. Scores from 5 to 19 are interpreted as Benign Paroxysmal Positional Vertigo (BPPV),
while if the score is 20 or higher, it can be interpreted as a Centrally Mediated problem. The scale is designed in such a way that at the end of the interview, the clinician is able to differentially diagnose the exact pathology and the patient can be directed to the specific diagnosis and the treatment required. The scale is of benefit for both clinicians and patients, because it avoids unwanted and expensive diagnostic procedures and saves a lot of time.

On their first visit to the clinic, all the patients who participated in the present study were evaluated with the Amer Dizziness Diagnostic Scale (ADDS) just once, followed by routine testing of clinical signs and symptoms, audiometry, and a neurological examination, coupled with tests of VOR function, which often serves as the “gold standard” for determining the probability of a vestibular deficit. To measure the sensitivity and specificity, by “true-positive” or “true-negative” response, the results of both tests were then compared statistically to establish the correlation, sensitivity and specificity of the scale.

Data was collected by researchers blinded to “gold-stand diagnosis”. Participants were instructed not to reveal the results of ADDS to the researchers during data collection. The results were analyzed using the statistical package SPSS for Windows version 19.0 (SPSS, Inc., Chicago, IL, USA), to test the scale’s sensitivity and specificity, positive predictive value, and negative predictive value of probability of a vestibular disorders. Statistical significance was accepted for values of p < 0.05.

RESULTS

Two hundred subjects (n=200) participated in this study. The demographic and baseline clinical characteristics of the patients with vestibular disorders who were enrolled in this study are presented in Table 1. The results show that the ADDS strongly correlated with the “true-positive” and “true-negative” results (r = 0.95, p < 0.05). A stepwise linear regression was conducted and the results indicated that ADDS is a significant predictor of “true-positive” and “true-negative” results ($R^2 = 0.90$, $p < 0.05$). Approximately ninety percent of the variability in “true-positive” and “true-negative” results was explained by its relationship to the ADDS. Moreover, the Amer Dizziness Diagnostic Scale had a sensitivity of 96% and a specificity of 96% demonstrating it can adequately diagnose people with vestibular disorders (Table 2). In this study, the coefficient ($r$) range of the validity of the ADDS was acceptable, at 0.766. Furthermore, content validity was assessed through examination by a bilingual panel (Arabic and English) of 12 experts, who were recruited to establish the content validity of the ADDS instruments. The panel consisted of experts in the fields of otolaryngology and vestibular therapy. They summarized the criteria for content validity the: clear and simple wording of questions, easy to understand, relevant to purpose of the expected diagnosis, comprehensive questions, appropriate language, appropriate length for each question, no bias in responses in either direction.

| Table 1. Demographic and baseline clinical characteristics of patients with vestibular disorders (N=200) |
|-----------------|------------------|------------------|
| Age (y), n (%)  | Below 50 years   | Above 50 years   |
|                 | 36 (18%)         | 164 (82%)        |
| Gender, n (%)   | Male             | Female           |
|                 | 72 (36%)         | 128 (64%)        |
| Diagnosis       | BPPV             | CM               |
| (Gold standard) | UVH              | 44 (22%)         |
|                 | CGD              | 26 (13%)         |

| Table 2. ADDS sensitivity and specificity |
|-----------------|------------------|
| Sensitivity     | 0.96             |
| Specificity     | 0.96             |

DISCUSSION

The purpose of the current study was to evaluate the sensitivity and specificity of a newly developed diagnostic scale, the Amer Dizziness Diagnostic Scale (ADDS), to evaluate and differentially diagnose vestibular disorders in people with vestibular dysfunctions demonstrate and to identify the strengths and weaknesses of its usefulness in clinical practice. It also aimed to understand the feasibility of the ADDS as a first-line evaluation tool in general clinics, so that even those who are not specialized in these areas can effectively screen a patient who complains of dizziness and can refer him or her to the appropriate specialty for further diagnosis and management, since the causes of dizziness are multi-factorial. Dizziness is one of the most common complaints in medicine and encompasses various abnormal sensations relating to perception of the body’s relationship to space. Typically, dizziness is divided into four subtypes —vertigo, lightheadedness, disequilibrium and oscillopsia — and this classification is still the basic definition of dizziness. Since dizziness is highly subjective, the components of the ADDS basically focus on subjective questions the answers to which are ultimately used in making a diagnosis, and ADDS is a clinical tool that classifies the causes of dizziness. To our knowledge, this is the first study to develop a comprehensive scale to differentially diagnose patients complaining of dizziness, which has been updated and extended to take account of key developments in research and practice as a first-line evaluation tool for dizziness. While there are many scales used to evaluate dizziness patients, such as the DHI and the VSS-VER, these scales are all basically used to assess patients who have already been diagnosed, to establish the intensity of dizziness and its functional impact. Before using any of these tests and scales, it is always preferable to provide direction to the clinician on how to proceed with further assessment and examination of a patient who presents with dizziness so that unnecessary diagnostic procedures can be avoided. We consider this study is basic research in the evaluation
and treatment of dizziness patients. All healthcare workers should find the ADDS a convenient tool as well as a reliable reference guide that promotes best practice for the differential diagnosis, evaluation and treatment of dizziness. The single most important element in reaching a correct diagnosis in dizziness patients is obtaining an accurate history. However, in the absence of a valid diagnostic scale for dizziness, the clinician is put in the difficult situation of possibly not being able to differentially diagnose patients. The results of this study indicate that the ADDS has high sensitivity and specificity and can be used differential diagnosis method for patients with vestibular disorders. Therefore, the ADDS provides clinicians with an objective measure to help in the clinical decision-making process, and can be used as a first-line evaluation tool in general clinics, so that even those who are not specialized in this area can effectively screen patients who complain of dizziness, and can refer them to the appropriate specialty for further diagnosis and management. The next step in the validation of the ADDS will be to demonstrate that it has comparable reliability and validity across a range of languages and cultural settings. Translation and validation in several languages for the final version of the ADDS will include translation instructions and a list of languages that will help a variety of patients in different countries and cultural contexts. It will be necessary to select additional cross-culturally relevant items to assess social activities and to establish the reliability and discriminant validity of the ADDS. A major advantage of establishing a scale suitable for use in a wide range of contexts is that this will permit direct comparison between studies and populations in different countries and cultures. This study suggests that the ADDS is an ideal tool for this role, as it has close continuity with the best existing measures of vestibular disorders. The ADDS includes seventeen questions which are divided into five categories. The first seven questions are general information questions that are intended for statistical and future research purposes. The next three questions are specific to UVH, and totally represent the features of UVH patients, especially drifting towards the same side while walking, which is a classic finding in UVH. The third set of questions focus on the diagnosis of BPPV, in which patients experience the features of dizziness while moving the head, or other body movements. The fourth group of questions is related to Centrally Mediated Problems and the aim of these questions is to understand the role of different clinical specialties, as UVH and BPPV can be treated by a physical therapist, whereas central mediated problems require a referral and consultation with a neurologist, neuro-physiologist, neuro-psychiatrist or neurosurgeon. Accordingly, each health-care professional in clinical rehabilitation can limit themselves to the diagnosis and management of patients with various neurological symptoms, which will ultimately benefit both the clinician and the patient. The last question, which is about dizziness episodes, relates to all previous vestibular disorders, in addition to Cervicogenic Dizziness (CGD), and a diagnosis of CGD is made after excluding if all other possible causes. The scale is designed in such a way that at the end of the interview, the clinician must be able to differentially diagnose the exact pathology and the patient can be directed to the specific treatment. This scale is of benefit to both clinicians and patients, because it avoids unwanted and expensive diagnostic procedures and saves considerable time. In order to ensure the relevance and reliability of the study and the scale, we have tested the scale’s specificity and sensitivity in comparison with the standard routine testing procedure for clinical signs and symptoms, audiometry, and neurological examination, together with tests of VOR (function), which often serves as the “gold standard” for determining the probability of a vestibular deficit. One limitation of our study is that we excluded subjects over the age of 60, because, as stated in the study by Landel, patients older than 60 years may not be physiologically stable, as many of them are likely to have cardiovascular disorders, which might alter the scoring of the scale and affect the results of the ADDS. Another issue is that there were no other Dizziness Diagnostic Scales that we could rely on to serve as a standard scale for comparison or to adjust the questions. Therefore, future studies should involve patients from a wider age group considering physiological changes, especially in the elderly, and there is also a need to study variations in the scale outcomes between genders. This study has shown that the Amer Dizziness Diagnostic Scale (ADDS) has high sensitivity and specificity and can be used as a method for the differential diagnosis of patients with vestibular disorders.

ACKNOWLEDGEMENTS

The work was funded by the Deanship of Scientific Research (DSR), King Abdulaziz University, Jeddah. The authors therefore acknowledge with thanks the DSR’s technical and financial support.

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