Bedside Testing in Acute Vestibular Syndrome

Subjects: Emergency Medicine

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Patients with stroke and vestibular neuritis can both present with an acute vestibular syndrome (AVS). Patients with AVS have acute-onset, continuous vertigo, dizziness, or unsteadiness lasting days to weeks, usually associated with vomiting, nystagmus, severe postural instability, and head movement intolerance.

Acute Vestibular Syndrome | bedside testing | vertigo | dizziness

1. Introduction

A broad range of clinical scores has been proposed to diagnose patients with Acute Vestibular Syndrome (AVS). These scores utilize a combination of different features including the patient's history (e.g., timing and triggers of the dizziness and cardiovascular risk factors), findings from the general neurologic examination, and findings from a dedicated oculomotor examination and biomarkers. The ABCD2 score, for example, relies on patient history and neurologic examination only [1][2][3], whereas the HINTS [4] and the STANDING [5] algorithms focus on findings from the dedicated oculomotor examination. Other scores combine the patient history, neurologic, and oculomotor examination (e.g., the TriAGe+ score) [6].

2. HINTS/HINTS Plus

The three-component bedside HINTS (Head-Impulse, Nystagmus, and Test of Skew) can accurately identify central causes (mostly ischemic stroke) in AVS patients [4]. The three components include a bedside assessment of the horizontal angular vestibulo-ocular reflex (aVOR) by applying the head-impulse test (HIT) [7], evaluating ocular stability at eccentric gaze (looking for a gaze-evoked nystagmus) and testing for a vertical divergence in the alternating cover test. In the hands of a trained oto-neurologist, HINTS was associated with a 100% sensitivity and 96% specificity for detecting a stroke [4]. Importantly, the presence of one out of these three signs was sufficient to suspect a central cause. The HINTS paradigm has become increasingly popular since its introduction in 2009 and is now considered the standard bedside examination technique in AVS patients in the ED with the caveat that the examiner be trained in using HINTS.

This is evidenced by the recently published GRACE3 clinical guideline on acute vertigo and dizziness in the ED [8], which includes the specific recommendation that HINTS should be used in the ED only by trained clinicians. This is because current use by emergency clinicians in routine practice does not achieve the same results as those attained by trained subspecialists [9][10]. In a recent systematic review of the literature (1980–2022) focusing on high-quality (level of evidence 1 to 3) studies reporting on the diagnostic accuracy of bedside eye movement

testing in acutely dizzy patients, ten studies investigating the diagnostic accuracy of bedside HINTS were included (representing data from 422 patients with a central AVS and 378 patients with a peripheral AVS). This meta-analysis reported a high sensitivity (95.3% [95% confidence interval (CI) = 92.5–98.1%]) and specificity (92.6% [88.6–96.5%]) for the HINTS bedside exam [11]. When adding a fourth sign (unilateral, new-onset hearing loss) to the HINTS battery (called HINTS-plus [1]), sensitivity increased further (97.2% [94.0—100.0%]) compared to the HINTS (by 1.9%). However, the sample size of patients was smaller for the HINTS+ battery (central AVS = 276, peripheral AVS = 252).

Importantly, both subspecialists (i.e., neuro-otologists/neuro-ophthalmologists) and ***trained*** non-subspecialists (i.e., general neurologists, neurology residents, and emergency physicians) demonstrated a high accuracy when using either the HINTS or the HINTS+ exam. Although the sensitivity of the HINTS exam was comparable amongst these two groups (94.3% vs. 95.0%, $p = 0.55$), the specificity of the HINTS exam was higher in the subspecialist group than in the non-subspecialist group (97.6% vs. 89.1%, $p = 0.007$), indicating potential differences in the interpretation of test results [11]. Another study, which fell outside of the inclusion criteria for this recent meta-analysis also suggested that trained ED clinicians can accurately perform and interpret two components of HINTS—the horizontal HIT and nystagmus testing [12]. Nevertheless, a limitation is that as of 2023, only small numbers of emergency clinicians have received adequate training in the HINTS exam. Moreover, the minimum effective curriculum, how to administer it, and its durability have not yet been clearly defined.

3. STANDING

The STANDING algorithm (i.e., a four-step algorithm including 1) the discrimination between **S**pon**TA**neous and positional nystagmus, (2) the evaluation of the **N**ystagmus **D**irection, (3) the head **I**mpulse test, and (4) the evaluation of equilibrium (sta**N**din**G**)) was designed to be more inclusive to include the diagnosis of benign paroxysmal positional vertigo (BPPV) as well. In addition to testing for spontaneous nystagmus, it also tests for positional nystagmus (by applying provocation maneuver for the posterior and lateral canals), and examines truncal ataxia [5][12]. However, this algorithm was more selective in applying single bedside tests based on initial findings (e.g., a head-impulse test was applied only in patients with unilateral spontaneous nystagmus). Likewise, the grading of truncal ataxia was less granular than proposed by others [13]. Specifically, an inability to stand or walk was considered indicative of a central origin, approximately reflecting grade 2 or grade 3 truncal instability. It is important to note that the emergency physicians who participated in the STANDING trial all received training that included 4 h of lecture, 2 h of demonstration on normal volunteers, and 10 proctored exams on ED patients [12].

Three prospective studies with relatively unselected patient ED cohorts have been published. When first proposed, the developers of the STANDING algorithm reported a high overall diagnostic accuracy (sensitivity = 95% [83–99%]; specificity = 87% [85–87%]) in a cohort of 352 patients with acute vertigo/unsteadiness [12]. In a more recent, prospective study with 300 patients with isolated vertigo and unsteadiness, enrolled by a different group in a different country, the specificity of the STANDING algorithm was lower (75% vs. 87%), whereas the sensitivity (94% vs. 95%) was similar compared with the prior validation study [3]. In a follow-up prospective study, this second group investigated the diagnostic accuracy of the STANDING algorithm performed by ED physicians (both interns

and senior emergency physicians) who had received 4 h of training (lectures and practical demonstrations) [14]. The STANDING algorithm demonstrated sensitivities of 84.8% (75.6–93.9%) and 89.8% (82.1–97.5%) in the interns and the senior emergency physicians, respectively. Likewise, the specificity reached 88.9% (85.1–92.8%) and 91.3% (87.8–94.8%) in both respective groups.

Overall, these prospective studies confirm that the STANDING algorithm is valuable in the ED setting, with a diagnostic accuracy similar to that when using the HINTS. Advantages include the ability to diagnose BPPV, of both the posterior and lateral canals, which is far more common than posterior circulation stroke presenting as isolated dizziness. A confident diagnosis of a peripheral problem makes a central cause extremely unlikely. Another advantage is that STANDING is “blind” to the presenting timing and triggers. Because some patients with BPPV will present early and have lingering symptoms, mimicking an AVS [15], STANDING can be used in these patients too.

A potential limitation is the relatively small number of studies published, with two of the three studies available coming from the same group. Furthermore, all of the emergency physicians involved received training and used Frenzel lenses, which is not standard practice for emergency physicians.

4. TriAGe+ Score and PCI-Score

The TriAGe+ score incorporates information from the patient’s history (the triggers and the type of dizziness and the presence or absence of vascular risk factors) and from the bedside physical examination (including performing the alternating cover test and testing of stance and gait), which are combined. This score (range = 0–17 points) was first proposed by Kuroda and co-workers in 2017 and was compared to the ABCD2 score [6]. In a single-center observational retrospective study, 498 patients presenting to the ED with vertigo or dizziness were included [6]. Based on the area under the curve (AUC), the diagnostic accuracy of the TriAGe+ score was maximal when selecting a cutoff value of 10 points, resulting in a sensitivity of 77.5% and a specificity of 72.1%. Compared to the ABCD2 score, the TriAGe+ score had a significantly larger AUC for the occurrence of stroke ($p < 0.001$), although well below diagnostic accuracy values reported for the HINTS(+) or STANDING algorithms.

Recently, a single-center, retrospective validation study of the TriAGE+ score of 444 ED patients with dizziness, of whom 73 (16.4%) had strokes, was published [16]. This study has two important limitations—some patients had findings beyond isolated dizziness (e.g., brainstem findings, facial palsy, aphasia, and “cerebellar findings”), and they only included patients who had an MRI as part of their routine care, both of which could affect their results. Nevertheless, their findings were largely in line with those of Kuroda; they found that when using a cutoff of ≥5, the TriAGE+ score was 100% sensitive but only a 16% specificity for stroke. Notably, the HIT and nystagmus testing on the lateral-gaze test are not part of the TriAGe+ score and more detailed information on how truncal instability was rated is missing. Considering this evidence as a whole, the value of the TriAGe+ score currently remains unclear, and better-validated scores such as HINTS+ or STANDING perform better.

Likewise, the PCI score combines nine items, addressing reported symptoms (type of dizziness), vascular risk factors, and focal neurologic findings such as limb or gait ataxia [17]. Importantly, the PCI score also does not

include any subtle oculomotor signs. As with the TriAGe+ score, the AUC for the PCI score was significantly larger than for the ABCD2 score (0.82 vs. 0.69), and has a sensitivity of 94.1% and a specificity of 41.4%. Importantly, this score was retrieved from a retrospective data set and was not prospectively validated, substantially limiting its current clinical applicability.

5. ABCD2 Score

The ABCD2 score (0–7 points) was originally developed as an epidemiologic tool to predict the stroke risk in patients after a transient-ischemic attack (TIA) [18]. In a retrospective study by Navi and colleagues, it has been suggested that such a risk stratification approach based on the ABCD2 score might help identify strokes acutely in ED patients presenting with dizziness [19]. Being based on five items readily assessable in the ED setting, it can be reliably and quickly calculated by emergency clinicians. Navi and colleagues identified a cutoff value of four points or more as an indication of a central (usually ischemic) cause. The diagnostic accuracy of the ABCD2 score has been compared to other algorithms proposed for distinguishing peripheral from central causes in acutely dizzy patients, including the TriAGe+ score, the PCI score, the HINTS+ bedside exam, and the STANDING algorithm.

In a prospective, cross-sectional study including high-risk patients with AVS (*n* = 190), using brain MRI including DWI as the gold standard in all patients, the AUC of the ROC curve was significantly smaller for the ABCD2 score (0.613, [0.531–0.695]) than for HINTS (0.995 [0.985–1.000]) [1]. Thus, HINTS (stroke sensitivity = 96.5%, specificity = 84.4%) substantially outperformed the ABCD2 score (cutoff value= ≥4 points,≥4 points, sensitivity = 61.1%, specificity = 62.3%) for stroke diagnosis in ED patients with AVS. Another prospective study compared the HINTS, STANDING, and ABCD2 scores in a single-center diagnostic cohort study among patients with isolated vertigo and unsteadiness presenting to the ED [3]. Both the HINTS and the STANDING algorithms reached high sensitivities of 97% and 94% and negative predictive values (NVP) of 99% and 98%, respectively. However, the ABCD2 score failed to predict half of the central vertigo cases and had a sensitivity of 55% and an NPV of 87% [3]. Likewise, the ABCD2 score was inferior to the TriAGe+ score [6] and the PCI score [17] as described above. A prospective, single-center cross-sectional study including patients with acute dizziness presenting to the ED, compared the diagnostic accuracy of the ABCD2 score and HINTS [2]. All patients received a brain MRI including DWI at least 48 h after symptom onset. Whereas the sensitivity of the ABCD2 score for stroke was 71.4% for a score of ≥4, these authors reported 100% sensitivity for the HINTS exam. Interestingly, when using a combination of a “central pattern of nystagmus”, defined as the presence of a bidirectional gaze-evoked nystagmus, isolated torsional nystagmus, or vertical nystagmus in any position, plus an ABCD2 score of ≥4, a sensitivity for detecting central causes of 100% was achieved as well.

6. Gait and Truncal Instability (GTI) Rating

In the hands of neuro-otologists and trained ED physicians, HINTS(+) has been very successfully applied [11]. Less experienced or untrained emergency physicians, do not use HINTS(+) properly, either using them on the wrong patients, performing the test improperly, or interpreting the results incorrectly [9][10]. Until training of this group is

successfully implemented at scale, other accurate tests that do not rely on subtle oculomotor findings might help. Gait assessment is an established part of the basic standard ED neurological exam for a dizzy patient. In addition, knowing whether or not a patient has a safe and stable gait is an important element of a safe discharge for ED patients, no matter what the cause. Finally, an inability to walk independently would strongly favor a central cause of dizziness and should make the clinician question very common diagnoses such as BPPV [15].

For these reasons, assessing for gait and truncal instability (GTI) has been proposed as a substitute for the HINTS exam for ED physicians who have not received any training in performing HINTS [13]. In an attempt to provide a graded truncal instability rating, different clinical findings have been linked to grade 1, 2, and 3 truncal instability.

In a recently published meta-analysis including ten studies reporting on GTI in acutely dizzy patients, pooled estimated sensitivity reached 69.7% (43.3–87.9%) and specificity was at 83.7% (52.1–96.0%) when considering GTI ratings of two or three as indicative of a central cause [20]. When comparing the performance of ED physicians and neurologists, a low correlation (Spearman's correlation r^2 = 0.17) was reported in a single study [21]. The investigators did not speculate on the reason for this disparity, nor did they report details about how the disparities might have affected patients' management. This makes it difficult to account for this finding.

Focusing on grade 3 GTI, another recent meta-analysis found a sensitivity of 35.8% (5.2–66.5%) and a specificity of 99.2% (97.8–100.0%), emphasizing that the presence of grade 3 GTI is highly suggestive of a central cause [11], whereas the absence of grade 3 GTI does not exclude presence of a central cause of AVS (missing 2/3 of all vertebrobasilar strokes with this cutoff value). Furthermore, in patients presenting with acute truncal ataxia without (spontaneous or gaze-evoked) nystagmus, HINTS may not be applicable. Considering the graded GTI rating instead may therefore be useful, as recently demonstrated by Carmona and colleagues [22].

Importantly, several limiting factors in GTI analysis need to be considered. First, the timing of GTI testing varied among studies. Whereas some studies applied truncal instability testing early in the clinical examination, others performed testing only after having the patient rest for at least 5–10 min. Secondly, severe nausea or motion intolerance may prevent adequate testing for grades 2 and 3 GTI [23]. However, assessing the ability to sit up on the stretcher without holding on to the guard rails can be considered a proxy for the GTI assessment, allowing detection of those patients with severe (i.e., grade 3) gait and truncal instability who are very likely to have a central cause of their AVS.

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