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JOURNAL READING

Acad Emerg Med. 2013 Oct;20(10):986-996. doi:
10.1111/acem.12223.

HINTS Outperforms ABCD2 to Screen for Stroke in Acute Continuous Vertigo and Dizziness

Background

- In patients with dizziness and vertigo presented at ED, 4-6% have cerebrovascular causes
- Difficulty
 - CT: very sensitive for acute intracranial hemorrhages (93%), but cannot "rule out" ischemic stroke
 - MRI: costly, not always available, 20% false negative in early strokes

ABCD2

- Risk stratification originally for TIA

| Five-item ABCD2 risk score | Stroke findings: risk score ≥ 4 |
|----------------------------|---|
| • Age | • A ≥ 60 years = 1 |
| • Blood pressure | • B systolic ≥ 140 or diastolic ≥ 90 = 1 |
| • Clinical features | • C unilateral weakness = 2, speech disturbance without weakness = 1, any other symptom = 0 |
| • Duration of symptoms | • D < 10 min = 0; 10-59 min = 1; ≥ 60 min = 2 |
| • Diabetes | • D present = 1 |

Stroke

JOURNAL OF THE AMERICAN HEART ASSOCIATION



Application of the ABCD² Score to Identify Cerebrovascular Causes of Dizziness in the Emergency Department

Babak B. Navi, Hooman Kamel, Maulik P. Shah, Aaron W. Grossman, Christine Wong, Sharon N. Poisson, William D. Whetstone, S. Andrew Josephson, S. Claiborne Johnston and Anthony S. Kim

Stroke. 2012 Jun;43(6):1484-9. doi:
10.1161/STROKEAHA.111.646414. Epub 2012 Mar 22.

ABCD2 for dizziness

- The study showed 86% sensitivity for stroke at a cutoff of ≥ 4 with nearly 40% specificity
- Limitations
 - Dizziness duration was not quantified
 - MRI brain scans were obtained in only 11% of patients
 - Investigators did not follow patients to identify missed strokes
 - Young patients (vertebral artery dissection rather than atherosclerosis)

H.I.N.T.S

- A 2-minute, three-item bedside eye movement screen
 - Head impulse
 - Nystagmus
 - Test of skew

Stroke

Journal of the American Heart Association



HINTS to Diagnose Stroke in the Acute Vestibular Syndrome: Three-Step Bedside Oculomotor Examination More Sensitive Than Early MRI Diffusion-Weighted Imaging
Jorge C. Kattah, Arun V. Talkad, David Z. Wang, Yu-Hsiang Hsieh and David E. Newman-Toker

Stroke. 2009 Nov;40(11):3504-10. doi: 10.1161/STROKEAHA.109.551234. Epub 2009 Sep 17.

Acute vestibular syndrome (AVS)

- Acute, persistent vertigo or dizziness lasting days to several weeks with associated nausea or vomiting, head motion intolerance, gait unsteadiness, and nystagmus
- AVS patients (10% to 20% of ED dizziness presentations) are at higher risk for stroke (25%) than average ED dizziness patients (4% to 6%)

HINTS for INFARCT

| | |
|--|---|
| Three-step "H.I.N.T.S." eye examination* | Stroke findings: "I.N.F.A.R.C.T." (any of these) [†] |
| • Head Impulse (right- and leftward) | • Impulse Normal (bilaterally normal) |
| • Nystagmus type (gaze testing) | • Fast-phase Alternating (direction-changing) |
| • Test of Skew (alternate cover test) | • Refixation on Cover Test (skew deviation) |

VIDEO

HINTS for INFARCT

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Study design

- Data(1999–2012) from an ongoing, institutional review board–approved, prospective, cross-sectional diagnostic study of AVS patients

Populations

- A single academic medical center
 - a regional stroke referral center for 25 hospitals
 - 86,000 annual ED visits and 900 stroke admissions per year
- Inclusion
 - Acute vestibular syndrome (at least 1 hour, within a week)
 - 1 or more risk factors for stroke

Study protocol

- All ED patients
- Patients with peripheral vertigo were followed for at least 3 months
- All patients underwent NE + HINTS, and then neuroimaging (97.4% MRI)
- MRI: axial T2, FLAIR, and diffusion-weighted imaging
- Delayed MRI

Outcome measures

- Diagnosis
 - Central: neuroimaging or lab data
 - Peripheral: by exclusion
- HINTS and modifications
 - one-item head impulse test alone
 - HINTS “plus” (+new onset hearing loss)

| Attribute | Result |
|---------------------------------|---|
| Total enrollees (included) | 193 (190*) |
| Admitted | 100% |
| Age range, yr | 18–92 |
| Median (IQR) age, yr | 61.0 (52.0–70.0) |
| Sex | 60.5% men (n = 115) 39.5% women (n = 75) |
| Race | 90.0% white, non-Hispanic (n = 171) 6.3% black or African American (n = 12) 3.7% other race/culture (n = 7) |
| Diagnoses | 34.7% vestibular neuritis (n = 66) [†] 59.5% posterior fossa stroke (n = 113) • 92.9% infarction (n = 105) • 7.1% hemorrhage (n = 8) 5.8% other central causes (n = 11) [‡] |
| Symptom onset to examination | 2 hours–7 days [§] |
| ED presentation to examination | <24 hours for all subjects |
| ED presentation to neuroimaging | <24 hours for all subjects (MRI n = 186; CT n = 4) |
| Complications of testing | ABCD2, HINTS—none CT—none; MRI—one claustrophobic reaction |
| False negative initial MRI-DWI | 14.3% of ischemic strokes (n = 15/105) • 2–24 hours after onset of symptoms (n = 9) • 24–48 hours after onset of symptoms (n = 5) • >48 hours after onset of symptoms (n = 1) |
| Thrombolytic therapy for stroke | None |
| Hospital course for stroke | 19.5% of stroke patients deteriorated (n = 22/113) [¶] • 7.1% required surgery (n = 8) • 0.9% basilar intravascular stent (n = 1) • 3.5% died acutely (n = 4) |

Results

- More stroke in men(64.3% vs 52.0%), and women were much more likely to have other central causes(0% vs 14.7%)

Results

Table 3
Test Properties of ABCD2 for Diagnosing Stroke in AVS at Different Thresholds

| ABCD2 Score Cutoff Value | Sensitivity for Stroke,* % (95% CI) | Specificity for Stroke, % (95% CI) | LR+ Stroke, (95% CI) | LR- Stroke, (95% CI) |
|--------------------------|-------------------------------------|------------------------------------|-------------------------|----------------------|
| 2 or above | 100.0 (97-100) | 0.0 (0-5) | 1.00 (1.00-1.00) | NC |
| 3 or above | 92.9 (87-99) | 19.5 (12-30) | 1.15 (1.02-1.30) | 0.36 (0.16-0.82) |
| 4 or above | 81.1 (62-98) | 62.3 (61-72) | 1.62 (1.17-2.24) | 0.62 (0.47-0.83) |
| 5 or above | 12.4 (8-20) | 97.4 (91-99) | 4.77 (1.12-20.40) | 0.90 (0.83-0.97) |
| 6 or above | 2.7 (1-8) | 100.0 (95-100) | >2.65 [†] (NC) | 0.97 (0.94-1.00) |
| 7 | 0.9 (0-5) | 100.0 (95-100) | >0.88 [†] (NC) | 0.99 (0.97-1.01) |

ABCD2 = age, blood pressure, clinical features, duration of symptoms, diabetes; AVS = acute vestibular syndrome; DWI = diffusion weighted imaging; LR+ = positive likelihood ratio; LR- = negative likelihood ratio; MRI = magnetic resonance imaging; NC = not calculable.
*Includes ischemic strokes (n = 105) and hemorrhages (n = 8). Stroke diagnoses were based on MRI-DWI showing acute stroke and three of whom required surgical decompression.
[†]The LR+ for ABCD2 ≥ 6 and ABCD2 ≥ 7 were calculated using a specificity of 99.0% and listed as ">" since the LR+ associated with 100% specificity (measured in this sample) is infinite.

Results

Table 4
ABCD2 ≥ 4 Versus HIT, HINTS, and HINTS "plus" for Stroke or Central Cause in AVS

| Test Properties | ABCD2 ≥ 4 (Five-item Rule*) | HIT (One-step Rule*) | HINTS (Three-step Rule*) | HINTS "Plus" (Four-step Rule*) |
|--|-----------------------------|-------------------------|--------------------------|--------------------------------|
| Stroke only (n = 113 stroke, n = 77 nonstroke) | 61.1 (51.8-69.7) | 90.3 (83.7-94.8) | 96.5 (91.7-98.9) | 99.1 (95.7-100.0) |
| Sensitivity for stroke | 62.3 (51.2-72.6) | 87.0 (78.1-93.2) | 84.4 (75.0-91.3) | 83.1 (73.5-90.3) |
| Specificity for stroke | 1.62 (1.17-2.24) | 6.95 (3.09-12.43) | 6.19 (3.08-10.42) | 5.87 (3.58-9.64) |
| LR+ stroke | 0.62 (0.47-0.83) | 0.11 (0.06-0.20) | 0.04 (0.02-0.11) | 0.01 (0.00-0.08) |
| Reduction missed stroke [†] | Reference case | 75.0 | 90.9 | 97.7 |
| Any central cause (n = 124 central, n = 66 peripheral) | 58.1 (48.2-66.5) | 91.1 (85.1-95.3) | 96.8 (92.4-99.0) | 99.2 (96.1-100.0) |
| Sensitivity for central | 60.6 (46.5-71.8) | 100.0 (95.6-100.0) | 90.5 (82.8-99.9) | 97.0 (90.4-99.5) |
| Specificity for central | 1.47 (1.05-2.06) | >91.1 [†] (NC) | 63.9 (9.13-446.85) | 32.7 (8.36-126.16) |
| LR+ any central cause | 0.69 (0.52-0.92) | 0.09 (0.05-0.16) | 0.03 (0.01-0.09) | 0.01 (0.00-0.06) |
| Reduction missed central [‡] | Reference case | 78.8 | 92.3 | 98.1 |

Data are reported as percentages, except LRs, with (95% CI).
ABCD2 = age, blood pressure, clinical features, duration of symptoms, diabetes; AVS = acute vestibular syndrome; LR+ = positive likelihood ratio; LR- = negative likelihood ratio; HINTS = head impulse, nystagmus type, test of skew; HINTS "plus" = HINTS plus new hearing loss detected by finger rubbing; HIT = head impulse test.
[†]The ABCD2 rule requires five historical elements. The standard HINTS approach has three physical examination elements, the most predictive of which is the HIT. HINTS "plus" adds the presence of new hearing loss by bedside finger rub as a predictor of a stroke syndrome.
[‡]These values represent the reduction in missed stroke or central causes relative to ABCD2 that would be projected if HIT, HINTS, or HINTS "plus" were used to determine the diagnosis instead of ABCD2.
[§]The LR+ for HIT alone was calculated using a specificity of 99.0% and listed as ">" since the LR+ associated with 100% specificity (measured in this sample) is infinite.

Results

- False negative HINTS cases were uncommon (n=4), and all but one was captured by HINTS "plus"
- A single false positive HINTS (and HINTS "plus") - a patient with vestibular neuritis who had skew deviation
- The head impulse test as a single item had 11 false negatives (5 with new hearing loss)

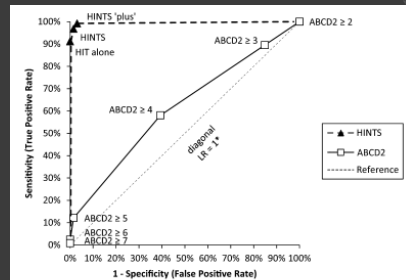


Figure 2. ROC analysis for central causes of AVS: HINTS versus ABCD2. *The reference diagonal line indicates a hypothetical useless diagnostic test with a LR of 1 at all threshold cutoffs. Such a test provides no additional information about the underlying diagnosis. A perfect test or decision rule has threshold cutoffs in the upper left corner (100% sensitivity, 100% specificity). ABCD2 = age, blood pressure, clinical features, duration of symptoms, diabetes; AVS = acute vestibular syndrome; HINTS = head impulse, nystagmus type, test of skew; HINTS "plus" = HINTS plus new hearing loss detected by finger rubbing; HIT = head impulse test; LR = likelihood ratio; ROC = receiver operating characteristic.

Results

- Sensitivity for initial MRI was 86.7% (95%CI 79.5-92.1%)
- Sensitivity for eye movement approaches
 - Head impulse alone 90.3% (95%CI 83.7-94.8%)
 - HINTS 96.5% (95%CI 91.7-98.9%)
 - HINTS "plus" 99.1% (95%CI 95.7-100.0%)

Discussion

- HINTS sensitivity appears higher than any other published diagnostic strategy at initial ED assessment
- Specificity of HINTS might turn out to be lower in population with lower stroke prevalence

Discussion

- HINTS outperform ABCD2 on sensitivity and specificity, regardless of the endpoint considered
- HINTS differentiates central from peripheral causes
- HINTS “plus” would yield 98% fewer missed strokes at 87% lower cost

Discussion

- Many ED clinicians use risk factor-based reasoning to assess the likelihood of stroke or need for neuroimaging
- In current clinical practice, up to 35% of strokes may be missed in ED patients with acute dizziness or vertigo
- If ABCD2 is used to determine the need for imaging, 71% of strokes would have been missed in patients with AVS younger than 60 years old (40%)

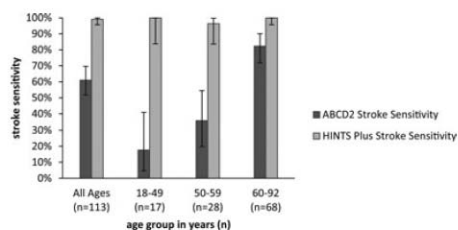


Figure 3. Stroke sensitivity of ABCD2 versus HINTS “plus” in AVS by age group. Includes ischemic strokes ($n = 105$) and hemorrhages ($n = 8$). Stroke diagnoses were based on MRI-DWI showing acute stroke in 97.4% and CT showing a clear infarction or hemorrhage in the remaining patients ($n = 4$, one of whom died and three of whom required surgical decompression). Error bars represent 95% CIs around the proportions; all differences are statistically significant. AVS = acute vestibular syndrome; ABCD2 = age, blood pressure, clinical features, duration of symptoms, diabetes; HINTS = head impulse, nystagmus type, test of skew; HINTS “plus” = HINTS plus new hearing loss detected by finger rubbing.

Discussion

- HINTS is based on anatomic and physiologic neuroscience
 - Head impulse: primary vestibular pathways from labyrinth to lateral pons
 - Gaze-evoked nystagmus: gaze holding circuit in brainstem and cerebellum
 - Vertical ocular alignment: central otolithic pathways in brainstem
- With rare inner ear strokes (AICA territory), sudden hearing loss maybe the only clue

Discussion

- A commercially available device that can measure these eye movements holds promise as a future stroke diagnostic tool
- It is currently used in Europe and is now available in the US following recent FDA approval
- Further education is needed for emergency physicians

Limitations

- Imperfect masking
- Follow-up MRI were obtained only if clinical findings didn't match a peripheral vestibular pattern
- Highly selected population limits generalizability
- It remains unknown whether nonspecialist clinicians can accurately identify the eye movement findings

Conclusions

- HINTS outperforms ABCD2 and initial MRI for efficiently detecting stroke in AVS
- For AVS patients with negative initial MRI and positive HINTS, close follow-up and repeat MRI are probably warranted

commentary

Diagnosing dizziness: we are teaching the wrong paradigm!

Traditional paradigm

- Symptom quality: lightheadedness or vertigo
- Over 50% patients changed their type of dizziness when the same questions were reasked 10 minutes later
- Patients with BPPV might had lightheadedness, and patients with CV causes of dizziness complain of vertigo

“Time and triggers” approach

- Acute vestibular syndrome: abrupt onset of persistent dizziness lasting days to weeks
- Chronic vestibular syndrome: prolonged dizziness lasting weeks to months
- Episodic vestibular syndrome: intermittent episodes that arise spontaneously lasting minutes to days
- Triggered vestibular syndrome: brief episodes lasting <1 minute with a trigger

Misdiagnosis of stroke in dizzy patients

- A posterior stroke patients can have a NIHSS of zero, and about 10% of patients with cerebellar stroke present with symptoms mimicking vestibular neuritis
- More MRIs?
 - Unavailable
 - MRI misses 12% of posterior circulation strokes in the first 48 hrs

Cautions of HINTS

- Unlike most tests, a positive head impulse test signifies a peripheral cause and is a “reassuring” finding
- The HINTS should only be done in the population of patients with AVS!!!

“ATTEST” approach

- A- Associated symptoms
- TT- Timing and Triggers
- ES- Exam Signs (NE and HINTS)
- T- Testing

Thanks for your attention!!