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Dizziness and Vertigo in the Emergency Department: Epidemiology, Cost and Potential Methods for Cost Savings

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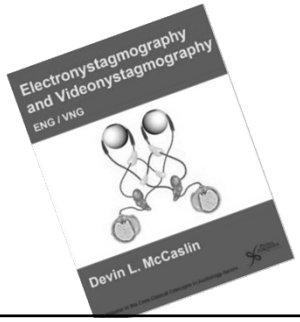
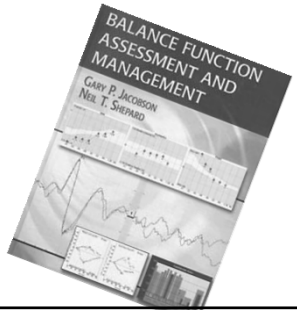




Dizziness and Vertigo in the Emergency Department: Epidemiology, Cost and Potential Methods for Cost Savings

Gary P. Jacobson, Ph.D.
Devin L. McCaslin, Ph.D.
Division of Vestibular Sciences, Department of Hearing and Speech Sciences

COI Disclosure

- **We have consulted for Interacoustics on the development of their VEMP normalization software.**
- **We have lectured for Interacoustics on the general topics of assessment of vestibular and balance function testing.**

"Background"

Gary P. Jacobson, Ph.D.

Primary Sources

- **Kerber KA, Meurer WJ, West BT, Fendrick AM. 2008. Dizziness presentations in U.S. Emergency Departments, 1995-2004. Academic Emergency Medicine 15: 744-750.**
- **Tehrani AS, Coughlan D, Hsieh Y-H et al. 2013. Rising annual costs of dizziness presentations to U.S. emergency departments. Academic Emergency Medicine 20: 689-696.**


Dizziness Presentations in U.S. Emergency Departments, 1995–2004

Kevin A. Kerber MD, William J. Meurer MD, Brady T. West MA, A. Mark Fendrick MD

Purpose of Investigation

- **10 year retrospective study**
- **Part of National Hospital Ambulatory Medical Care Survey (NHAMCS)**
  - **cross-sectional…**
  - **annual…**
  - **…probability sample…**
  - **…of visits to randomly-selected, non-institutional, general and short-stay hospitals, in the USA with emergency or outpatient departments**

Purpose of Investigation

- **Describe characteristics and health care utilization information with a focus on dizziness**
- **Comment on trends**
- **Use trend information to plan future research**

Methods

- **Collected data from patient medical records during a randomly assigned, 4-week, data collection period from the sampled hospitals**

Methods

- **Data recorded included:**
  - **"reason for visit" (limited to a max of 3)**
  - **key demographic information**
  - **Patient condition at the time of triage**
  - **Up to 3 discharge diagnoses,**
  - **Screening and diagnostic tests performed,**
  - **Length of stay (LOS),**
  - **Medications prescribed**

Methods

- **Data analysis consisted of 3 parts:**
  - **Descriptive analysis,**
  - **Trend analysis and**
  - **Multivariate logistic regression modeling**

Results

- **7,160/285,622 ED visits for dizziness/vertigo**
  - **2.5% of all ED visits, or,**
  - **25 per 1000 ED visits**
- **Using this data they estimated that 26M ED visits in the USA or ~2.6M/year occurred for dizziness and/or vertigo**
- **From 1995-2004 rate of dizziness/vertigo visits increased 37%**
  - **45-64 years = 15% increase**
  - **> 65 years = 67% increase**

Results

- **Where dizziness was the primary "Reason for Visit" - RFV**
  - **36% had no additional RFVs (Dz was often the only complaint)**
- **Rare diagnoses were:**
  - **Cerebrovascular (3.9%)**
  - **Brain tumor (0%)**
  - **Central vertigo (0%)**

Accompanying Reasons for Referral

Accompanying Reason for Referral	Percent
Nausea	12.9
Headache	11.7
Generalized Weakness	10.7
Vomiting	8.0
Shortness of Breath	3.0

Results
Healthcare Utilization

- **Median of 3.6 tests were administered**
  - **13.1% had 0 tests ordered**
  - **14.0% had 10 or more tests ordered**
- **Despite the small number of CNS diagnoses CT/MRI increased 169% from 1995 – 2004**
  - **Rates of use greatest for ≥ 65 years (38% of visits)**
  - **However, the largest increase (281%) for 20-44 year olds**
  - **For every 1 year age increase = 14% increase in the odds of having a CT or MRI**

Results
Length of Stay (LOS)

- **3.0 hrs = median LOS in the ED**
- **More than 20% of visits for dizziness/vertigo resulted in hospital admission (older patients)**

Discussion

- Vertigo/dizziness visits to the ED are increasing
- Not clear why
  - American Stroke Association has instructed patients to call 911 immediately
  - Lack of education of non-ED physicians who instruct patients to come to ED if acutely dizzy/vertiginous

Discussion

- CT and MRI referrals in dizziness/vertigo has increased dramatically
- Not clear what benefits are derived from imaging (considering the low yield of CNS pathology)

Discussion

- **Rate of CNS diagnoses did not increase with rate of imaging referrals**
  - **Stroke in the posterior circulation occurred in 3.2% - 3.9% of all dizziness visits**
  - **Stroke is the primary CNS rule-out**
  - ***"…no study [yet] presents a validated method for discriminating [at bedside] dizziness caused by stroke from non-stroke causes…"***

Discussion

- **Re: imaging**
  - **Sensitivity to acute stroke very low**
  - **May be contributing to increased (LOS)**
- **"*A clinical decision rule assessing stroke risk could make an important contribution to optimizing neuroimaging utilization and patient care.*"**

ORIGINAL RESEARCH CONTRIBUTION

Rising Annual Costs of Dizziness Presentations to U.S. Emergency Departments

Ali S. Saber Tehrani, MD, Diarmuid Coughlan, MPharm, MSc, Yu Hsiang Hsieh, PhD, MS, Georgios Mantokoudis, MD, Fredrick K. Korley, MD, Kevin A. Kerber, MD, MS, Kevin D. Frick, PhD, and David E. Newman-Toker, MD, PhD

Epidemiology of Dizziness and Vertigo in the ED

- **2M visits to the ED each year for dizziness or vertigo**
- **Dizziness and vertigo constitute ~4.4% of symptoms for awake patients in the ED**
- **Patients have longer LOS and undergo more tests than patient w-o dizziness and vertigo**
- **Neuroimaging (CT and MRI) over-used despite low sensitivity**

Purpose of the Investigation

- **Primary outcome was to obtain an estimate of:**
  - **total national annual costs of managing dizziness and vertigo in the ED, and,**
  - **what fraction of annual total ED costs did this represent.**

Sample for Analysis

- **15 year sample**
- **Dizziness and vertigo visits - N = 12,202**
- **Non-dizziness and vertigo visits - N = 360,424**
- **Trend for visits for dizziness and vertigo to increase over years:**
  - **1995 = 2.0M visits**
  - **2000 = 2.8M visits**
  - **2005 = 3.0M visits**
  - **2009 = 3.8M visits**

Percent of Visits for Dizziness and Vertigo

Stable from 2000

Year	Percent of total patients attributable to dizziness/vertigo
1995	2.7
2000	3.4
2005	3.4
2009	3.6

Effect of Age on Visits to the ED for Dizziness or Vertigo

Hint: There is no effect

Year surveyed	Percent of total visits to ED for dizziness/vertigo for patients ≥ 65 yrs
1995	25.6
2000	31.9
2005	29.7
2009	28.5

Percent Increase in CT Scan Use in the ED for Dizziness and Vertigo

Year	% increase in CT scan use
1995	9.4
2000	17.1
2005	22.8
2009	37.4

Proportion of dizzy/vertiginous patients having MRI = 96.3% vs non-dizzy/vertiginous patients = 48.3%
Proportion of dizzy/vertiginous patients having CT = 87.6% vs 50% non-dizzy/vertiginous patients = 50.0%

Results

- Projected total dizziness/vertigo patients to ED = 3.9M
- From 1995-2011
  - Dizziness visits increased from 2.0-3.9M (97% increase)
  - Non-dizziness visits increased from 70.7- 101.9M (44% increase)
- Dizziness visits are increasing out of proportion to all ED visits

Result

- Average cost per dizziness visit = $1,004
- Total estimated cost of dizziness and vertigo in the ED was $3.9B in 2011
- ED costs were (unexpectedly) lower for those ≥ 65 years
  - However, inpatient costs were higher for elders (more elders were admitted)
- $360M spent on head non-contrast CT scans of the head.
- $110M spent on non-contrast MRI of the head

Results

- Otologic and vestibular causes were the most common diagnoses seen in the ED.
- Cost estimate of $3.9B is 70% higher than a national estimate in 1992 ($2.32B in 2011 dollars)
- Increase reflects increase in ED visits imaged…
  - in 1992 out of 2.0M, *10% imaged* &
  - in 2011 out of 3.9M, *40% imaged*
- Yet yield from imaging is low for patients with dizziness or vertigo who lack clear neurologic signs even when stroke is the cause

Conclusions

- **~$4B/yr is spent on patients who present to the ED with complaints of dizziness or vertigo**
- **Diagnostic testing is responsible for a large part of the costs (est. $470M+ for neuroimaging alone)**
- **Costs could be reduced if tests could be limited to those patients with neurological symptoms**

Conclusions

- **"*…greater attention should be paid to streamlining diagnostic evaluations of dizziness and vertigo.*"**
- **"Future economic analyses should measure the specific breakdown and principal drivers of total costs. *New diagnostic pathways should be assessed for both their cost-effectiveness and outcomes.*"**

"The Proposal"

Devin L. McCaslin, Ph.D.

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

David E. Newman-Toker, MD, PhD, Kevin A. Kerber, MD, MS, Yu-Hsiang Hsieh, PhD, John H. Pula, MD, Rodney Omron, MD, Ali S. Saber Tehrani, MD, Georgios Mantokoudis, MD, Daniel F. Hanley, MD, David S. Zee, MD,and Jorge C. Kattah, MD

Academic Emergency Medicine, (20): 987–996, 2013

Background

- Dizziness and vertigo account for about 4 million emergency department (ED) visits annually in the United States, and some 160,000 to 240,000 (4% to 6%) have cerebrovascular causes.
- Stroke diagnosis in ED patients with vertigo/dizziness is challenging because the majority have no obvious focal neurologic signs at initial presentation.

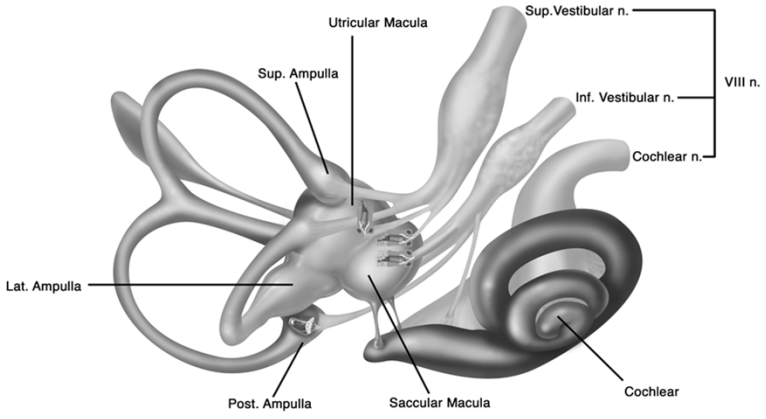
The Problem

- Vestibular strokes may be misdiagnosed as a benign peripheral vestibular disorder (Li et al., 2000)
- In referral cases, more than half of ED ear diagnoses are revised (Moulin et al. 2003).
- A VOG-guided decision rule may offer a way to discriminate between central and peripheral causes of vertigo.

The Problem

- A patient presents to the ED with:
  - Dizziness
  - Nausea
  - Vomiting
  - Unsteady gait
  - Headache
- These symptoms can be generated by central or peripheral impairments.

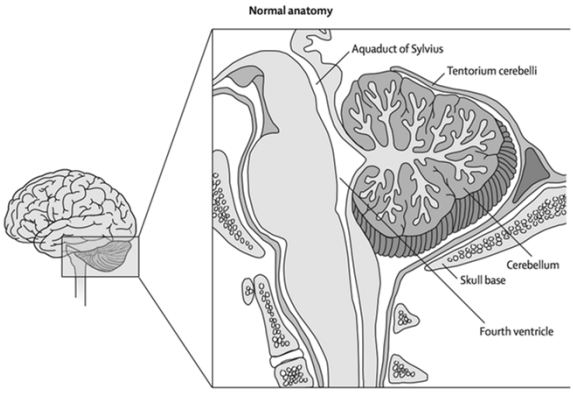
Peripheral Vestibular System



Posterior Circulation Strokes

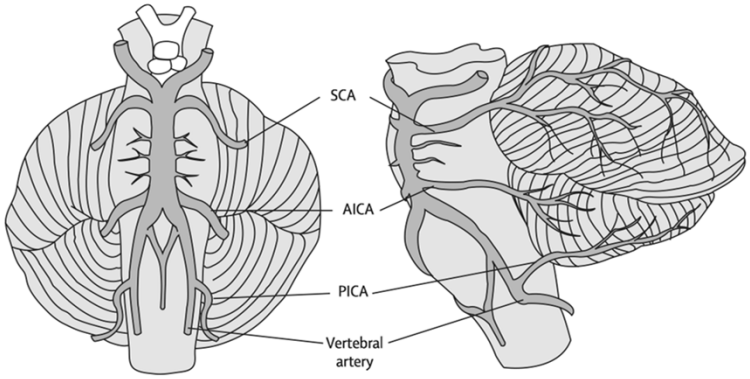
- When vestibular symptoms are of cerebrovascular cause, over 90% are ischemic strokes in the vertebrobasilar (posterior) circulation (Tarnutzer et al, 2007).
- How can one determine if the impairment is peripheral or central? MRI?

Posterior Fossa



Edlow et al., *Lancet Neurol,* 2008

Posterior Circulation Stroke



Edlow et al., *Lancet Neurol,* 2008

MRI Diffusion Weighting Imaging

- MRI in the diagnosis of a posterior circulation stroke
  - It has been shown that false negatives can occur in a subset of stroke patients early on.
  - Has been reported that there is a substantial false negative rate in the first 24 hours.
  - Can be dangerous to rely solely on MRI in the acute phase.

The Study

- The authors compared the accuracy of two bedside approaches for screening for possible stroke in patients with dizziness
  - H.I.N.T.S.
  - ABCD2-Clinical decision rule to assess short term risk of stroke in patients with TIA (age, blood pressure, clinical features, duration of symptoms, diabetes).

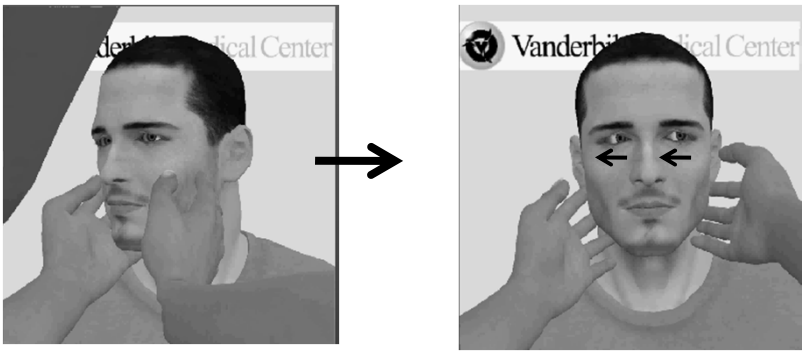
What is the HINTS exam

- Three step clinical decision rule:
  - Composed of three eye movement exams that have been suggested to be critical in differentiating peripheral from central impairments of acute <u>continuous</u> vertigo/dizziness (not transient-BPPV).
    - Head impulse
    - Nystagmus type
    - Test of skew

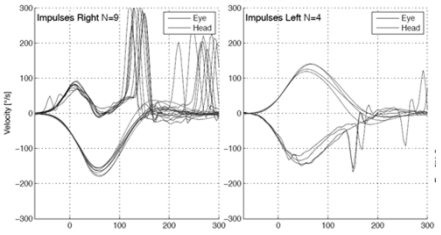
"H.I.N.T.S."-"I.N.F.A.R.C.T."

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)

Physiology of HINTS Tests



Physiology of HINTS tests



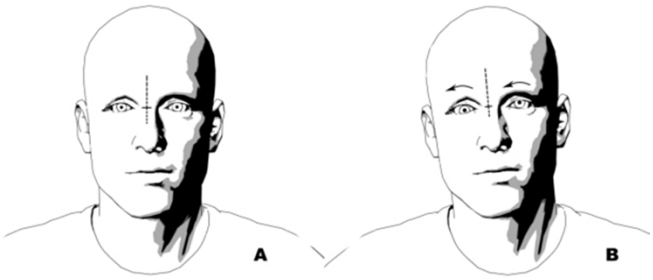
Physiology of HINTS tests

- Acute Spontaneous Nystagmus
  - Present without provocation
  - Will diminish in amplitude with fixation
  - Is direction fixed (follows Alexander's law).
  - Beats in the direction opposite the side of the impairment.

Physiology of HINTS tests

- Test of skew deviation (vertical misalignment of the eyes)
  - Can assess using the alternate cover test
  - Ask patient to look at a fixed target, alternately cover each eye, occlude each eye one after the other.
  - In a patient that has an acute central vestibular impairment, the neural mechanism that controls the vertical position of the eyes is impaired
  - In these cases one eye will be higher than the other.

Subjective Visual Vertical



McCaslin et al., *Balance Function Assessment and Management,* 2008

Hearing Test

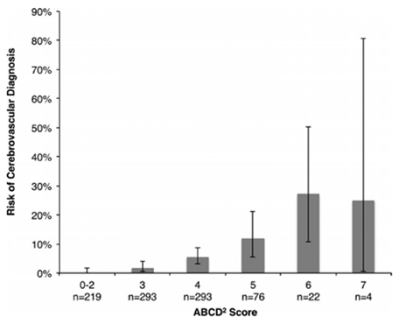
- A fourth step (H.I.N.T.S. “plus”) includes assessing the presence of new hearing loss.
- The hearing loss is typically unilateral and on the side of the abnormal head impulse test (the side opposite the fast phase of the nystagmus).

Is it a Peripheral Impairment?

- Looking for a pattern of findings:
  - Abnormal head impulse test
  - Direction-fixed spontaneous nystagmus that follows Alexander’s law.
  - No evidence of skew deviation (normal vertical alignment of the eyes.

ABCD2

- The ABCD2 is a risk prediction score (range 0 to 7) that assigns points based on five elements.



Navi et al., S*troke,* 2012

ABCD2

Five-item ABCD2 risk score	Stroke findings: risk score ≥ 4
Age	>60 years = 1
Blood Pressure	Systolic > 140 or diastolic >90 = 1
Clinical features	Unilateral weakness = 2, speech disturbance without weakness = 1, any other symptom = 0
Duration of symptoms	<10 minutes = 0, 10-59 minutes = 1; >60 min = 2
Diabetes	Present = 1

Is it a Central Impairment?

- Central patterns included
  - bilaterally normal head impulse with any spontaneous or gaze-evoked nystagmus.
  - bilateral, direction-changing, horizontal gaze-evoked nystagmus (or predominantly vertical or torsional nystagmus)
  - skew deviation by alternate cover test
  - any combination of these.

Methods

- Cross-sectional study of high-risk patients (190) (more than one stroke risk factor).
  - acute vestibular syndrome.
  - acute, persistent vertigo or dizziness with nystagmus.
  - nausea or vomiting.
  - head motion intolerance.
  - new gait unsteadiness.

Methods

- All patients underwent and neurotology examination, neuroimaging (97.4% by magnetic resonance imaging [MRI]), and follow-up.
- ABCD2 risk scores (0–7 points), using the recommended cutoff of ≥4 for stroke, were compared to a three-component eye movement battery (HINTS).

Methods

- Sensitivity, specificity, and positive and negative likelihood ratios (LR+, LR–) were assessed for stroke and other central causes, and the results were stratified by age.
- False-negative initial neuroimaging was also assessed.

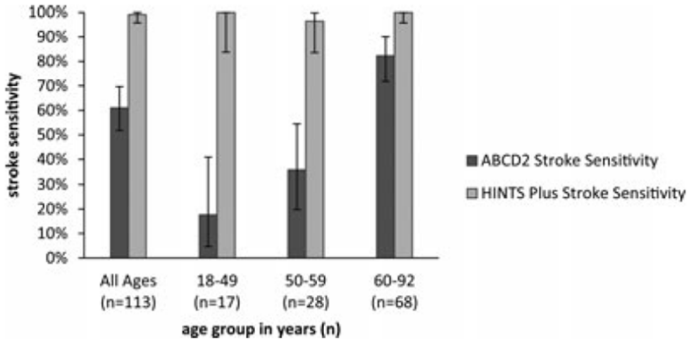
Study Diagnoses

- Final diagnoses:
  - Vestibular neuritis (34.7%)
  - posterior fossa stroke (59.5% [105 infarctions, eight hemorrhages])
  - other central causes (5.8%).

ABCD2 vs. HINTS

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)				
Sensitivity for stroke	61.1 (51.8–69.7)	90.3 (83.7–94.8)	96.5 (91.7–98.9)	99.1 (95.7–100.0)
Specificity 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)
LR+ stroke	1.62 (1.17–2.24)	6.95 (3.89–12.43)	6.19 (3.68–10.42)	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)				
Sensitivity for central	58.1 (49.2–66.5)	91.1 (85.1–95.3)	96.8 (92.4–99.0)	99.2 (96.1–100.0)
Specificity for central	60.6 (48.5–71.8)	100.0 (95.6–100.0)	98.5 (92.8–99.9)	97.0 (90.4–99.5)
LR+ any central cause	1.47 (1.05–2.06)	>91.1‡ (NC)	63.9 (9.13–446.85)	32.7 (8.36–128.16)
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

Performance



MRI Performance

- Initial MRIs were falsely negative in 15 of 105 (14.3%) infarctions (all but one was obtained before 48 hours after onset)
- All strokes were confirmed by delayed MRI.

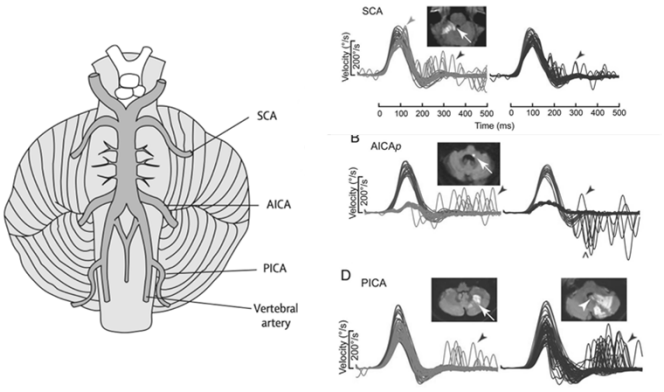
Conclusions

- The HINTS decision rule outperformed ABCD2 for detecting stroke and other central causes in AVS.
- The HINTS approach was more sensitive for stroke than MRI-DWI in the first 48 hours after symptom onset.

Conclusions

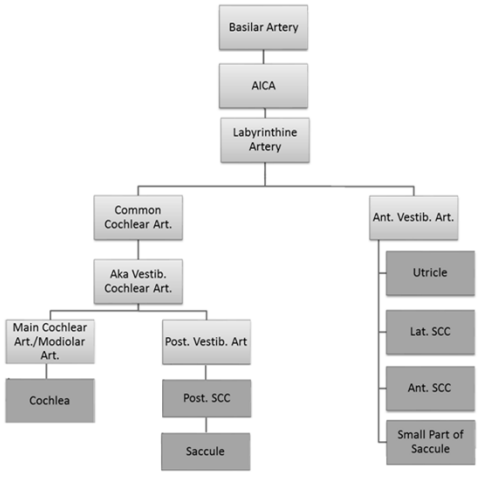
- Use of HINTS may provide a way for differentiating AVS from stroke when clinicians have appropriate training.
- For AVS patients with negative early magnetic resonance imaging but HINTS signs suggestive of stroke and MRI may be warranted 3 to 7 days after symptom onset.

Abnormal vHIT Due to Posterior Circulation Strokes



Edlow et al., *Lancet Neurol,* 2008

Chen et al., *Neurology*, 2014



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